Engineering and Technology Journal e-ISSN: 2456-3358

Volume 09 Issue 07 July-2024, Page No.- 4526-4531

DOI: 10.47191/etj/v9i07.23, I.F. – 8.227

© 2024, ETJ

Solar Power Plant Design Using Automatic Transfer Switch on PLN-PLTS Network

Slamet Han[1], Gatot Santoso[2], Joko Susetyo[3], Alfi Hadi Permana[4]

[1,2,4] Electrical Engineering Study Program, AKPRIND University Indonesia

[3]Industrial Engineering Study Program, AKPRIND University Indonesia

ABSTRACT: Solar power plants are conventional generators, solar power is often in demand by the public in general, but the use of solar power plants experiences several problems, such as batteries that are easily damaged. This is because the use of the battery exceeds the depth of discharge. This study designed a PLTS using an Automatic Transfer Switch with a solar panel capacity of 20 Wp using a quantitative method. The results of this study in the first test the light intensity income at 10.00 was 28803 lux with a maximum power of 9.22 Watt and a charging power of 7.02 Watt, then at 11.00 the light intensity increased by 54733 lux followed by a power of 8.80 Watt with a charging power of 7.15 Watts. So the conclusion of this study is that the greater the intensity of the light produced, the higher the output power.

KEYWORDS: Automatic Transfer Switch; solar cell; interlock

1. INTRODUCTION

Electrical energy is an important factor amidst the very rapid and advanced development of technology. The main power supply, namely PLN (State Electricity Company) is not always continuous in its distribution, at some point there will definitely be a blackout which could possibly be caused by a disruption in the transmission system or distribution system.

Indonesia is a tropical region that has enormous sunlight which provides renewable energy potential with an average daily irradiation of 4.5–4.8 kWh/m2. As renewable energy, sunlight is not polluting and will not run out, but is free or free. Therefore, this energy source can be utilized for electricity through a PLTS (Solar Power Plant) system [1].

To anticipate PLN blackouts, researchers designed a PLN-PLTS ATS control. When the supply from PLN goes out, the energy supply is diverted to PLTS to replace it. So PLTS will be activated automatically when PLN goes out, and automatically transfer distribution from PLN to solar cells. Meanwhile, ATS functions as an interlock from PLN to PLTS. The system used is an interlock from PLN to PLTS. So that PLTS can replace the role of PLN in supplying electrical resources to buildings. Furthermore, if PLN returns to normal, it will move the distribution of electrical power to PLN again [2].

With a generator set, if a sudden power outage occurs due to a cut in supply from PLN, the way to overcome this is by activating the generator automatically [3]. If this is done manually, it will require a longer transition time between the PLN supply and the generator supply. For this reason, a tool is needed that functions to control the transfer from the main supply (PLN) to the backup supply (genset) which is called ATS (Automatic Transfer Switch [4].

One of the renewable energies used is solar energy because it is the right solution to meet the needs of human life. The nature of solar energy can be said to be eternal because it will not run out and its use is easier compared to other renewable energy sources. The use of renewable energy sources must be developed because the role and price of fossil energy itself is always increasing and soaring sharply provider of energy sources that are always used from PLN [5].

Almost all PLTS equipment consists of a system with electronic devices, so installation is plug and operate. Understanding the important factors of this equipment will make it easier to plan a PLTS. In principle, when planning a PLTS, factors must be taken into consideration, including: the planned PLTS operation pattern and whether or not the PLTS is connected to the electricity network in the planned location [6].

Although the SHS (solar home system) distributed PLTS system is more commonly used because it is relatively cheap and its design is simple, currently centralized PLTS and hybrid PLTS (PLTS combined with other energy sources such as wind or diesel) are also widely applied, which aims to obtain power. and higher energy use and achieving better system sustainability through collective (communal) ownership. Distributed PLTS can be an option when people's houses are located far from each other [7].

Automatic Transfer switch is a series of power inverter switch controls with PLN that is fully automatic. This tool is useful for turning on and connecting the power inverter to the load automatically when the PLN goes out. When PLN comes back on, this tool will move the power source to the load from the power inverter to PLN [8].

ATS (Automatic Transfer Switch) is a system equipment that can regulate the change of electrical power supply from the main electricity source from PLN to a backup electricity source that works automatically by controlling the timing. ATS functions as a replacement for a position transfer switch. The electricity source in previous methods was used to move the main electricity source handle/switch from PLN to a backup electricity source [9].

ATS (Automatic Transfer Switch) is a tool that functions to move connections between one electrical voltage source and another electrical voltage source automatically or is called Automatic COS (Change Over Switch), while AMF (Automatic Main Failure) functions to start the generator engine if the load is too high. served by losing the main source of electrical energy, namely PLN [10].
From the above, this design will create "Design Analysis for Making a Solar Power Plant Using an Automatic Transfer Switch on the PLN-PLTS Network" for consumer needs.

2. METHODOLOGY

This research method uses quantitative methods and empirical methods. This research method discusses how to solve problem formulation in research and can help researchers in processing data in overcoming problems in problem formulation assisted by using research stages. The tools and materials that will be used in designing a Solar Power Plant Using Automatic Transfer Switch PLN-PLTS are:
Tools used :
1. PC/Laptop
2. Multimeter
3. Ampere pliers
4. Solder and Tin
5. Tang Skun
6. Cutting pliers and peeling pliers
7. Screwdriver

Materials Used:
1. Solar Panel 20 WP
2. Inverter 500 W
3. Battery/motorcycle battery 3.5 Ah
4. Solar Charge Controller
5. Box Panels
6. Pilot Light
7. NYAF cable
8. Plug
9. Skunk

In this design, a block diagram was created that describes the design of the PLN-Solar Cell ATS. Like a flowchart where the working principle of a block diagram is when the PLN source provides power to the load, but when trouble occurs at PLN, the contactor on the ATS will automatically divert the PLN resource to the solar cells. The working principle of this design is based on an interlock system so that the distribution of electrical energy will be continuous with the interlock of PLN-solar cells.

Figure 1. PLN ATS Block Diagram - Solar Cells

PLTS Design

Design of a Solar Power Plant Using Automatic Transfer Switch PLN-
PLTS.

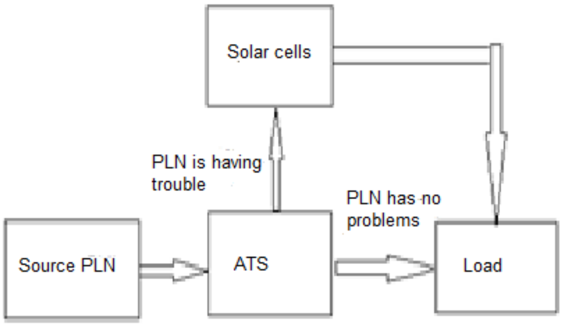

Figure 2. PLN-PLTS ATS circuit

The working principle of the design is that when the PLN source provides power to the load, however, when a problem occurs at PLN, the contactor on the ATS will automatically divert the PLN resource to the solar cells. The working principle of this design is based on an interlock system so that the distribution of electrical energy will be continuous with the interlock system from PLN-solar cells.

Testing Phase

Tool testing is carried out if all systems are connected and complete.

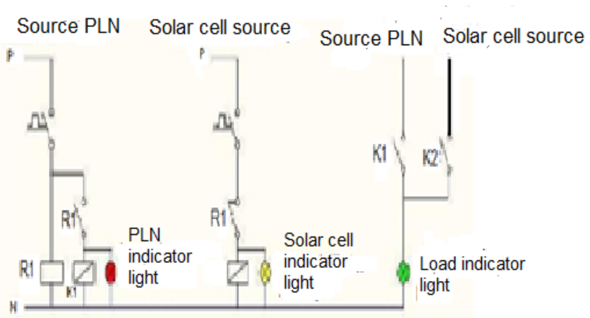

Figure 3. Solar Panel System Using Automatic Transfer Switch

The stages of testing the design tool are as follows:

1. Make sure the equipment is ready to be tested and has been installed and prepared.
2. Make sure all the circuits on the Solar Panel System Prototype Using Automatic Transfer Switch on the PLN and PLTS Networks are connected.
3. Do the test
4. Install or set this tool first with the PLN on and Inverter on models
5. Install or set this tool first with the PLN model off and the Inverter on
6. Record all data on paper

3. RESULTS AND DISCUSSION

As a result of this research, researchers measured various kinds of data which will later become material for analysis. The data collected by researchers included light intensity, ambient temperature, air humidity, voltage and current on solar panels, voltage and current on batteries and voltage and current. AC and DC on the load or inverter. In the results of this research only the average value is used, for the results of measurements in the field the researchers put them in the attachment. The results of the average values from the measurements are as follows:

PLN-PLTS ATS Design Testing

Experimental results of designing a Solar Power Plant Using Automatic Transfer Switch PLN-PLTS.

The test was carried out during the day when the weather and temperature changed and the results for the Solar Power Plant Using the PLN-PLTS Automatic Transfer Switch were as follows:

Table 1. Solar System Prototype test results Panel Using Automatic Transfer Switches on the PLN Network and Solar Cells

No	Source PLN	Inverter	Red Indicator (Inverter)	Green Indicator(PLN)
1.	ON	ON	ON	ON
2.	OFF	ON	ON	OFF
3.	ON	OFF	OFF	ON

From the results above, it shows that the design for making a Solar Power Plant Using the PLN-PLTS Automatic Transfer Switch works well.

Solar Panel Testing

The average value of solar panel testing was recorded in 2 days of testing by researchers, with 7 hours of testing starting from 10.00-16.00, the results of the solar panel testing are as follows:

1. Average First Day Solar Panel Testing

The following are the results of the first day of solar panel testing in table 2 below:

Table 2. Average Days of Solar Panel Testing First

No	Time	Voltage (V)	Current (A)	Power (W)	Lux	Temperature (°C)	Weather
1.	10.00	13.97	0.66	9.22	28803	27	Cloudy
2.	11.00	13.98	0.63	8.80	54733	29	Cloudy
3.	12.00	14.10	0.68	9.58	70688	30	Bright
4.	13.00	14.12	0.70	9.88	93290	32	Bright
5.	14.00	14.29	0.66	9.43	82691	35	Bright
6.	15.00	14.15	0.65	9.19	60906	35	Bright
7.	16.00	14.02	0.62	8.69	50343	34	Cloudy

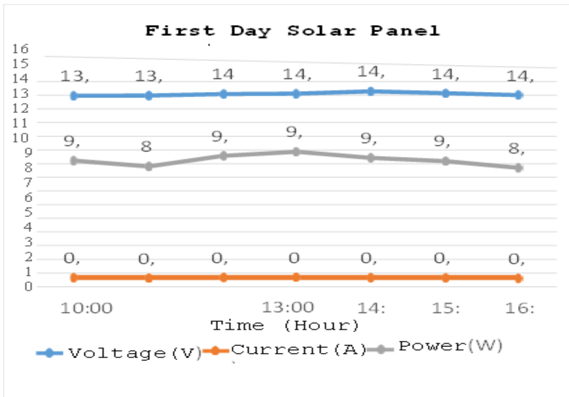

Figure 5. First Day Panel Testing

Figure 4 is a graph of the solar panel measurement process on the first day, there is the highest current at 13:00 because the average measurement value is very high, the current obtained fluctuates over time due to weather conditions at that time changing between sunny and cloudy.

Average of Second Day Solar Panel Testing

The following are the results of the first day of solar panel testing in table 3 below:

Table 3. Average of First Day Solar Panel Testing

No	Time	Voltage (V)	Current (A)	Power (W)	Lux	Temperature (°C)	Weather
1.	10.00	14.02	0.65	9.11	32431	26	Bright
2.	11.00	14.10	0.67	9.44	72508	28	Bright
3.	12.00	14.12	0.68	9.60	86561	30	Cerah
4.	13.00	15.24	0.77	10.82	74735	32	Hot
5.	14.00	15.27	0.71	10.84	78505	35	Hot
6.	15.00	14.88	0.70	10.41	73186	33	Hot
7.	16.00	14.56	0.69	10.04	57911	33	Bright

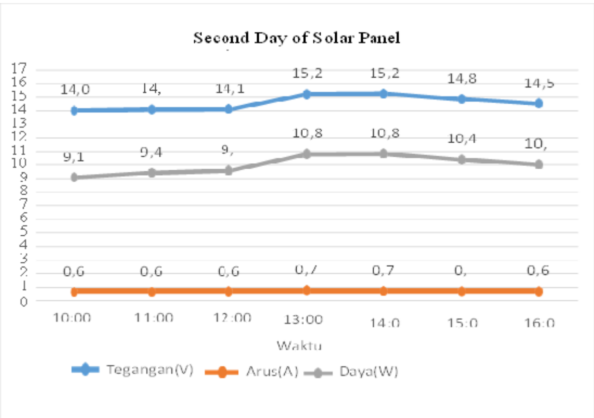

Figure 6. Second day of panel testing

In figure 4.2 is a graph of the solar panel measurement process on the second day, there is the highest current at 13:00-15:00 because at that time the weather was hot and cloudless, in hot sunny weather conditions the voltage and current obtained were quite high because there are no clouds blocking sunlight from reaching the panels. So we got quite stable results even though there was a high voltage spike at 13:00.

Battery Testing

The average value of the solar panel test was recorded 2 times by the researcher, with 7 times of testing starting from 10:00-16:00, so the average value of the solar panel test for 2 days is as follows:

1. Average First Day Battery Charge

Table 4. Average First Day Battery Charge

Time	Voltage (V)	Current (A)	Power (W)
10.00	12.78	0.55	7.02
11.00	12.78	0.56	7.15
12.00	12.80	0.58	7.42
13.00	12.80	0.58	7.42
14.00	12.79	0.59	7.54
15.00	12.78	0.57	9.28
16.00	12.76	0.55	7.01

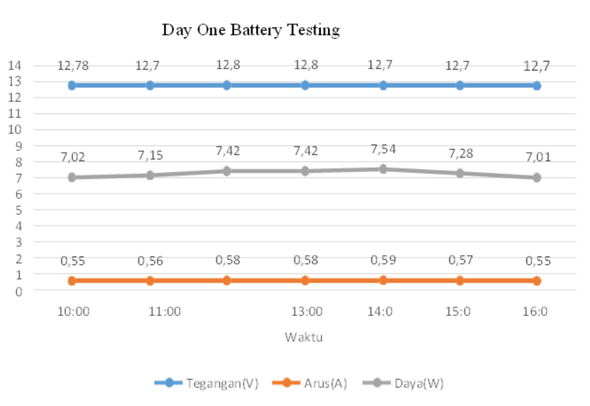

Figure 7. First Day Battery Testing Graph

Looking at Figure 6 in the battery charging graph, it can be concluded that the voltage when charging the battery is very stable, this is because the solar charger reads the voltage on the battery, and when charging the voltage will be more linear because the solar charger regulates the current when charging the battery so charging is more stable and regular. if the weather or conditions are sunny.

2. Average Second Day Battery Charge

Table 5. Average second day battery charge

Time	Voltage (V)	Current (A)	Power (W)
10.00	12.80	0.60	7.68
11.00	12.80	0.59	7.55
12.00	12.83	0.64	8.21
13.00	12.84	0.65	8.34
14.00	12.83	0.6 3	8.08
15.00	12.81	0.62	7.94
16.00	12.79	0.60	7.61

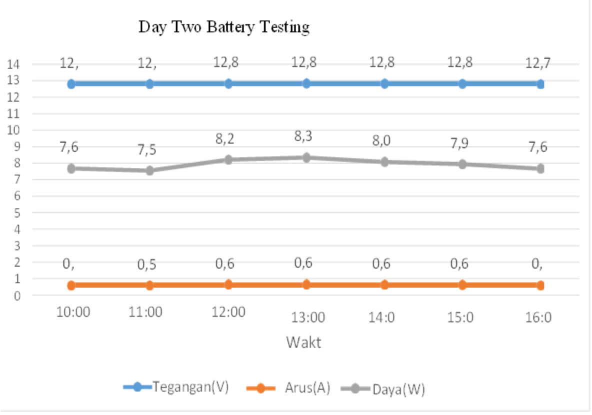

Figure 8. Second Day Battery Testing Graph

In figure 4.4 is a graph of battery charging on the second day, for the voltage when charging the battery, the voltage on the solar charger follows the voltage of the battery because it is regulated by the solar charger controller, however, during charging the current increases from 12:00-14:00, at 10.00 we found a current of 0.6 A because the weather at that time was sunny and at 12.00 we found the highest current with an average of 0.65 A because the weather at that time experienced an increase in light intensity, then decreased until at 15.00 by finding a battery charging current of 0.62 A.

Load Testing

Table 6. Load Testing

Load	Voltage (V)	Current (A)	Power (W)
Light 5W	13.21	0.53	7.00
Light 7W	13.16	0.59	8.29
Light 12W	13.10	0.79	10.34
Light 12+5W	12.90	1.15	14.83
Light 12+7W	12.80	1.36	17.40

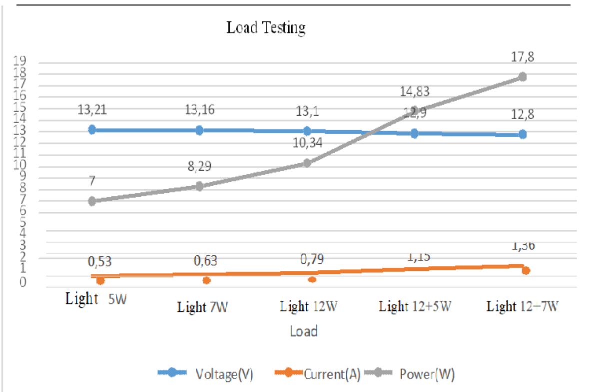

Figure 9. Load Testing

In figure 4.5, it can be seen that if a battery is given a greater load, the voltage will decrease and the current will increase and the power produced will increase. As can be seen in figure 4.5, it can be seen in the 5 W lamp load for a measurement voltage of 13.21 V with the measurement current is 0.53 A then increases at a lamp load of 12+7 W with a measurement current of 1.36 A then the voltage decreases by 12.8 V.

Device Analysis

The working principle of the whole system is very dependent on sunlight, where the solar cell system will work if it receives heat from sunlight which is then converted into electrical energy through a photovoltaic process, then the electrical energy produced by the solar cells will be channeled to the battery, this process is called charging . The battery will carry out the charging process as long as the solar cells are still producing electrical energy, the charging process is not yet optimal due to changing weather making the sun's heat unpredictable.

5. CONCLUSION

Prototype Solar Panel System Using Automatic Transfer Switch on the PLN Network and Solar Cells, namely:

1. Designing a Solar Power Plant Using an Automatic Transfer Switch on the PLN Network and Solar Cells will be a solution when trouble occurs at PLN where the contactor on the ATS will automatically divert PLN resources to solar cells using an interlock system so that the distribution of electrical energy will be continuous. there is an interlock system from PLN-solar cells.
2. Solar panels or also often called photovoltaics are an active element that converts sunlight into electrical energy.
3. ATS (Automatic Transfer Switch) makes it easy to switch between two different sources, namely the PLN source and the Solar Cell Source. If there is a blackout at the PLN source, the inverter will work to supply the electrical energy source. The voltage source obtained by solar panels can be stored in batteries.

Thank-you note

In this section, I would like to thank Allah SWT who has blessed me from the beginning of this research to the end, I will not forget to say thank you to my family, especially my parents who have provided support both spiritually and morally, we will not forget to thank my supervisor 1 and supervisor 2 who has provided direction and content in writing this thesis so that it can run smoothly. I also don't forget to say a big thank you to my fellow electrical engineering students class of 2016 at IST AKPRIND Yogyakarta.

REFERENCES

1. M. Hutasuhut, T. Tugiono, and A. H. Nasyuha, "Analysis of Arrhythmias (Heart Rhythm Disorders) Applying the Factor Certainty Method," J. Media Inform. Budidarma, vol. 5, no. 4, p. 1386, 2021, doi: 10.30865/mib.v5i4.3289.

2. H. Utomo, A. Sadnowo, and S. R. Sulistiyanti, "Implementation of a PLC-based Automatic Transfer Switch in the Electronics Engineering Laboratory, Department of Electrical Engineering, University of Lampung," J. Inform. and Tech. Electro Therap., vol. 2, no. 2, 2014, doi: 10.23960/jitet.v2i2.235
3. A. R. Wijaya and Z. Lutfiyani, "Design of Water Tendon Pump Motor Control Prototype with Automatic Transfer Switch (ATS) for PLTS and PLN," JTERAF (Raflesia Electrotechnical Journal), vol. 1, no. 2, pp. 1–7, 2021.
4. A. W. Setyono, "Implementation of ATS Amf Using a Hybrid System," Tech. Electro, vol. 10, pp. 341–349, 2021.
5. D. Ramschie, A. A. . Ramschie, L. Wenas, and R. Katuuk, "Implementation of Protection Systems and Automatic Transfer Switch (ATS) in Solar Power Plants (PLTS)," Elektrik, vol. 2, no. 1, pp. 16–26, 2023
6. Y. Apriani, D. Dipociala, Z. Saleh, and W. Oktaviani, "Automatic Transfer Switch (ATS) Based on Battery Voltage Sensors for PLTS," Electr. J. Engineering and Technology. Electro, vol. 17, no. 1, pp. 44–51, 2023, doi: 10.23960/elc.v17n1.2420.
7. Rimbawati, "Zelio-Based Automatic Transfer Switch Design (Application on Pematang Johar PLTS)," Zelio-Based Automatic Transfer Switch Design (Application on PematangJohar PLTS), pp. 7–12, 2021.
8. S. Keran and A. Nugraha, "Switching System on Automatic Transfer Switch (ATS) using Arduino UNO," J. Surya Energy, vol. 7, no. 2, pp. 47–53, 2023, doi: 10.32502/jse.v7i2.5756.
9. M. Syahwil and N. Kadir, "Design of an Off-grid Solar Power Generation (PLTS) Module as a Practical Support Tool in the Laboratory," J. Lab Management. Educator., vol. 3, no. 1, pp. 26–35, 2021, doi: 10.14710/jplp.3.1.26-35.
10. H. Alwani, "PLTS Using an Automatic Transfer Switch System," Semnas Avoer 12, no. November, pp. 246–250, 2020.