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Installation of a Solar Power System for a school in Malang, Indonesia

Yus Mochamad Cholily[1], Akhsanul In'am[2] , Machmud Effendy[3]

[1,2] Full Professor, Dept. of Mathematics Education, University of Muhammadiyah Malang, 65126, Indonesia

[3] Associate Professor, Dept. of Electrical Engineering, University of Muhammadiyah Malang, 65126, Indonesia

Corresponding Authors : machmud@umm.ac.id

Abstract—Solar power system installed in the school used to supply the electric load in the classroom. This generator system is equipped with photovoltaic, automatic transfer switch, inverter, and battery. This work emphasizes operating the Solar Power system in several schools in Malang, Indonesia. Furthermore, the solar power system is utilized to supply the electrical load in the class. At the end of this study, an analysis of system performance has been carried out by measuring the voltage and current of the PV and inverter, the output power of the PV and inverter and the power efficiency of the system. Measurements were carried out from 07:00 AM to 15:00 PM with a given load variation. Based on the measurement results, the solar power system has a power efficiency of 97.1% at a maximum load of 388.7W.

Keywords— Solar Power, School, Power Efficiency.

I. Introduction

Solar energy is one of the renewable energy sources (RES) that replace conventional fossil fuels due to their cleanliness and abundance almost everywhere [1,2]. Solar energy comes from the sun, and this energy is very cheap. With the latest technology allows solar energy to be captured by cells known as solar cells or photovoltaic cells. Photovoltaic cells are placed in direct sunlight, when direct sunlight hits the cell a chemical reaction occurs which produces an electric current [3].This electric current can be converted into electricity which is used to power electrical loads in schools such as lamps, LCD projectors, fans, and laptops.

The use of electrical energy in the globalization era has increased along with innovation in the electricity-based technology sector, especially in the household and commercial needs sector [4], including the education sector. The urgency of the need for electricity in the education sector must be a major concern, because electricity is believed to improve the quality of learning. For schools that have not been reached by the national electricity network, the use of solar energy is a promising alternative solution to overcome electricity problems in schools. Solar panels are the main tool for converting solar energy into electrical energy. Solar power plants using phoovoltaic modules require converters and controllers as voltage regulators and protectors [5].

The main purpose of installing a solar power system is to demonstrate various solar energy projects based on the country's energy policy. These projects are supported by the government budget, involving PV systems such as energy independent classroom systems in schools, street lighting, and solar home systems (SHM) [6]. Fossil energy sources such as coal, oil and natural gas are also used in Indonesia. This fossil energy source is limited in number and if this source is used continuously it will quickly run out in the coming decades [7]. Therefore the use of a stand-alone solar power plant is necessary. The need for electrical energy is a very important part of life and its utilization is increasing in line with technological developments. However, the fact is that the use of fossil energy sources continues to increase and this will result in natural damage and global warming

In this paper, we propose a solar system installation and its components for a school in Malang, Indonesia. Malang is one of the cities in Indonesia that has several potential sources of renewable energy, including geothermal, wind and solar energy. We chose solar energy as the best option for sustainable electricity due to the greater solar radiation in Malang. It requires low cost and simple maintenance.

II. Configuration System

The solar power system installed in schools can be explained through the block diagram below.

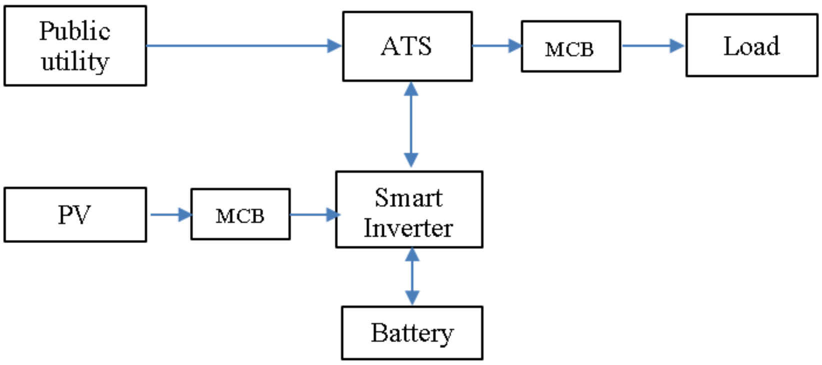

Fig. 1. Block Diagram of Solar Power System

Fig. 1 explains that the operated solar power system has several main components, including:

a. Photovoltaic (PV), functions to convert sunlight energy into electrical energy. The number of PV is 4 modules, each of 200 Wp. The four PVs are connected in series-parallel to produce a voltage of about 36V.

b. Smart Inverter, serves to change the DC voltage (Direct Current) to AC voltage (alternating current). This inverter is also equipped with SCC (solar charger controller). This inverter works on 24V DC with a capacity of 1500 V

c. Battery, serves as energy storage. The number of batteries is 2 pieces, each of 50Ah 12V. The two batteries are connected in series to get 24V voltage.

d. MCB (Miniature Circuit Breaker), serves to isolate the circuit from over current and short circuit disturbances.

e. ATS (Automatic Transfer Switch), functions to automatically control the transfer of 2 power sources

f. Load is an electrical load that is installed in energy independent classes at schools, including: lamps, fans, LCD projectors and laptops.

g. The public utility is the national electricity network. If there is a disturbance in the solar power system , ATS will move its electricity source from PV to public utilities .

III. Methodology

In this study using the method of Literature Study and Observation. Electrical data measurements were carried out during the teaching and learning process at 07.00 – 15.00 AM The research flowchart can be seen in Fig. 2

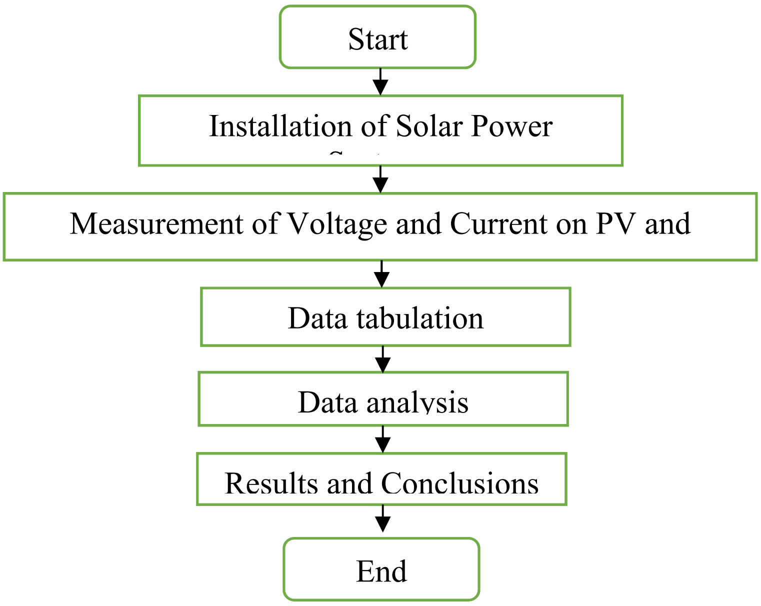

Fig. 2. Research Flowchart

Fig. explains that this research begins with installing the PV module connected to the ATS, inverter and battery. Then the voltage and current of the PV and inverter are measured. The results of these measurements will be tabulated in order to obtain PV power efficiency.

IV. RESULT AND DISCUSSION

The first step taken in this study was to install 4 PV modules of 200Wp each. PV is connected in series-parallel to get a maximum voltage of 36V. Figure 3 shows the installation of PV on the roof top.

Fig. 3. Pemasangan PV di Roof Top

Furthermore, other main components such as inverter, ATS, and battery are assembled. The results of the component assembly are shown in Fig. 4.

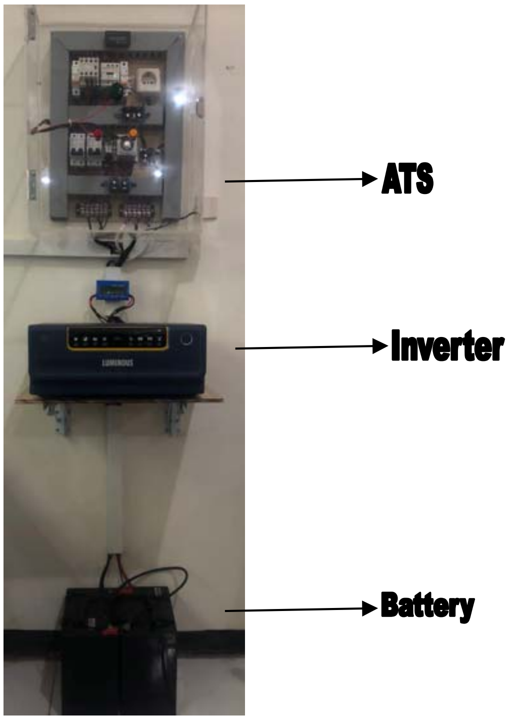

Fig. 4. Pemasangan ATS, Inverter, dan Battery

After that, measurements of voltage and current on the PV and inverter were carried out. The measurement results are shown in table 1.

TABLE 1. MEASUREMENT OF VOLTAGE, CURRENT, POWER, AND POWER EFFICIENCY ON PV AND INVERTER

No	Time	V_{pv}(V)	I_{pv}(A)	V_{inv}(V)	I_{inv}(A)	P_{pv}(W)	P_{inv}(W)	Power Efficiency (%)
1	07:00	29,7	5,3	220,8	0,68	157,4	150,1	95,4
2	08:00	30,4	8,4	221,1	1,1	255,4	243,2	95,2
3	09:00	32,1	8,4	221,1	1,17	269,6	258,7	95,9
4	10:00	33,4	10,3	222,2	1,47	344,0	326,6	94,9
5	11:00	35,1	10,4	222,2	1,56	365,0	346,6	95,0
6	12:00	36,1	2,9	222,1	0,45	104,7	99,9	95,5
7	13:00	34,4	11,3	222,1	1,7	388,7	377,6	97,1
8	14:00	32,3	11,2	221,4	1,57	361,8	347,6	96,1
9	15:00	32,1	2,85	221,1	0,4	91,5	88,4	96,7

Table 1 explains that the PV output power (P_{PV}) and inverter output power (P_{INV}) are greatest at 13:00 PM, at which time there is the use of light loads, LCD projectors and fans in independent classes.1 Meanwhile, the PV output power and inverter output power were the lowest at 15:00 PM, because only the light load was turned on. Table 1 also shows that the average power efficiency of a solar power system is 95.8%. Even at 13:00 PM, the power efficiency of the solar power system reached 97.1%, this means that the power generated by the PV is 388.7W, only 377.6W is used for load requirements. It is proven that the performance of the solar power system in the energy independent class is almost 100% working optimally to meet load requirements.

V. Conclusion

The electricity load in schools, especially in energy independent classes, can be fully supplied from a solar power system without using national electricity. The performance of the solar power system can be seen from the efficiency of the system which reaches 97.1%. So that only 2.9% of the power from PV is not absorbed by the load. This occurs because of power losses in the cable and inverter.

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