

PLTS 200 Wp to Meet Energy Needs at the Taqwa Muhammadiyah Mosque, Sei Litur Village, Sawit Sebrang Langkat District

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Abstract

At the Taqwa Muhammadiyah Mosque, a local place of worship, the power blackout is becoming very troublesome. On one side of the village where the research was conducted, the light intensity was high enough so that it is very good to be used as a source of renewable energy, namely solar panels or better known as PLTS. Method used in this research is experiment which is fully functional to control the implementation of the solar panel for electricity supply for the Mosque everyday activity Based on the results of measurements and calculations, the 200 Wp solar panel, when the weather is sunny, will be able to charge a battery by 68.2% or 87.2 Watts. In using the battery, the efficiency factor of the battery must be considered because it cannot be operated until all power is used up. Battery Capacity is 754.7 Ah and is able to supply DC lamps for 1 day and is able to supply AC loads for 1.02 day. So in 11 hours (lowest data) the 200 Wp solar panel is able to charge a battery with a capacity of 100 Ah at 80% of the full battery capacity.

Keywords: generator; PLTS; solar cell

Introduction

Data shows that energy consumption has increased every year, in line with national economic growth. Especially in Indonesia, this increase in energy consumption will be a problem if the supply is insufficient compared to demand. The policies issued by PLN (State Electricity Company) as a State-Owned Enterprise (BUMN) to provide energy have shown that the existing electricity availability is no longer able to meet the national electricity needs. If the problem of electricity demand is not resolved, the growth of the national economy will be disrupted, considering that all aspects of Indonesian society depend on electrical energy (Harahap, 2019). Various efforts have been made by the government and researchers to solve the problem of the electrical energy needs. One of the efforts made is by searching for alternative and renewable energy, which in this case is the renewable alternative energy of sunlight. Considering that Indonesia is a tropical country traversed by the equatorial line, solar energy available in Indonesia is very effective to be used as an alternative renewable energy source. Efforts have been developed to harness the solar energy in the form of PLTS (*Pembangkit Listrik Tenaga Surya*, Solar Power Plants). The energy produced by PLTS is strongly influenced by the amount of sunlight intensity in an area (Harahap, 2020).

PLTS or better known as solar cells will be more desirable to build if it can be used for relevant purposes, especially in houses of worship. Particular to the Sei Litur Village, Sawit Sebrang District, Langkat Regency, this village was prone to power outages. This made the activities of residents who are dependent on electrical energy often be disrupted. Power cuts could occur as many as 5 times a day. This had a very bad impact on the growth of the village economy and also often be the cause damage to commonly used electronic equipment. At the Taqwa Muhammadiyah Mosque, a local place of worship, the power blackout is becoming very troublesome. Therefore, the application of alternative renewable energy (in this case, solar power) would be beneficial for the economic development of the villagers and also in worshipping activities (Rimbawati et al., 2019).

For the Sei Litur village, a place with a high intensity of solar light, the author accompanied by students carried out research and community service activities in order to meet the needs of electrical energy by installing a 200 Wp solar power plant. This research aimed to get an insight on the level of effectivity of the 200 Wp solar cell usage to supply electricity in Taqwa Muhammadiyah Mosque, Sei Litur Village.

Methods

The research was carried out at the Taqwa Muhammadiyah Mosque, which is located in Sei Litur Village, Sawit Sebrang District, Langkat Regency, Dusun number 8, starting with the data collection of the mosque building's electrical load. Research method used in this research is experiment which is fully functional to control the implementation to the object to be studied (Khaffi et al., 2020)

This data collection had been carried out because it is necessary to determine the amount of electrical load that is commonly used in the Taqwa Mosque, so that the most effective solar cell design can be determined according to the load. Collection of data on solar panels for 7 consecutive days from 08:00 to 18:00 WIB, comprising voltage and electric current generated and light intensity received to link the output power of the solar panels to the total load in the mosque in order to find out which kind of solar cell was more effectively being used.

The highest value data obtained from solar panels for 7 days of data collection was being associated with the total load used in the mosque. Then the effectiveness level of the 200 Wp solar panel in supplying the load for the mosque was being observed. The total electricity power use in this mosque is listed in the following:

Known DC load : 1 Unit of 5 Watt Lamp
: 1 Unit of 15 Watt lamp
: 3 units of 9 Watt lamps

Known AC load : 1 unit of 100 Watt fan
: 1 unit of 60 Watt amplifier device

Where the total DC load : 1 Unit 5 Watt DC LED lights on for 3 hours/day
: 1 Unit 15 Watt DC LED lights on for 3 hours/day
: 3 Unit 9 Watt DC LED lights on for 12 hours/day

Then the total load used in the mosque is:

$$\begin{aligned} P_{\text{total}} &= (1 \times 5 \times 3) + (1 \times 15 \times 3) + (3 \times 9 \times 12) \\ &= 15 + 45 + 324 \\ &= 384 \text{ Watt DC Load/day or 16 Watt/hour} \end{aligned}$$

Where the Total AC Load : 1 unit of 100 Watt fan turns on for 3 hours/day
: 1 unit of 60 Watt amplifier device turns on for 1 hour/day

$$\begin{aligned} P_{\text{total}} &= (1 \times 100 \times 3) + (1 \times 60 \times 1) \\ &= 300 + 60 \\ &= 360 \text{ Watt AC Load/day or 15 Watt/hour} \end{aligned}$$

Then the total load used in the mosque is 384 Watt DC and 360 Watt AC.

The components and devices needed to build the PLTS system were:

1. 200 Wp Solar Panel
2. Solar Charger Controller
3. Battery
Type : VRLA-AGM Dry
Battery Storage Capacity : 100Ah Max
Voltage : 12V DC
4. Inverter
Power : 1000Watt
Input Voltage : 12V DC
Output : 230V AC
5. Cables, Lux Meter, Amperemeter and Multitester

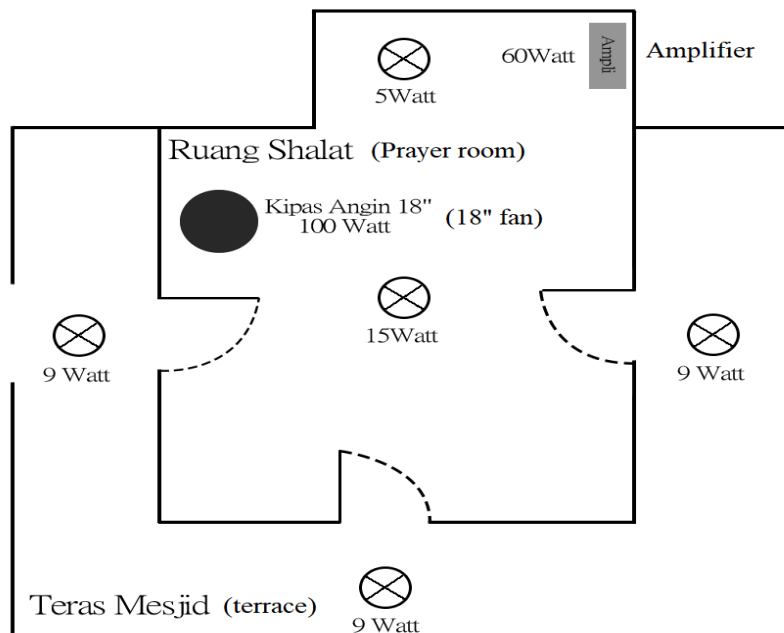


Fig 1. The Layout Plan of The Mosque with Installed Loads

The mosque layout plan with the installed loads that will be calculated is depicted in Figure 1. After obtaining the data (lux, current and voltage), the output power value of each of the 200 Wp solar panel would be determined with the equation:

$$P = V \times I$$

Where:

I = Current (Ampere)

V = Voltage (Volt)

P = Power (Watt)

Then to determine the average current and voltage from each day observed data collected, calculation done with the equation:

$$I_{\text{average}} = I_{\text{total}}/7 \text{ (number of data collected in a day)}$$

$$V_{\text{average}} = V_{\text{total}}/7 \text{ (number of data collected in a day)}$$

$$P_{\text{average}} = P_{\text{total}}/7 \text{ (number of data collected in a day)}$$

From the results, output power, current and voltage generated by the solar panel, will be compared through a comparison charts.

Results and Discussions

Results

The measurement analysis is carried out to find out how much current, voltage and power is produced by the 200 Wp solar panel. These data were collected to prepare analysis to conclude the effectiveness of implementation in the solar panel implementation for the mosque.

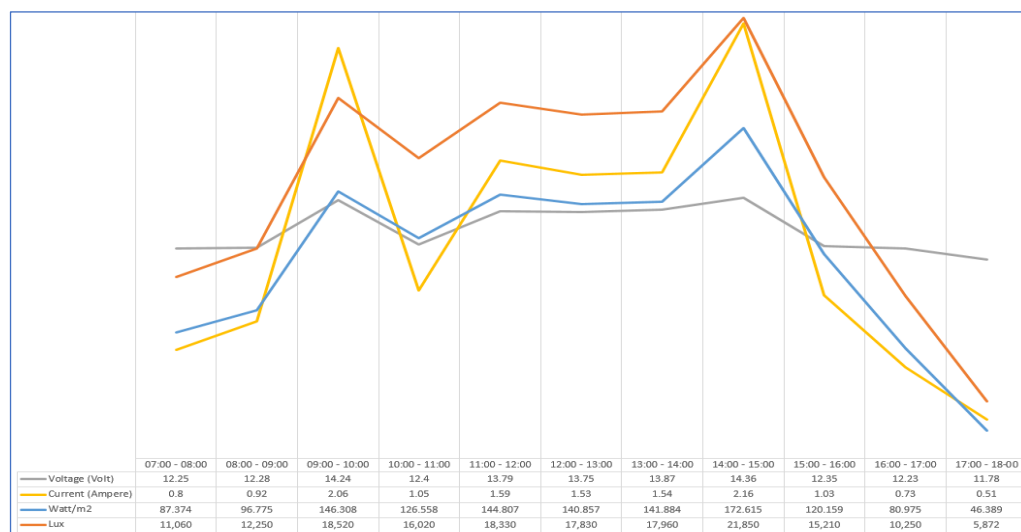


Fig 2. Measurement Result at Day 1, Friday 25/09/2020 in Cloudy Weather

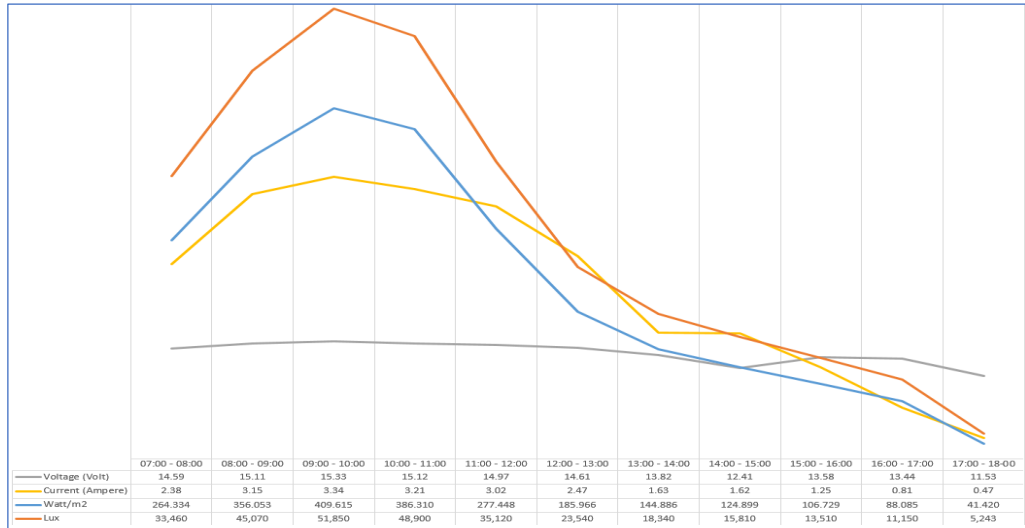


Fig 3. Measurement Result at Day 2, Saturday 26/09/2020 in Cloudy Weather

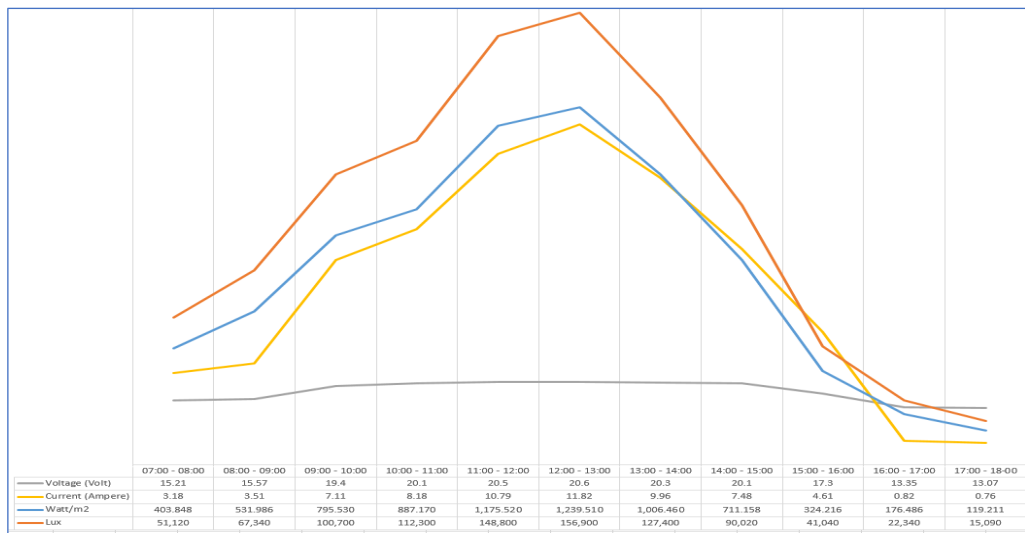


Fig 4. Measurement Result at Day 3, Sunday 27/09/2020 in Cloudy Weather

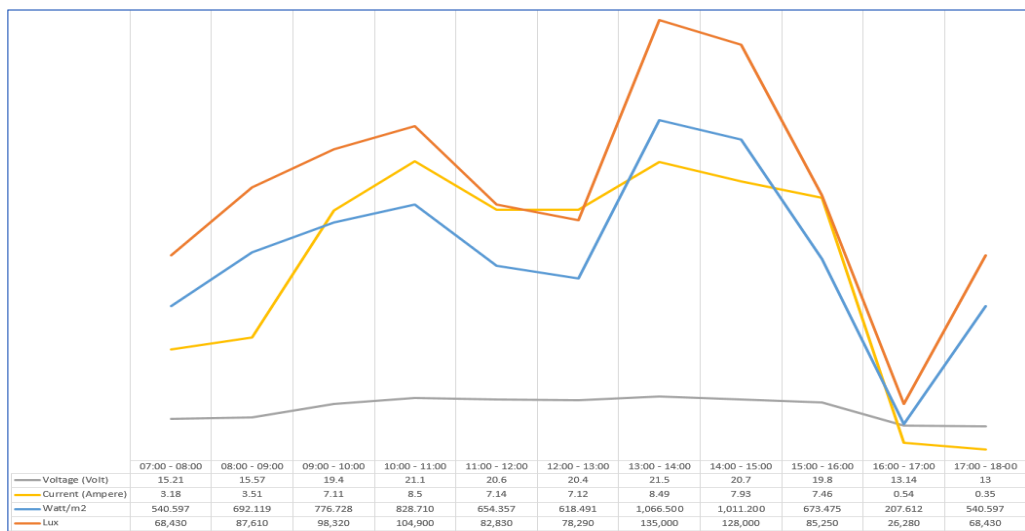


Fig 5. Measurement Result at Day 4, Monday 28/09/2020 in Cloudy Weather

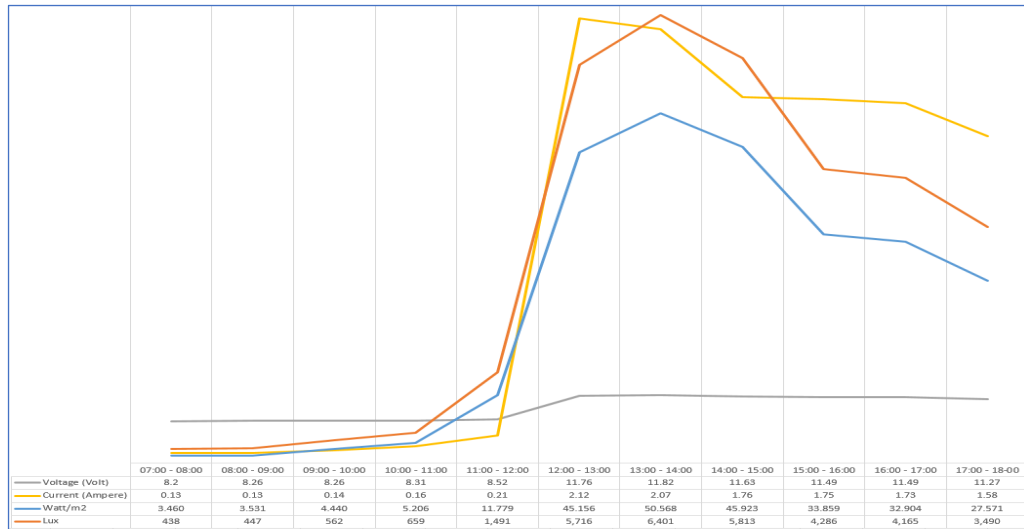


Fig 6. Measurement Result at Day 5, Tuesday 29/09/2020 in Rainy Weather

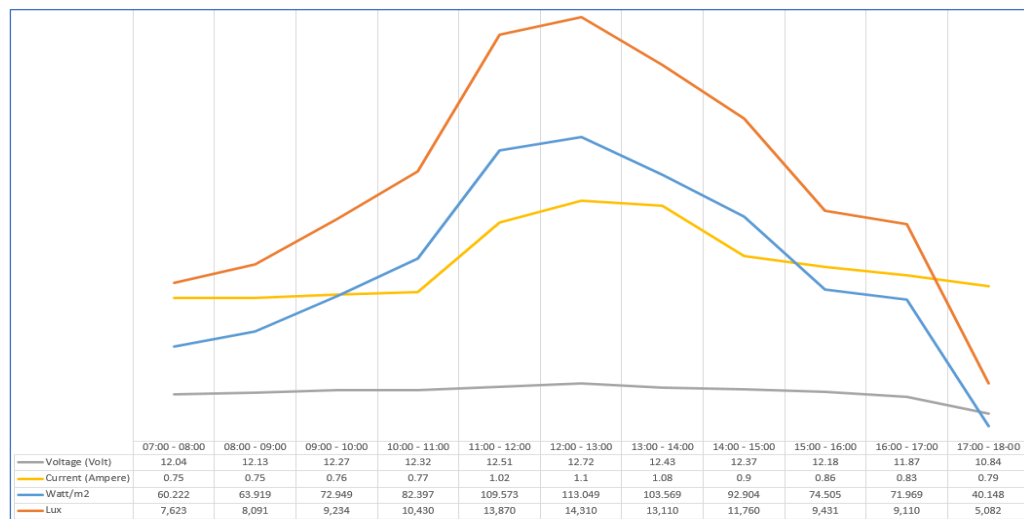


Fig 7. Measurement Result at Day 6, Wednesday 30/09/2020 in Cloudy Weather

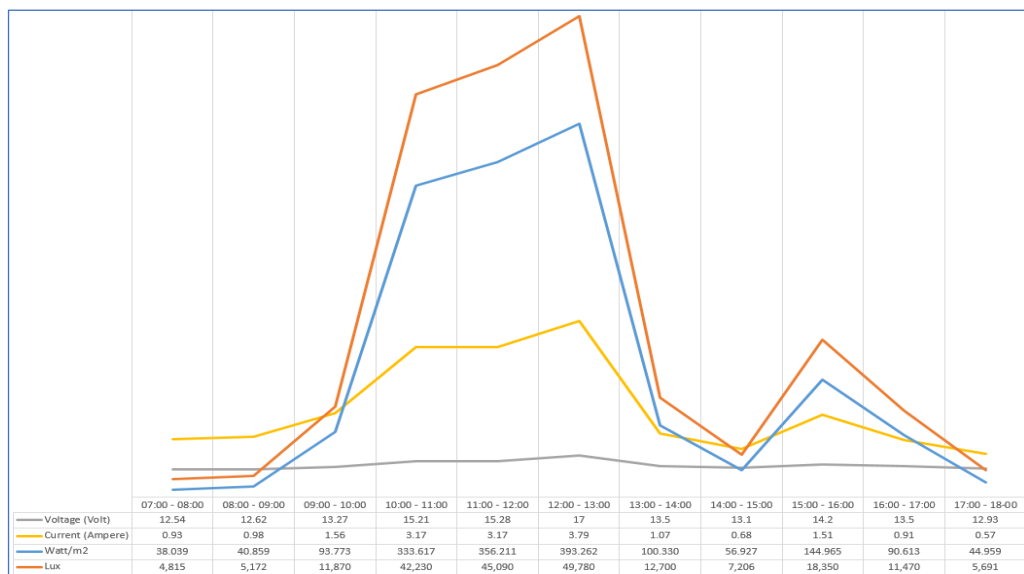


Fig 8. Measurement Result at Day 7, Thursday 01/10/2020 in Rainy Weather

So from the 7 consecutive days hourly data collection above (Figure 2 through Figure 8, the scale values of current, voltage, watt/m², and lux are drawn not the same to each other in the charts) the average of current, voltage and output power produced by the 200 Wp solar panel can be calculated. The result is shown in Table 1 and depicted in Figure 9.

Table 1. Average Current, Voltage and Power of The Solar Panel 200 Wp

Date and time	Average - Average/Hour		
	200WP Solar Panel		
	Current (Ampere)	Voltage (Volt)	Power (Watt)
Friday, 25/09/2020	1.26	16.95	13.02
Saturday, 26/09/2020	2.12	14.04	30.84
Sunday 27/09/2020	6.2	17.71	120.29
Monday 28/09/2020	5.57	18.22	110.78
Tuesday 29/09/2020	1.07	10.09	12.18
Wednesday, 30/09/2020	0.87	12.15	10.64
Thursday, 01/10/2020	1.66	13.99	24.57

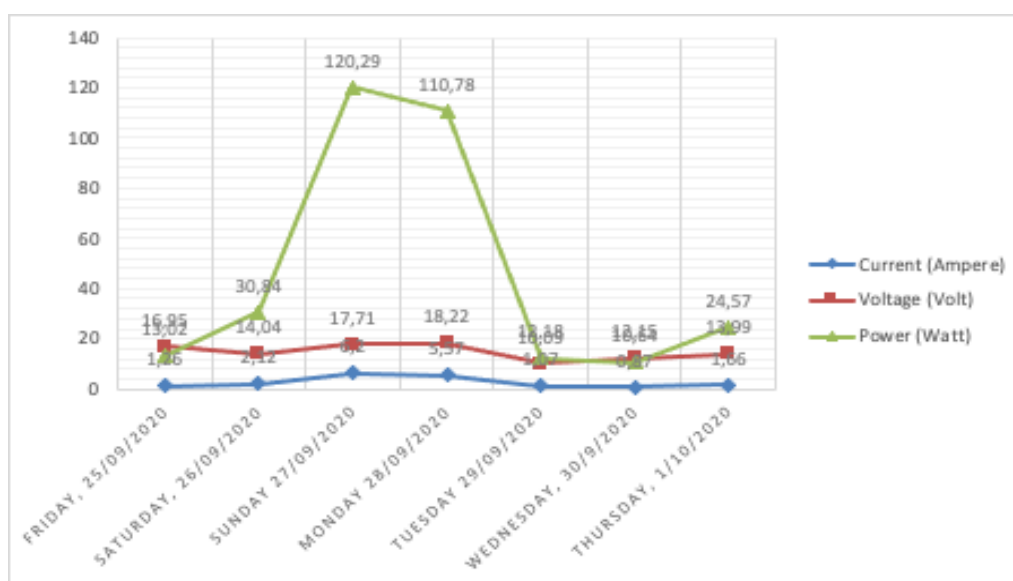


Fig 9. Average Current, Voltage and Power of The 200 Wp Solar Panel each day

Discussions

From the measurement data of 25 September to 1 October 2020, the total power generated by the 200 Wp solar panel is:

$$I_{\text{mean}} = I_{\text{total}}/\text{day} = 18.7/7 = 2.69 \text{ Amperes}$$

$$V_{\text{Average}} = V_{\text{total}}/\text{day}$$

$$\begin{aligned}
 P_{\text{Average}} &= 91.6/7 = 13 \text{ Volts} \\
 &= P_{\text{total}}/\text{day} \\
 &= 208.2/7 = 29.7 \text{ Watts}
 \end{aligned}$$

To find out how much energy can be stored, it is necessary to convert Ah to Wh power per-hour (Watt-Hours), so that the total capacity of the existing battery can be found out. Power can be found by multiplying the current capacity Ah by the battery voltage V, the equation is:

$$P \text{ (power per hour or Wh)} = I \text{ (hourly current or Ah)} \times V \text{ (battery voltage or V)}$$

So that: $P \text{ (Wh)} = 100 \text{ Ah} \times 12 \text{ Volt} = 1200 \text{ Wh}$ can only be used 960 Wh

Batteries used in solar panel technology or industrial batteries usually have an ideal limit of 80%. That means from a maximum battery charge of 100%, only about 80% can be used. For example, for a battery type 12V, 100Ah with a power of 1200 Wh, only about 960 Wh can be converted for use, explained in the following equation:

$$P = E/t$$

So that: $P = 960 \text{ Wh}/11 \text{ jam}$
 $= 87.2 \text{ Watt}$

Then the ability to charge a 100Ah battery is 87.2 Watt

By looking at the numbers, it will produce $P = 12 \times 100$ so that the battery power is 1200 Watts. Then, it is also necessary to know how long the battery can last to meet electricity demand if the total power is 200 watts/hour.

In calculating the battery specification must also consider the days of autonomy, or days when the sun do not shine optimally due to the weather, this usually taken into account so that the system can still active even though the weather is cloudy. To accomodate should the PV system cannot convert solar power for 3 days, the power requirement per day must be multiplied by 3. Apart from that, the efficiency factor of the battery must also be taken into consideration and when using the battery, it should not be operated until all the power is used up.

$$\begin{aligned}
 \text{So, battery capacity (Ah)} &= (\text{Total power} \times 3) / (0.85 \times 0.6 \times 12) \\
 &= (29.7 \times 3) / (0.85 \times 0.6 \times 12) \\
 &= 754.7 \text{ Ah}
 \end{aligned}$$

From the analysis of the data obtained, that the 200 Wp solar panel is able to charge the battery by 68.2% every day (every sunny day). The data analysis of the capacity of the battery that has been charged by the 200 Wp solar panel to supply the loads on the mosque is as follows:

Known: 360 Watt/day or 15 Watt/hour AC Load

384 Watt/day or 16 Watt/hour DC load

100 Ah battery chargeability = 68.2%/day (sunny day)

1200 Watt/hour battery capacity

How long does the 68.2% battery last with a 100 Ah capacity to supply the mosque?

36% battery capacity = $68.2/100 \times 1200$

Battery = $68.2/100 \times 1200$
= 818.4 Watts/Day

Battery Resistance = Overload DC load
= $818.4 - 384$ (can support DC loads as long as needed)
= 434 Watt DC left
= Then the ability to supply the AC load is $434.4/360$
= 1.2 Days x 85% (Inverter Efficiency) = 1.02 Days

The 200 Wp solar panel is in sunny day can charge the battery by 68.2% and can supply the DC lamp for as long as 1 day and is able to supply the AC loads needed for 1.02 days.

Conclusion

Based on the results described in the previous chapter, it can be concluded that:

1. Research and community service in implementing the installation of 200 Wp solar panel was successfully installed for Taqwa Muhammadiyah Mosque.
2. The maximum output power of 200 Wp solar panels on a sunny day is 120 Watt/hour.
3. The 200 Wp solar panel can charge a 100 Ah battery to 87.2 Watts.
4. Battery capacity is 754.7 Ah from the total average power.
5. The 200 Wp solar panel is in sunny day can charge the battery by 68.2% and can supply the DC lamp for as long as 1 day and is able to supply the AC loads needed for 1.02 day.

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