Design of mini electric car with electric charging using solar cells

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Abstract. The reduced reserves of fuel oil encourage people to create machine with alternative energy sources, while the needs of vehicles are increasing, the development of electric vehicles is getting more intense. The problem is electric vehicles that have been developed still have weaknesses, for example, requiring a lot of batteries, no charging system, and the price is relatively expensive. The research objective is to design an electric vehicle charging system using a solar cell. The electric car battery charging system is designed using batteries and 60Wp solar cells as a voltage generator. The results showed that the highest voltage of solar cell 60wp on the first day was 12 am with a voltage of 19.02 V with light intensity of 104000 Lux, while on the second day at 12 am with a voltage of 18.81 V with a light intensity of 81000 Lux, and on day The third is at 2 pm with a voltage of 18.37 V with a light intensity of 62000 Lux. The conclusion of the research is not always high light intensity the output voltage is high. Battery charging time in measurement that is about 4 hours 16 minutes.

1. Introduction

In the present day the reduced fuel oil reserves encourage humans to create machine with other alternative energy sources, for example the development of electric vehicles. The problem is, electric vehicles that have been developed still have weaknesses, for example, requires a lot of batteries, no charging system, and the price is relatively expensive. The research objective is to create an electric vehicle charging system using solar cells [1].

Research on solar cells has been done by many researchers before, both those who are researching about how to generate electrical energy with solar cells, improve the performance of solar cell output voltage, or who have been more specifically using solar cell output voltage to charge batteries. Solar cells or also often called photovoltaic are devices that are able to convert sunlight directly into electricity. Solar cells can be analogous to devices with two terminals or connections, where when conditions are dark or not enough light functions like a diode, and when illuminated with sunlight can produce voltage. When irradiated, generally a commercial solar cell produces a DC voltage of 0.5 to 1 volt, and a short-circuit current on a milliampere per cm^2 scale. This voltage and current are not enough for various applications, so generally a number of solar cells are arranged in series to form solar cell modules. One solar cell module usually consists of 28-36 solar cells, and the total produces a DC voltage of 12 V under standard irradiation conditions. The solar cell module can be combined in parallel or in series to increase the total voltage and output current according to the power needed for a particular application [1-3]. Illustration of solar cell modules as shown in Figure 1.

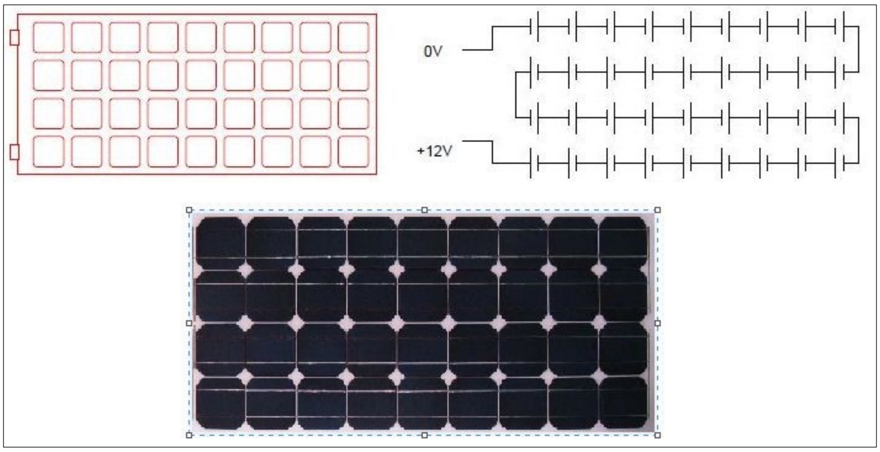

Figure 1. Solar cell modules with 28-36 solar cells arranged in series.

Conventional solar cells work using the principle of p-n junctions, which are junctions between p-type and n-type semiconductors. Semiconductors consist of atomic bonds in which there are electrons as the basic constituents. N-type semiconductors have excess electrons (negative charges), while p-type semiconductors have excess holes (positive charges) in their atomic structure. The role of the P-N junction is to form an electric field so that electrons (and holes) can be extracted by contact material to produce electricity [4,5,6]. How the solar cell works is illustrated as Figure 2.

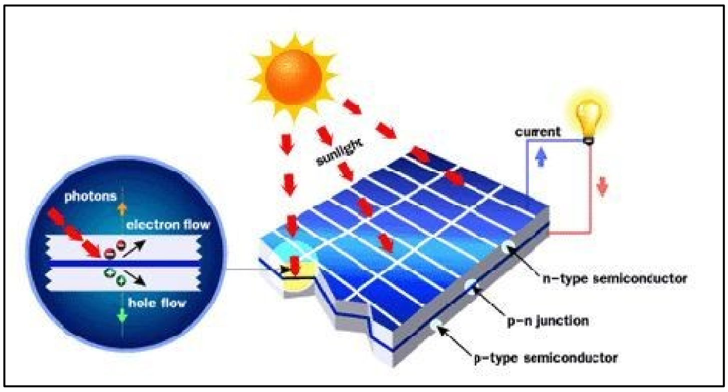

Figure 2. Illustration of how solar cells work with the p-n junction principle.

2. Methodology

This research was carried out in the workshop of the state polytechnic of Bengkalis with the first step in designing an electric car. After the design is carried out proceed with the making of a car and installing solar cell devices and others. After making the car is complete then proceed with taking the data voltage, current and light intensity. After all data can be analyzed, conclusions can be drawn. For more details, the flow of research shown in the form of Flowchart Figure 3.

This research is an experimental study, where data collection is carried out directly on the test equipment that has been prepared in the laboratory to test the independent variables and the dependent variable.

The independent variables in this study were the intensity of sunlight (08.00 AM - 04.00 PM) and the area of the solar cell (60WP) [4-6]. While the dependent variable is the output voltage of the solar cell.

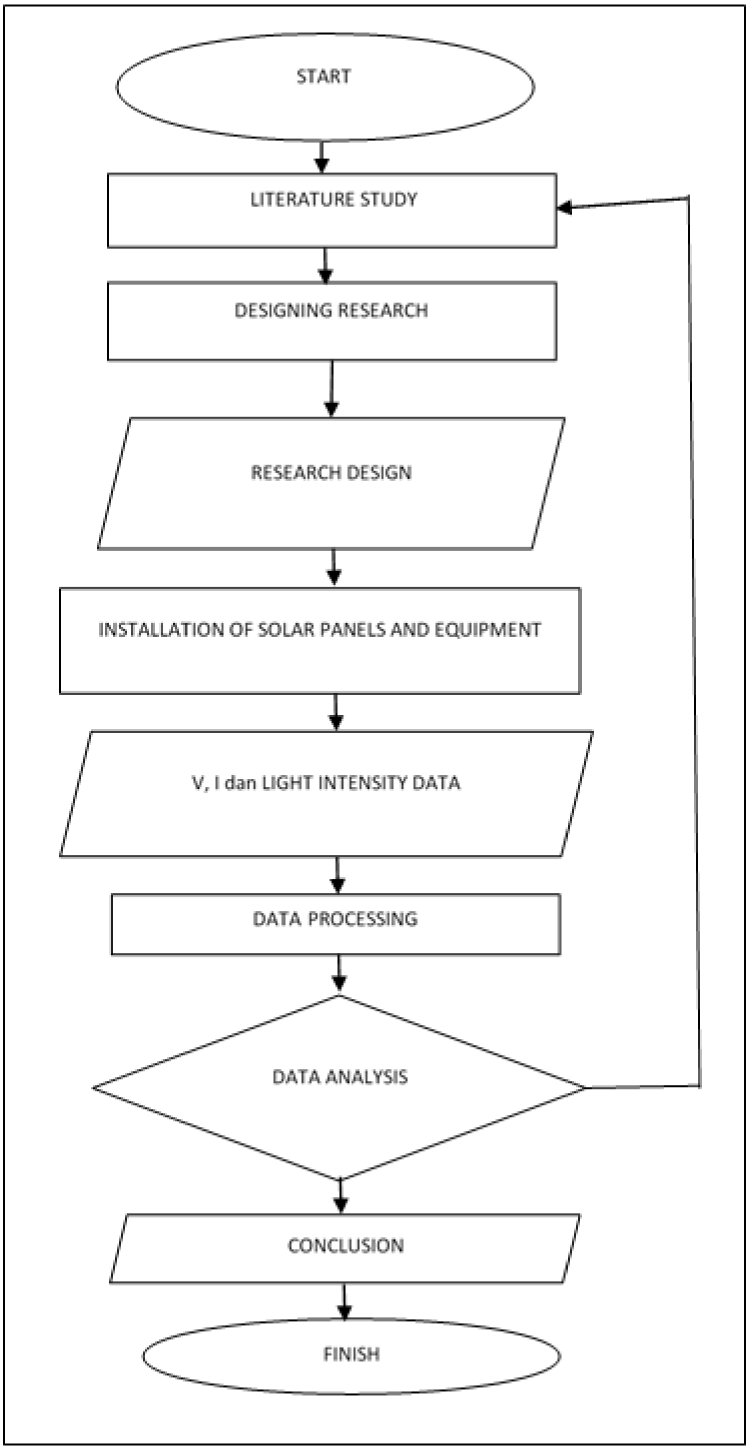

Figure 3. Research flowchart.

The research design to be used in this research is shown in Figure 4.

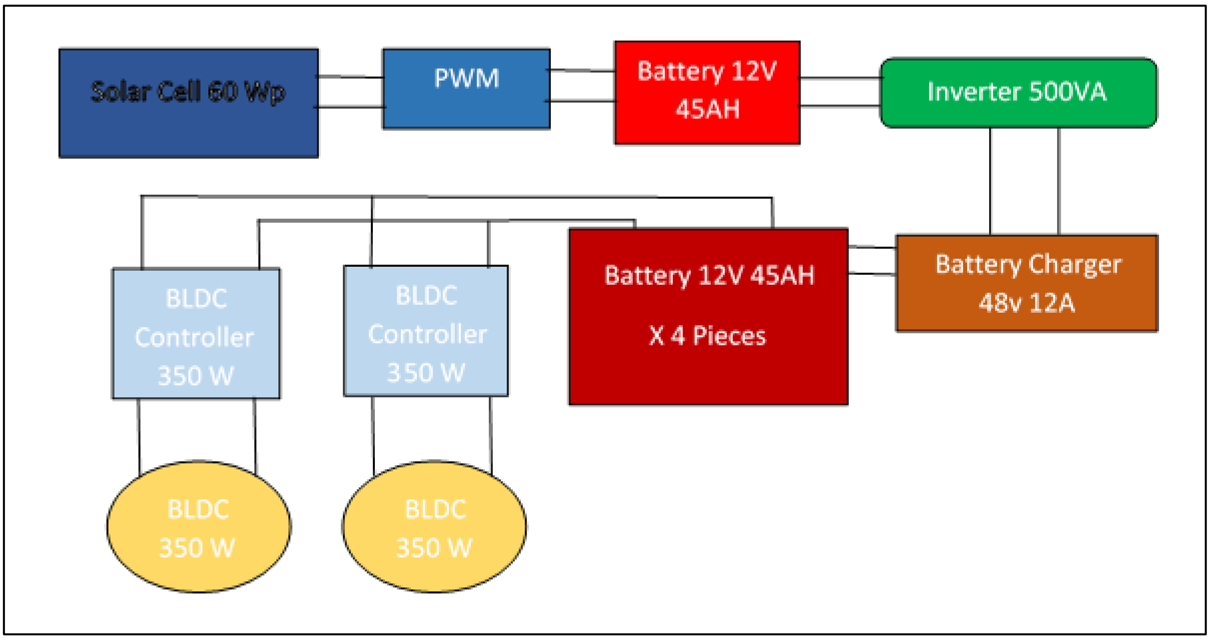

Figure 4. Research design.

The design of the Electric Car with solar cell that want to make in this research is shown in Figure 5, Figure 6.

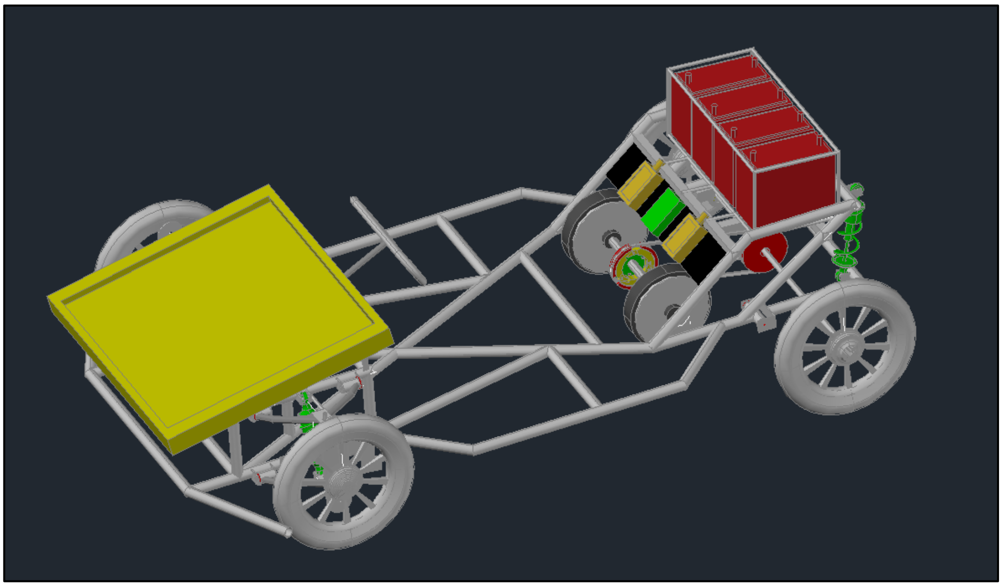

Figure 5. Car design.

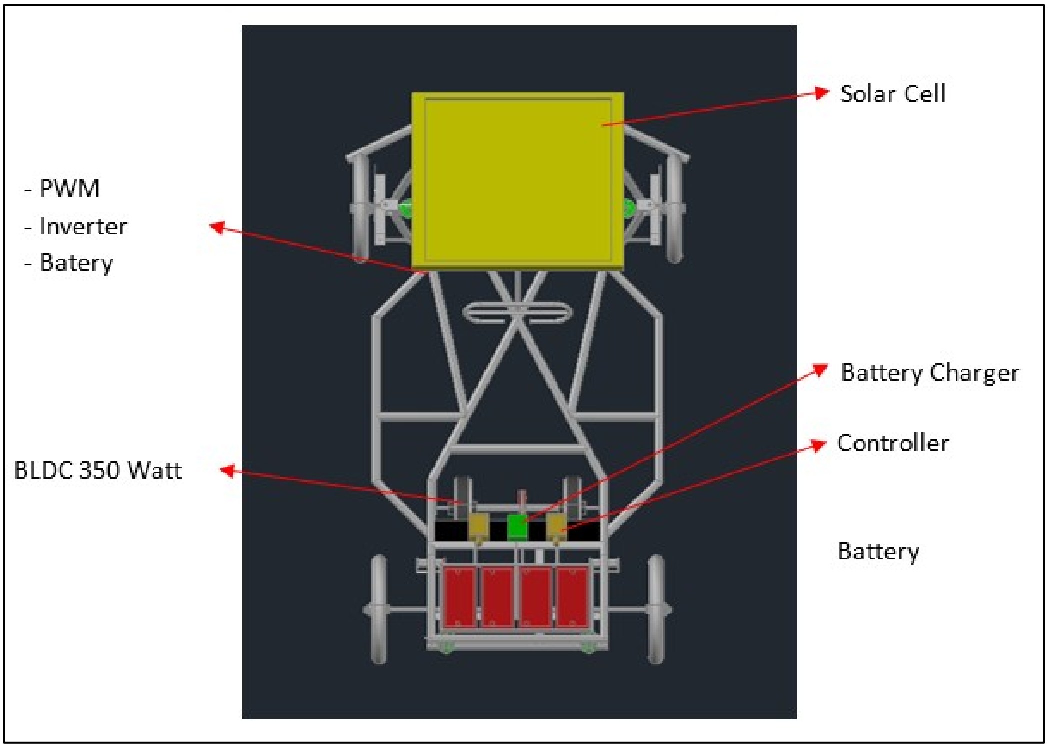

Figure 6. Description of the car.

3. Results and discussion

3.1. The relationship between time vs voltage, light intensity, and electric current

From the design of an electric car built as in Figure 7 and then taken data from the car.

Figure 7. Photograph the electric car.

From the data collection on the first, second, and third day, the data obtained as Table 1.

Table 1. V in, I in and light intensity data at 60Wp solar cell.

Time	Day	V in (Volt)	I in (Ampere)	Light Intensity (Lux)
8 am	1	18.45	3.04	56000
	2	18.55	3.02	64000
	3	18.25	3.07	51000
10 am	1	18.75	2.99	75000
	2	18.02	3.11	72000
	3	18.23	3.07	82000
12 am	1	19.02	2.94	104000
	2	18.81	2.98	81000
	3	18.34	3.05	84000
2 pm	1	18.63	3.01	83000
	2	18.26	3.07	78000
	3	18.37	3.05	62000
4 pm	1	17.89	3.13	68000
	2	18.17	3.08	71000
	3	17.67	2.77	45000

From the table above can be seen the relationship between time and voltage in Figure 8, the relationship between time and Light Intensity in Figure 9, and the relationship between time and Electric Current in Figure 10.

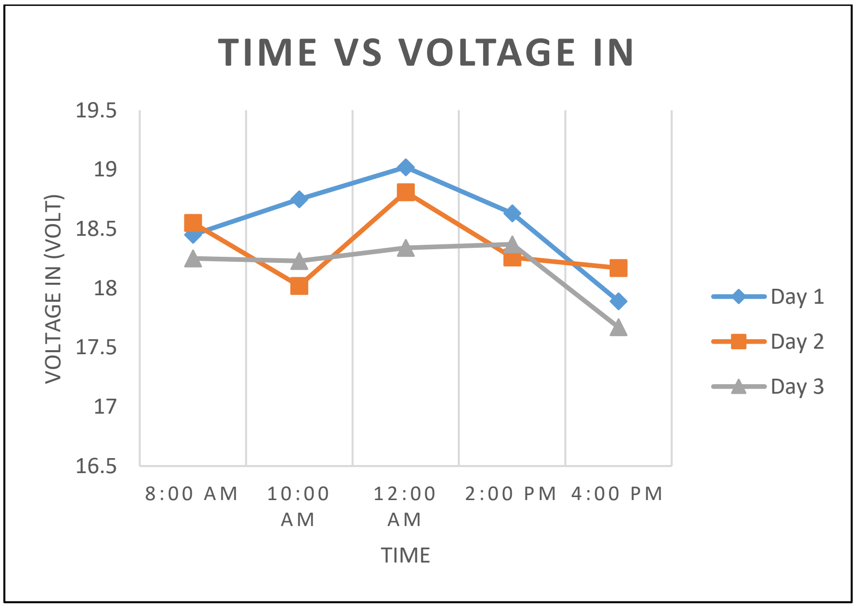

Figure 8. Time vs input voltage graph.

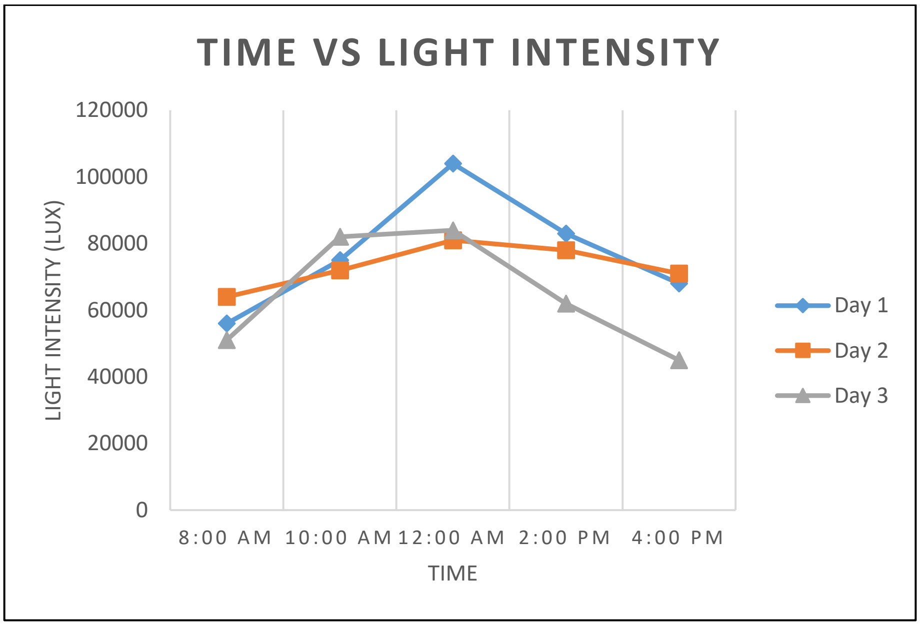

Figure 9. Time vs light intensity graph.

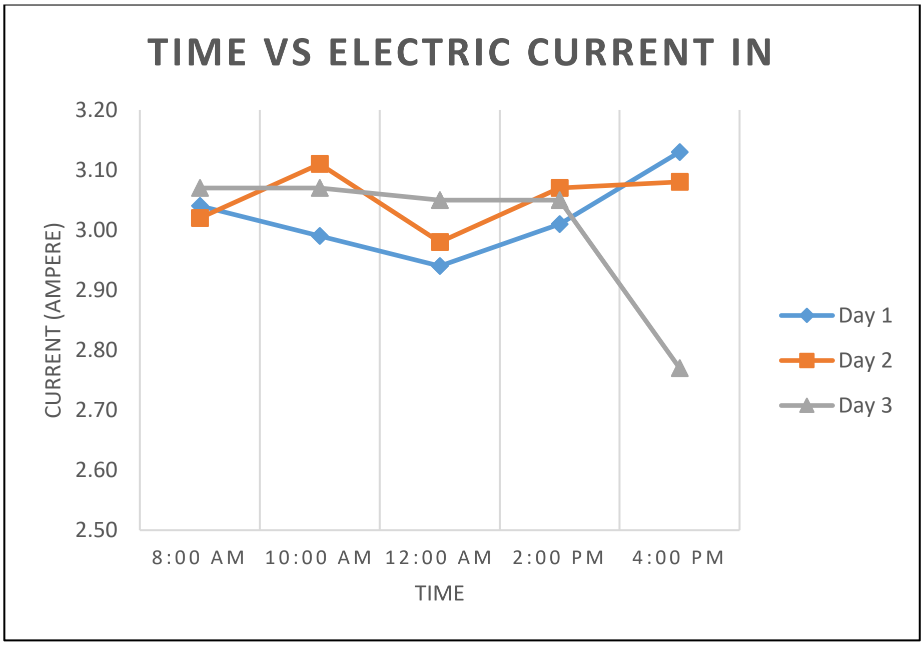

Figure 10. Time vs electric current in graph.

3.2. Analysis of 60WP solar cell data

Based on testing on the solar cell 60WP on the first day between the hours of 8.00 WIB until 16.00 WIB, it was seen that the highest voltage of 19.02 V was reached at 12 am, with the intensity of sunlight at 104,000 lux and the lowest reached at 4 pm at 68,000 WIB lux which produces a voltage of 17.89 V.

In the 60WP solar cell test on the second day between the hours of 8 am and 4 pm, it was seen that the highest voltage of 18.81 V was reached at 12 am at 81,000 lux and the lowest voltage at 10 am with value 18.02 V at 72,000 lux sunlight intensity [5, 6]. Testing of solar cell 60WP on the third day between

8 am to 4 pm, it was seen that the highest voltage reached 18.37 V at 4 pm with the intensity of sunlight at 62,000 lux and the lowest intensity of sunlight at 4 pm worth 45,000 lux and produces a voltage of 17.67 V [7-9].

From this research it appears that the highest intensity of sunlight does not always produce the highest solar cell voltage. This is because at high sunlight intensity, the temperature of the surrounding environment is not necessarily too high. Environmental temperature can affect the output voltage of the solar cell and in this research did not measure the ambient temperature [10-13]. We use Equation 1 to calculate the charging time.

$$Charging\ Time\ (Hours) = \frac{Battery\ Capacity}{Total\ Electric\ Current} \tag{1}$$

This research uses a 45Ah 12V battery to charge the battery. It supplies the 500VA inverter. The total electric current is 3.02 A from solar cell. So, the charging time is 14 hours 25 minutes. For charging a BLDC motor drive battery using a 48v 12A battery charger to charge a 45Ah 48v car battery needs 4 hours 16 minutes.

To calculate the electric vehicle usage time, we use Equation (2) and (3).

$$Electric\ Current\ (Ampere) = \frac{Motor\ Power}{Battery\ Voltage} \tag{2}$$

$$Usage\ Time\ (Hours) = \frac{Battery\ Capacity}{Electric\ Current} \tag{3}$$

Using motor power of 350 Watt × 2 and battery voltage of 48 Volt, the electric vehicle usage time is ± 2 hours 5 minutes.

4. Conclusions

From the discussion of this research, it can be concluded as follows. High intensity sunlight does not always produce high voltage and electric current. This is because it is influenced by ambient temperature because at high light intensity it is not necessarily ambient temperature is also high. The charging time of the battery used to turn on the inverter is theoretically 14 hours while the measurement time of charging the battery is ± 14 hours 25 minutes. The charging time of the BLDC Motor Drive is theoretically 3.75 hours while the measurement of the charging time is ± 4 hours 16 minutes. The usage time of electric vehicles is theoretically 3.1 hours while the Measurement of usage time is ± 2 Hours 5 Minutes. The suggestions from research for further research. It is necessary to measure the ambient temperature and examine the effect of temperature on the voltage and current released by the solar cell.

5. References

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