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# Development of a Portable Solar Generator

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**Abstract:** This study aims to develop a portable solar generator system. One of the considerable aspects is to design a suitable solar tracking system and create a suitable sizing for the system. In addition, the dissimilarity between the type of photovoltaic modules was studied to make sure the Solar Energy Generation Systems (SEGS) operates with the most effective type of photovoltaic (PV) module. The Battery Storage System is protected and controlled by a charge controller. The outcomes from the result obtained for power comparison between the single axis and dual axis clearly shows that the dual axis can improve the efficiency of the solar panel by moving and tracking the movement of the sun. Charging mobile phones and laptops show that the inverter was correctly chosen and it was able to support the power needed by the load. From the experiment conducted throughout the development of the work, the portable solar generator manages to charge mobile phones and laptops.

**Keywords:** Solar Energy Generation System, Solar Tracking System, Battery, Charge Controller, Inverter

## 1.0 INTRODUCTION

Electricity generation in our country depends on the burning of fossil fuels such as coal, oil, and gas. This led to many consequences such as climate change and global warming. Due to this pandemic, most people are working, studying, and even shopping online at home. This situation makes electricity one of the important needs in the home to finish important tasks or jobs [1]. Malaysia is located near the equator which gives this country able noontime sunlight that can be used to generate power [2].

The portable solar generator is an electricity generation system that can be used to connect electricity load. It is a good alternative as it is a sustainable energy [3]. They are very suitable and useful if the is no electricity supply in that area or if power fails at home as it is portable. The solar panel will turn sunlight into electricity. The most solar panel is a fixed axis and will not move if there is any shadow blocking [4].

To increase the efficiency of the solar panel this project will be planning a dual-axis solar tracker. The dual-axis solar tracker will turn the solar panel to the highest sunlight available [5]. The energy produced by the solar panel will be stored in a battery. This paper will relate the development of a portable solar generator that can be used to charge mobile phones, laptops, and power up Wireless Fidelity (Wi-Fi) modems [6].

Due to this pandemic situation, most people working, studying, and even shopping online from home to reduce the chances of getting infected by Corona Virus 2019 (COVID-19). Electricity nowadays is very important, especially during this pandemic when people study and work from home. Power failures or no electricity supply at a certain time or place will affect people's life [7]. Furthermore, PV modules depend on the amount of solar radiation received to produce the required amount of electrical power. The output is not fully optimized, and it will be a waste as Malaysia is blessed with stable sun time [8].

This project aims to design a reliable solar tracking system using a Light Dependent Resistor (LDR) to increase and maximize the output produced by the solar panel. By using LDR this project aims to develop a dual-axis solar tracker. On the other hand, the objective of this project is to develop a portable solar generator that can be used to supply or charge different types of loads such as laptops, mobile phones, and Wi-Fi modems.

## 2.0 METHODOLOGY

### 2.1 Introduction

Sun-powered energy is yet viewed as another energy supply in Malaysia [9]. The use of sunlight based as an energy provider is very late whenever contrasted with another energy provider. It began in 2012 and the energy input in power stations is exceptionally low contrasted with other

Energy providers. According to the statistics from Malaysia Energy Information Hub, Malaysia relies heavily on fossil sources such as natural gas (41.9%), crude oil, petroleum products, and others (30%), and coal and coke (30%). However, from 1997 to 2017 the usage of fossil fuels decreased due to the cost of the fossil fuels themselves and the emergence of sustainable energy as energy input in Malaysia [10].

**2.2 Solar Tracker System**

A solar tracker is a mechanism that follows the sun's movement across the sky. When solar trackers and PV modules are combined, the modules may follow the sun's course and give users more environmentally friendly power. [11]. Solar tracker hardware is typically involved with the racking of PV panels. From that moment forward, the PV modules will follow the sun's path. There are various types of sun trackers, including:

**A. Manual solar tracker**
Manual trackers expect somebody to genuinely change the PV panels on various occasions for the day to follow the sun. This isn't generally pragmatic, as you want somebody to continually screen the sun and change the position of the PV modules.

**B. Passive solar tracker**
Passive trackers contain a fluid with a low edge boiling point that will dissipate when presented with sunlight radiation. At the point when the fluid vanishes, the PV modules framework becomes imbalanced. This imbalance makes the PV modules slant towards the area of the sunlight beam.

**2.3 Active solar tracker**

A motor or hydraulic cylinder regulates the orientation of an active solar tracker. The PV modules in an active solar tracker will be moved toward the sun by the motor. While this is more convenient than manual trackers, the motor's working parts may not get much of a rest. This could result in greater maintenance expenditures during the framework's lifetime.

**A. Single-Axis Solar Tracker**

There are two types of single-axis trackers horizontal-axis trackers and vertical-axis trackers. Single-axis solar tracker is low-priced and exceptionally straightforward in setting up and running at low cost. It also suits organizations that need a minimal expense option. Furthermore, it has superior productivity compared with a PV module in a fixed structure. These are commonly used in large-scale projects. The output of a single-axis solar tracker can be increased by 25% to 35% [12]. The basic principle of a single-axis solar tracker is depicted in Figure 1.

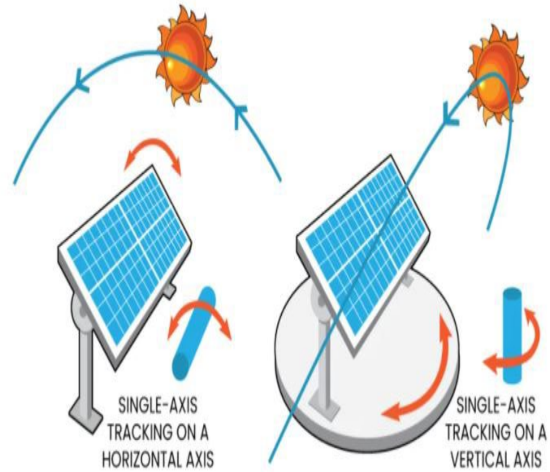


Figure 1: Single-Axis Solar Tracker

**B. Dual-Axis Solar Tracker**

Dual-axis solar trackers not just trail the sun as it moves from east to west, but they trail the sun as it moves from north to south. Dual-axis solar trackers are more normal among private and small-scale solar business activities that have restricted space, so they can create sufficient energy to meet their energy needs [13]. A dual-axis solar tracker can generate 40% more power than a fixed PV module. Besides, it also has more flexibility compared to the single-axis solar tracker and stationary PV module. The basic principle of a dual-axis solar tracker is depicted in Figure 2.

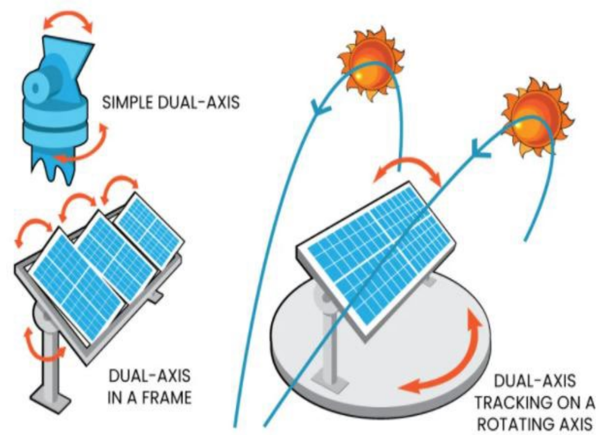


Figure 2: Dual-Axis Solar Tracker

**2.4 Solar Energy Generation System**

Solar energy generation system predominantly utilizes PV modules to turn sunlight into electricity [14]. The electricity generated can be stored in a battery or utilized straightforwardly relying upon their usage. Solar energy generation system comprises several components. These elements are selected based on the structure type, location, and purposes. The components of solar energy generation system are:

1. Solar Panel
2. Charge Controller
3. Battery
4. Inverter
5. Load

### A. Off-Grid Solar Generation System

Off-grid generation systems utilize sunlight that has been converted to electricity to charge the batteries, and this charge is then provided to the user when required [15]. The battery power either straightforwardly works the Direct Current (DC) loads such as DC lights or drives the power inverter that turns over the DC to AC power to power the machine such as water pump, lighting appliances, fridges, and so on [16]. This type of system is followed for any independent system whether it is a stand-alone device or appliance or a total off-grid network home. Off-grid solar generation systems are relatively small and simple [17]. Figure 3 shows the basic concept of an off-grid generation system.


Figure 3: Off-Grid Solar Generation System

Off-grid generation systems can be partitioned into more modest classes; direct-coupled and off-grid systems with batteries. The dissimilarity between direct-coupled and off-grid batteries is the presence of a battery. The direct-coupled supply electricity produced by PV modules is straightforward to the load while the off-grid system with batteries supplies electricity from the batteries. The direct-coupled system must be utilized during the day while the off-grid system with batteries can be utilized whenever because the power is kept in the battery.

### B. Grid-Connected Solar Generation System

Grid-connected generation systems adequately make a miniature power station and are connected to the utility grid. These are typically found in metropolitan regions where power is promptly accessible. During the day it transfers the unused power produced into the utility grid and during the evening and night, it uses the power from the utility grid. Here the utility grid becomes like a storehouse where power is taken from it when required [18]. Figure 4 shows the basic concept of a grid-connected solar generation system.

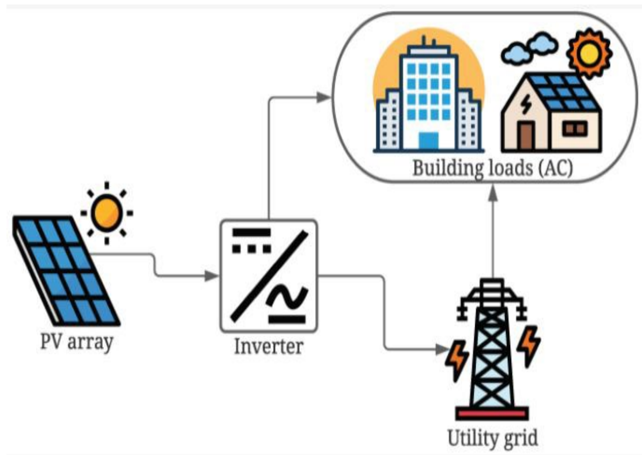


Figure 4: Grid-Connected Solar Generation System

A grid-connected generation system does not need to generate enough power to fulfill the entire power demand. Because of this, the system can be small-scale or large-scale upon the user's decision [19]. The user of the grid-connected system gets deducted for every kilowatt of electricity produced minus the usage from the utility grid supply which is called a Feed-In Tariff (FiT). This sort of establishment lessens the reliance on electric utilities and consequently diminishes the power bills.

### 2.5 Project Comparison

A portable solar generator system was already on the market. Most of the systems were designed with large-scale load applications with high power output. With large power output, it comes with a higher price but can be used for many applications. Due to budget and time constraints, this project offers lower output power but with an improvement of the solar tracking system. Other researchers such as Mahadzir Abdul Ghani, Nabilah Ishak, Suhaini Mohd, and Allya Badzura Baharuddin, have applied this design by the name of "Portable Lithium-Ion Solar Charger". They create a system just to store the energy produced the same as the current product in the market but just on small scale [5]. Another researcher, Awangko Arshaduddin Bin Awang

Zainudin applied the design with the enhancement of a solar tracking system (single axis) with his design [20].

**A.** Development of a Portable Solar Electricity Generating System by Awangko Arshaduddin Bin Awang Zainudin (2014).

The structure of the PV modules and the structure of the battery is attached which makes the system bulk and fragile. Other than that, the PV module is included with the single-axis solar tracker. Last but not least, the project uses a lead-acid battery with a low battery size.

**B.** Portable Lithium-Ion Solar Charger by Mahadzir Abdul Ghani, Nabilah Ishak, Suhaini Mohd and Allya Badzura Baharuddin (2013).

The structure of the PV modules and the structure of the battery was not attached. Other than that, the PV module does not have a solar tracking system which does not increase the efficiency of the solar panel. Finally, the system uses a Lithium-Ion battery with a low battery size.

**C.** Portable Solar Generator (in the current market).

The structure of the PV modules and the structure of the battery was not attached. Other than that, The PV module does not have a solar tracking system which does not increase the efficiency of the solar panel. Finally, the project uses a Lithium-Ion battery with a variety of battery sizes but at a higher cost.

## 3.0 MATERIALS AND METHODS

This Development of Portable Solar generators consists of two types of systems which were the portable solar generator and the dual-axis solar tracker. Dual-axis solar trackers not just trail the sun as it moves from east to our side it trails the sun as it moves from north to south. Dual-axis solar trackers are more normal among private and small-scale solar business activities that have restricted space, so they can create sufficient energy to meet their energy needs [3].

### 3.1 Block Diagram

As shown in Figure 5, the solar tracking system is the input for the generation system. The solar tracking system itself has an Arduino which acts as a processor, and LDR the input. While the solar tracking system is running, the produced electricity will flow towards the solar charge controller that will control the input for the battery so that no extra current or voltage enters the battery that could harm it. The electrical charge is stored in the battery. If any DC power is needed, the DC load can directly connect to the solar charge controller because it has the output socket for the DC load. If any AC power is needed, the energy stored from the battery will flow to the inverter and the inverter will convert DC power to AC power. The AC load can be connected to the socket outlet at the inverter.

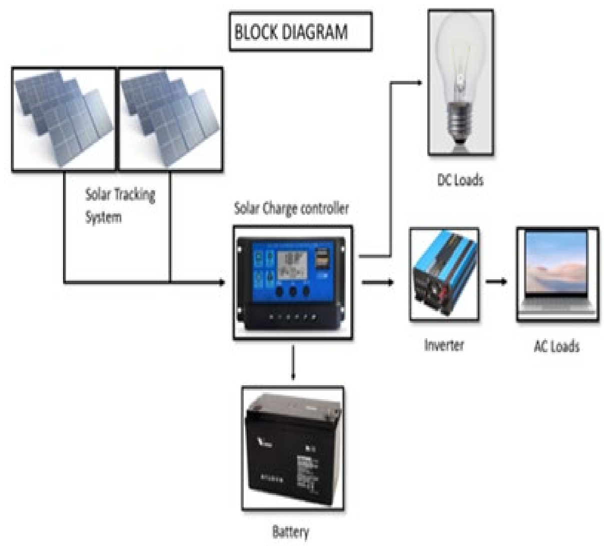


Figure 5: Block Diagram

### 3.2 Circuit Diagram

Figure 6 shows the connection between the input and output of the solar tracking system. Several types of components complete the circuit which are Arduino Uno, 4 LDR sensors, 4 resistors, 2 capacitors, 1 voltage regulator, and 2 servo motors. Every LDR will be connected to the resistor, and they will be connected to the input port of the Arduino as it acts as a sensor. The servo motors will relate to 2 capacitors and voltage regulators and will be connected to the output port of the Arduino.

Figure 7 shows the connection of the portable solar generator. Several types of components complete the circuit which are solar panel, charge controller, and power inverter. Energy from sunlight will be converted to electrical power by solar panel then transfer to charge controller. The charge controller will control the voltage from the solar panel from a fluctuated voltage into a fixed voltage, so it does not damage the battery. The energy will be stored in the battery and the battery will be connected to the power inverter so that an AC load can be used. The power inverter will convert the DC power to AC power, and it has a switch to preserve the energy if an AC load is not available.

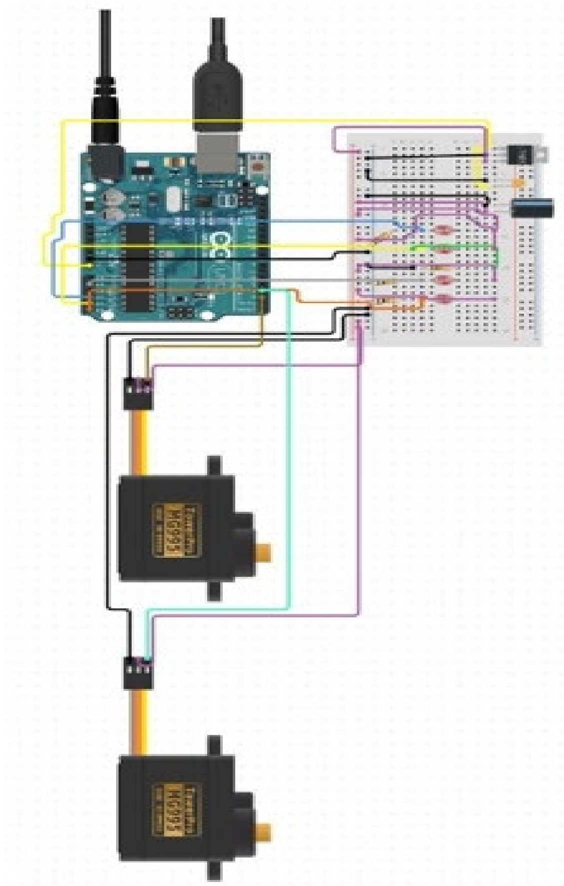

Figure 6: Circuit Diagram for Dual Axis Solar Tracker

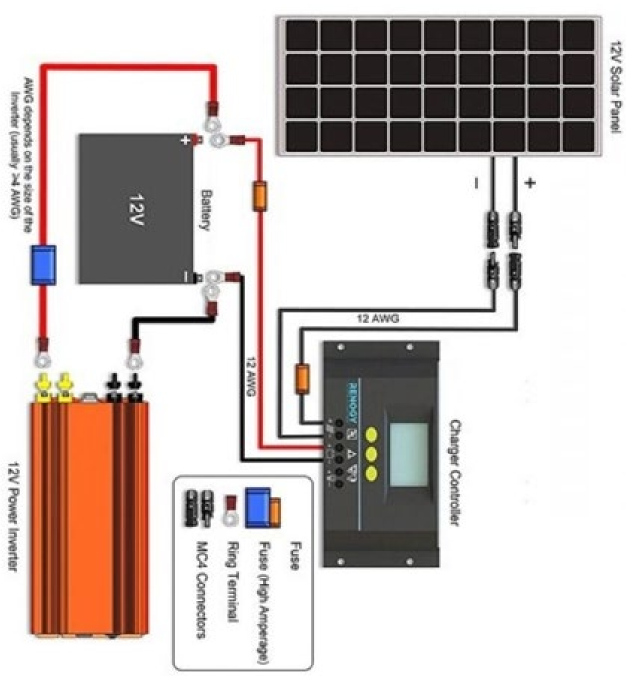


Figure 7: Circuit Diagram for Portable Solar Generator

### 3.3 Flowchart

As shown in Figure 8 below the flowchart depicted the process of the solar tracking system. The process starts when the presence of sunlight is detected by sensors which will send data to the controller. The controller then decides whether tracking is needed or not. If the tracking is needed the solar tracking system will determine which region has the highest intensity of sunlight and the controller will send the signal to the servo motor. The Servo motor will tilt and rotate the PV modules towards the highest intensity of light. If the tracking is not needed the controller will keep the current position where it already facing the highest intensity of sunlight.

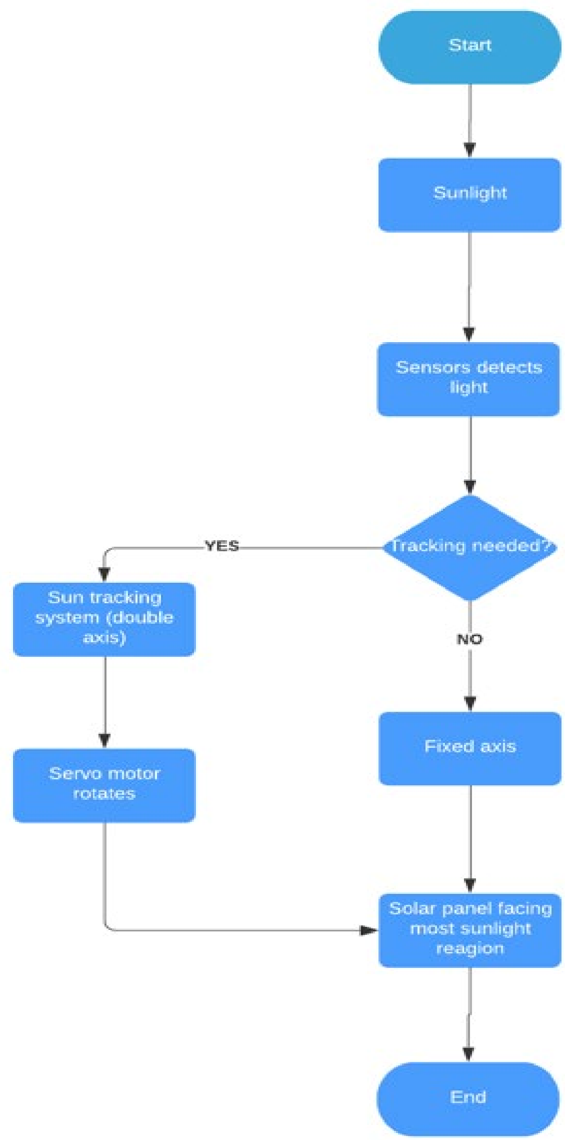


Figure 8: Flowchart

### 3.4 Materials

Table 1 shows the list of hardware equipment for this project. Software and hardware equipment are the two types of tools and equipment. The project's sketch or design is created using SketchUp software, and the system is programmed using the Arduino IDE.

**A. Dual-Axis Solar Tracker Components**

In all earlier sections, details of the block diagram and flowchart of the proposed dual axis were represented.

Table 1: List of Materials

| No. | Components | Function |
|---|---|---|
| **1.** | Arduino Uno | Control the input and output of the system |
| **2.** | 20W Solar Panel Monocrystalline | Convert sunlight to electrical power |
| **3.** | Servo Motor MG996R | Turn and tilt the PV modules |
| **4.** | Light Dependent Resistor | Act as a sensor that detects light |
| **5.** | Solar Charge Controller | Control current and voltage input for the battery |
| **6.** | Power Inverter | Convert DC power to AC power |
| **7.** | Lithium-Ion Battery | Store electrical energy. |
| **8.** | Handle | To ease the transport of the project |
| **9.** | Junction Box | Act as the structure of the project. |

The Photovoltaic (PV) panel used for hardware accomplishment is 20 watts and it's of monocrystalline type as shown in Figure 9. Two servo motors of static magnet types are used. The Servo motor moves in steps and is best suited for correct position control. Arduino Uno is used for controlling purposes that are less complicated to use as compared to microcontrollers such as Raspberry PI. Charge controllers were used to regulating the voltage and current from the solar panels reaching the battery. It prevents overcharging and will shield against overvoltage, which might scale back battery performance or period and will create a safety risk.

Figure 9: Monocrystalline Solar Module

**B. Portable Solar Generator Components**

The Rechargeable Lithium-Ion battery used for hardware accomplishment is 90Ah as shown in Figure 10. A power inverter rated at 300W is needed in this project to supply AC power to the AC load. The inverter will convert DC power from the PV modules to AC power. The project is an off-grid system so the inverter must be 3 times bigger than the total load so that the project works perfectly. Two socket outlets were installed so that the AC load can be connected easily. 12V DC car socket was also used so that the DC load can also be connected easily. Two emergency lights were installed to supply enough light in the absence of electricity.

Figure 10: Lithium Ion Battery

## 4.0 RESULTS

### 4.1 Comparison of Power Produced by Fixed Axis and Dual Axis Solar Tracker

The proposed system was placed in an open area for this experiment, and the data were analyzed. Two types of systems were tested which are fixed-axis solar tracker and double-axis solar tracker to identify which produced more power output. For fixed-axis solar panels, the panel was placed and tilted at 15 degrees which is the best tilt angle for Malaysia so that it can produce the most output power while the double-axis solar tracker has no fixed angle because it tracks the movement of the sun and faces the brightest region. This step is taken on two different days but at the same time. The results may be not accurate due to different light intensities on different days. The experiment was conducted on two different days because the same solar panel was used. The solar panel was connected to a charge controller to charge a battery that acts as a load. The measurement of output voltage and current were taken manually starting from 8.00 AM to 6.00 PM using a multimeter with a one-hour time gap.

Data collected in Table 2 shows that the highest power output obtained using a 20W solar panel module at a fixed axis is 12.03W. The power output increases from 8.00 to 14.00 and starts to decrease as the intensity of light decreases. The solar panel was tilted at 15 degrees which was the optimal module tilt angle in Malaysia.

Table 2: Fixed Solar Panel Output

| Time | DC Output Voltage (V) | Current (A) | Power (W) |
|---|---|---|---|
| **8.00 AM** | 6.14 | 0.01 | 0.08 |
| **9.0 AM** | 7.12 | 0.06 | 0.48 |
| **10.00 AM** | 12.34 | 0.76 | 9.38 |
| **11.00 AM** | 13.99 | 0.80 | 11.21 |
| **12.00 PM** | 14.05 | 0.76 | 10.69 |
| **1.00 PM** | 14.53 | 0.77 | 11.25 |
| **2.00 PM** | 14.49 | 0.83 | 12.03 |
| **3.00 PM** | 14.55 | 0.62 | 9.08 |
| **4.00 PM** | 12.34 | 0.56 | 6.91 |
| **5.00 PM** | 5.28 | 0.17 | 0.89 |
| **6.00 PM** | 5.27 | 0.11 | 0.58 |

Table 3 shows that the highest power output obtained using a 20W solar panel module at a fixed axis is 20.52W. The power output increases from 8.00 to 14.00 and starts to decrease as the intensity of light decreases. The solar panel was able to track the sun's movement at produce optimal module tilt angle all the time.

Table 3: Dual Axis Solar Tracker Output

| Time | DC Output Voltage (V) | Current (A) | Power (W) |
|---|---|---|---|
| **8.00 AM** | 7.51 | 0.07 | 0.51 |
| **9.00 AM** | 13.54 | 0.79 | 10.66 |
| **10.00 AM** | 17.31 | 0.99 | 17.16 |
| **11.00 AM** | 17.85 | 1.01 | 18.06 |
| **12.00 PM** | 18.07 | 1.04 | 18.75 |
| **1.00 PM** | 18.12 | 1.13 | 20.52 |
| **2.00 PM** | 17.54 | 0.94 | 16.43 |
| **3.00 PM** | 16.83 | 0.91 | 15.32 |
| **4.00 PM** | 16.74 | 0.88 | 14.67 |
| **5.00 PM** | 15.02 | 0.91 | 13.71 |
| **6.00 PM** | 9.40 | 0.44 | 4.14 |

The result depicted in Table 4 shows the information collected on output power in tabular form for two different systems. To perform a graphical comparison for these two systems by plotting two power curves with the assistance of knowledge collected in Table 4.

Table 4: Comparison of Output Power

| TIME | FIXED SOLAR PANEL (W) | DUAL AXIS TRACKER (W) |
|---|---|---|
| **8.00 AM** | 0.08 | 0.51 |
| **9.00 AM** | 0.48 | 10.66 |
| **10.00 AM** | 9.38 | 17.16 |
| **11.00 AM** | 11.21 | 18.06 |
| **12.00 PM** | 10.69 | 18.75 |
| **1.00 PM** | 11.25 | 20.52 |
| **2.00 PM** | 12.05 | 16.43 |
| **3.00 PM** | 9.08 | 15.32 |
| **4.00 PM** | 6.91 | 14.67 |
| **5.00 PM** | 0.89 | 13.71 |
| **6.00 PM** | 0.58 | 4.14 |

Figure 11 shows the graphical evaluation of output power for two different systems and those data were represented as experimental data. Graphical evaluation is undoubtedly showing the improved solar power conversion for dual-axis tracking cases. The dual axis is showing higher influence as compared to the fixed axis. It is due to the solar panel facing the highest intensity of light throughout the day. Dual axis system high power capturing property is clear from the graphical comparison.

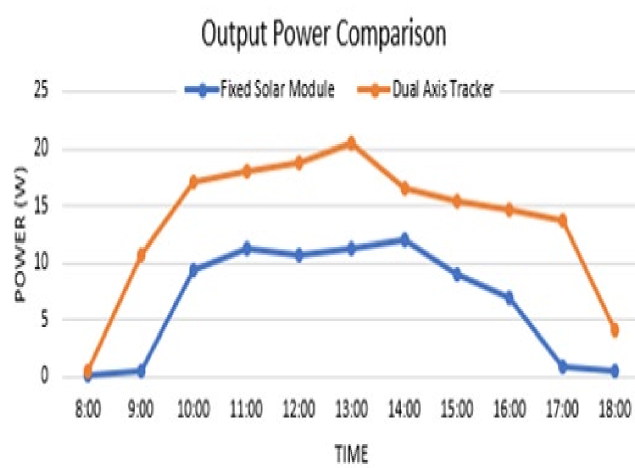


Figure 11: Graphical Output Power Comparison

### 4.2 Portable Solar Generator

The results of this experiment were achieved by connecting all the electronics and electrical components. The load was connected to the portable solar generator.

Figure 12 depicts the solar portable generator prototype and dual-axis solar panel. All the connections for the solar portable generator such as the battery, inverter, socket outlet, 12V DC car charging port, switch, and fan were installed in the box. The wire connected to the solar portable generator is the input power that was gained using a dual-axis solar panel that is used to charge the portable solar generator.

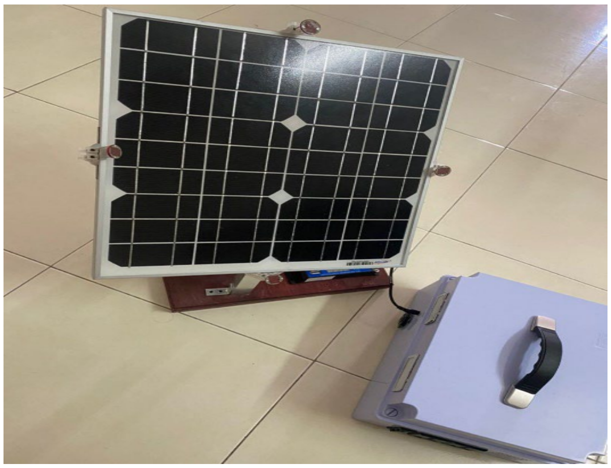

Figure 12: Prototype of the Project

Figure 13 depicts the solar portable side view which will show the switch, socket outlet, and ventilation system. The main switch function is to turn on the inverter and act as a safety and saving system so that it will only be turned on if power is needed. When the main switch is turned the socket outlet switch, and light switch can be turned on to be used.


Figure 13: Portable Solar Generator Sideview

Figure 14 depicts the solar portable side view which will show the handle, emergency light, charging port, and the 12V DC car socket. The handle is included in the design so that it is convenient for the user to transport the portable solar generator. As for the emergency light, it is included so that if there is no electrical supply and no light available it can be used to continue doing work. The charging ports were installed in that way so that it can be charged in two ways which are using the dual-axis solar panel or using an AC-DC converter for faster charging. Finally, the 12V DC car socket was installed for DC loads such as mobile phones.

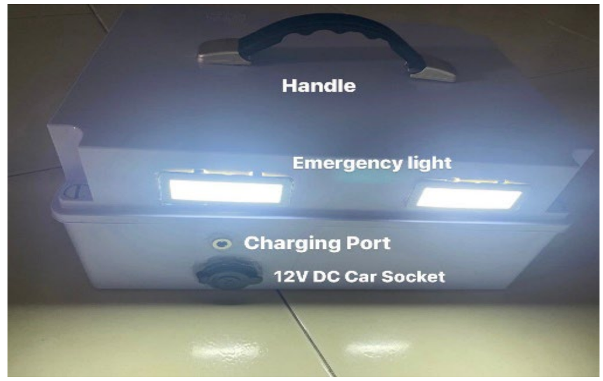


Figure 14: Portable Solar Generator Front View

Figure 15 depicts the solar portable generator which will show the socket outlet that was used to charge a mobile phone. The load of the mobile phone charger consumes 18Watt/hour. The voltage and current output from the charger adapter is 9V 2A. With a capacity of 90Ah battery, the socket outlet can be used to charge mobile phones for 45 hours continuously. However, the mobile phone does not need a continuous supply. It can be unloaded when the battery capacity is full. For iPhone 11pro the battery capacity is 3190mAh so with the capacity of the battery 90000mAh, it can be fully charged 28 times.

Figure 15: Charging Mobile Phone

Figure 16 depicts the solar portable generator which is connected to the load. The socket outlet was used to charge a laptop. The load of the laptop adapter consumes 36Watt/hour which is double compared to a mobile phone. The voltage and current output from the charger adapter are 19.5V 3.3A. With a capacity of 90Ah battery, the socket outlet can be used for laptops for 27 hours continuously. However, a laptop does not need a continuous supply. It can be unloaded when the battery capacity is full. For iPhone 11pro the battery capacity is 4400mAh so with the capacity of the battery 90000mAh, it can be fully charged 20 times. As for both loads connected the total load is 7590mAh so both of the loads can be fully charged 11 times.

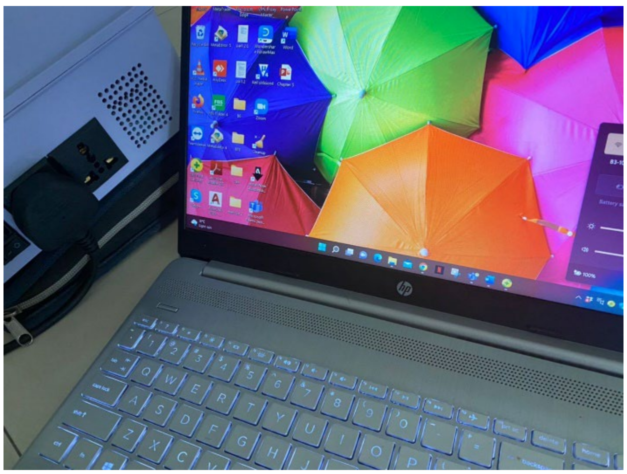

Figure 16: Charging Laptop

### 4.3 Light-Dependent Resistor

The results of this experiment were obtained by installing the dual-axis solar tracker device in an open location. This experimentation was conducted to observe the data from LDR from the Arduino IDE serial plotter which will show the resistance value of each of the LDR. The purpose of this experiment is to show the gap of resistance value between each other is not too big which depicts that all the LDR face the highest intensity of light from time to time.

Figure 17 shows the resistance value at 10.30 AM which the resistance value at the beginning of the serial plotter is high due to the low intensity of light. The differences between each other measurements are also low due to the dual-axis solar tracker.

Figure 18 shows the resistance value at noon when the resistance value of each LDR is low on the serial plotter due to the high light intensity. The differences between each other measurements are also low due to the dual-axis solar tracker. The difference between each LDR resistance value is below 10 ohms.

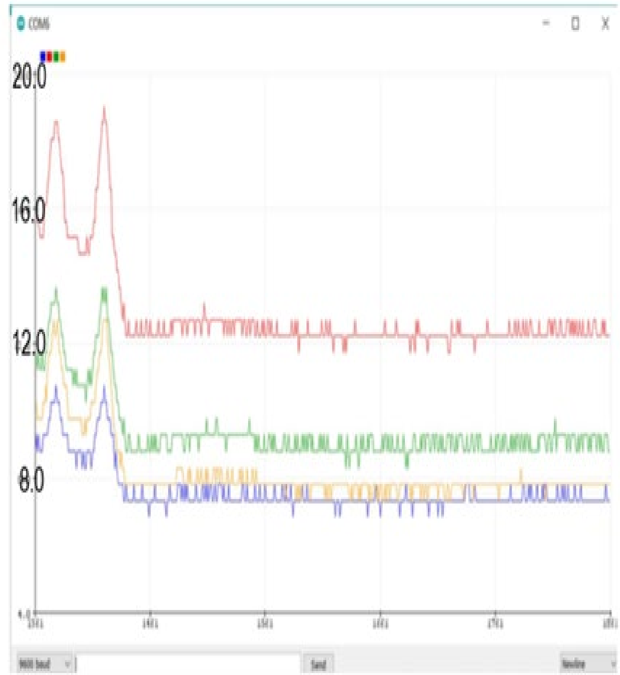


Figure 17: Resistance Value at 10.30 AM

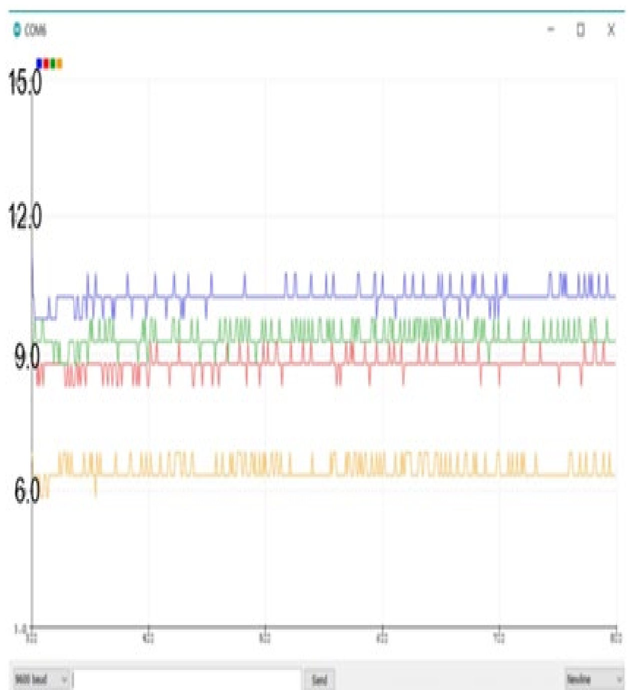


Figure 18: Resistance Value at 12 PM

Figure 19 shows the resistance value at 1.30 PM which the resistance value of each of the LDR is low on the serial plotter due to the high intensity of light. The differences between each other measurements are also low due to the dual-axis solar tracker. The difference between each LDR resistance value is below 10 ohms. The lowest is around 5 ohms while the highest is around 13ohm.

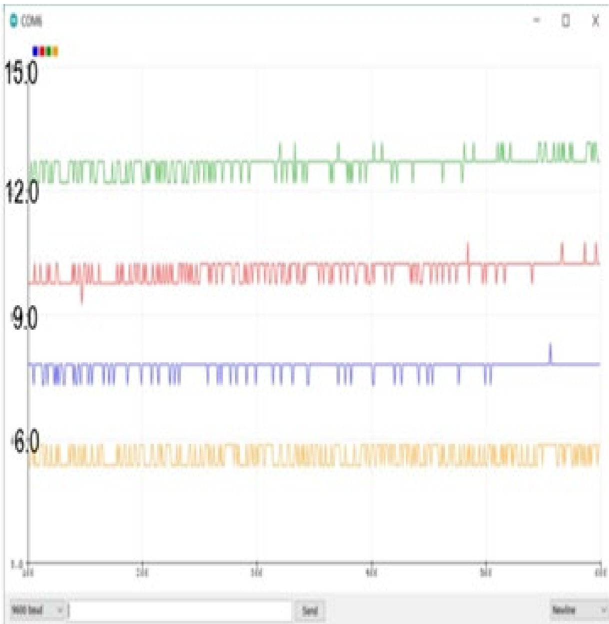

Figure 19: Resistance Value at 1.30 PM

Figure 20 shows the resistance value at 5 PM which the resistance value of each of the LDR is now increased from before on the serial plotter due to the low intensity of light during the evening. The differences between each other measurements are also low due to the dual-axis solar tracker. The differences between each LDR resistance value are below 10 ohms. The lowest is around 23 ohms while the highest is around 32ohm.

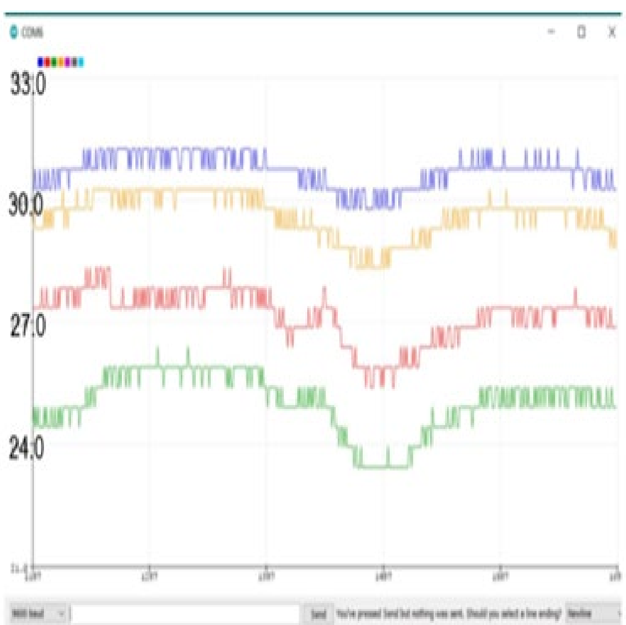

Figure 20: Resistance Value at 5.00 PM

Based on all the data collected, the resistance value of LDR starts decreasing from starting of the day until it reaches its peak time at 2.30 PM because LDR is exposed to higher intensity of light. After that, the resistance value increases throughout the day due to the lower intensity of light which is near dawn. The LDR also managed to get the differences between each other lower than 10ohm.

## 5.0 DISCUSSION AND ANALYSIS

Commercially, dual-axis solar tracking is still rare even in countries wherever a major part of electricity is being produced by solar energy as they claim that single-axis tracking is doing the work. However dual axis tracking will noticeably increase the potency. We've implemented this procedure on a sporadic power PV panel for our research work. Cost-effectiveness and proposed system potency may be discovered on a business level.

Dual axis tracker utterly aligns with the sun route and tracks the sun's movement in a very lot of cost-effective looms and includes a marvelous performance upgrade. The investigational outcomes clearly show that dual-axis tracking is good enough than single and fixed solar systems. The proposed system is value effective conjointly as a stroke adjustment in a single axis tracker provided notable power increase within the system. Through experiments, we've got found that dual-axis tracking will increase energy by about 40% of the fixed arrays. With a lot of work and higher systems, we tend to believe that this figure can raise more.

The outcomes from the result obtained for power comparison between the single axis and dual axis clearly shows that the dual axis could improve the efficiency of the solar panel by moving and tracking the movement of the sun. After that, charging mobile phones and laptops shows that the inverter was correctly chosen and it was able to support the power needed by the load. Finally, the result obtained from Arduino IDE was the resistance value of the LDR sensor able to keep the differences below 10ohm of each of the LDR clearly showing that the panel was facing the brightest region. From the test and results obtained the project is considered to be well-functioning and meet its objectives.

## 6.0 CONCLUSION

To sum up, everything that has been stated so far, the development of portable solar generators is to act as a backup supply that is portable that can be used whenever and wherever electricity is not there. It also can be charged using dual axis solar tracker that produces clean energy and will reduce the consumption of electricity from the utility provider. Dual axis solar tracker will increase the efficiency of the solar panel in converting the sunlight to electricity as proven in chapter 4 before.

All the planned work is accomplished successfully and on time. The feasibility study has been completed. The PV sizing analysis has been completed. The prototype was created, built, and tested. Thus, this project's objectives have been met.

## 7.0 RECOMMENDATION

The Development of a Portable Solar Generator with a dual-axis solar tracker is completed. But there is always room for improvement to make this design more efficient.

i. Make the structure stronger
By making the structure of dual-axis solar panels stronger, more solar panels can be added to the system hence will improve the charging time of the portable solar generator.

ii. Increase the inverter load capacity
By increasing the inverter load capacity, more loads can be used simultaneously or a higher power consumption load can be used using the portable solar generator.

iii. Change LDR to a more efficient sensor
LDR is good for a light-intensity application due to its low price, but it is affected by dust. A more efficient sensor will do the job more efficiently.

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