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Analysis Of Output Power Control Of Mini On Grid Plts Without Kwh Exim In Fajrul Iman Patumbak Modern Islamic Boarding School

Oleh

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ABSTRACT (10 PT)

The decreasing of world's supply of fossil energy caused by the human need for energy continues to increase. As a result, energy prices will be more expensive. Solar cells that utilize solar energy are a source of renewable electrical energy (RE). The use of solar cells to generate electricity can be used to reduce the burden of electricity bills anywhere as in Islamic boarding schools. The burden of electricity bills at the Fajrul Iman Patumbak Modern Islamic Boarding School, Deli Serdang Regency is quite a burden on Islamic boarding school expenses. To reduce the burden of spending on electricity bills at Islamic boarding schools, solar cells and control equipment are installed so that they can generate electricity. The control system is installed using an on-grid system, the electricity generated can be directly used by the Islamic boarding school during the day and will reduce some of the power absorbed/taken from PLN. After this service is carried out, the cost of spending on Islamic boarding schools has decreased.

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1. INTRODUCTION

The photovoltaic (PV) system, both solar cells and concentrated solar energy, is one of several devices that are free from pollution, therefore in the development of a sustainable smart grid, more integration of PV systems is needed. With this priority, distributed PV systems at the lowest/end grid level have increased rapidly throughout the world, so that network integration with the utilization of PV sources has become a challenging research area for academics and electricity providers alike. Solar radiation is a resource for PV power systems, but it is not constant over time and may fluctuate due to weather conditions, moving clouds, pollution, location, season, and time of day. However, the solar cell system remains a very good source of electrical energy in the future. Reducing costs in terms of electricity production using solar cells has also created interest in developing this solar cell system. The graph of reducing the cost of generating electricity with solar cells is shown in Figure 1.

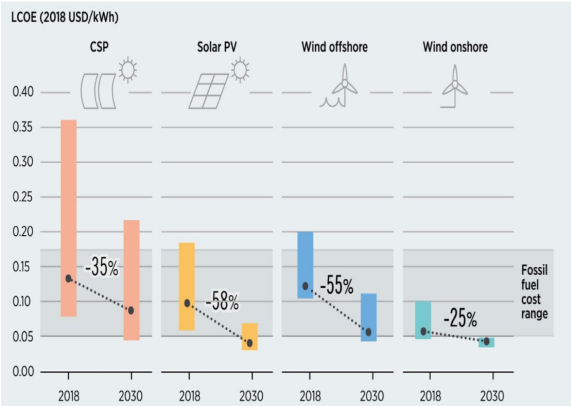


Figure 1. Estimated cost reduction for solar cell systems in 2018-2030[4] in [5]

Due to changes in solar radiation, the PV system's power output varies. The power supply source (PLN) supplies power to the load according to demand, but the power required by the load often changes according to needs which affects the electric power network. When the power generated by the PV system and the load are combined at the same node/branches in the interconnection system, power swings can occur. Power fluctuations can cause frequency and voltage deviations resulting in poor power quality for consumers.

Recent studies on the design and simulation of on-grid connected PV systems have been carried out and evaluated the effect of solar cells and power quality on the parameters of the primary photovoltaic system. It also describes the Battery Energy Store (BESS) method for producing active power by charging and discharging excess energy that is not used by the load and reducing the electric power from the solar cell.

Several ways of controlling the output are done using the shadow flux approach, digital pulse-width modulation (DSPWM) which can synchronize the sinusoidal output current with the network voltage and control the power factor. This control is based on single-phase inverter controlled by two-pole PWM switching and linear current control. There is also a 3-phase amplifier Inverter with harmonized maximum power extraction function (MPPT) at the same time ensuring regulation of the power fed to the grid. Energy Cooperative Approach (ECA) to regulate the flow of power between PV and the grid using batteries in DC micro-grids.[10] Additionally the nonlinear control of the grid-connected PV system uses an active power filter (APF) to force the PV output voltage to track a reference signal provided by the MPPT block to produce its maximum power and regulate the DC supply voltage to meet the correct operating mode of the power filter. Active three-phase, as well as for power factor correction (PFC) at the point of combining the inverter with the grid.

Solar cell installation is done on grid. The on-grid system is a system that works when connected directly to the grid (PLN). Has the advantage of being able to directly utilize the electrical energy generated for the load used. Another advantage is that it does not require investment in batteries which are quite expensive. This is what is being done at the Fajrul Iman Islamic Boarding School by installing 17 solar cell panels that are connected to the load used. Installation of the power supply system from the inverter is supplied directly to the network. At this time the installation used does not use KWH Exim in its operation.

However, there are also disadvantages of this on-grid system, namely the electrical energy produced by solar cells cannot be utilized when the main electricity supply grid network is not available or outages and at night. In addition, the power generated when the inverter is distributed is combined with the power generated by the grid, so that the power flow depends on the ratio between the power produced by the inverter and the load served by this hybrid system. A load that is smaller than the power generated by a solar cell at one time will cause the direction of energy flow not to the load but to the grid. On a network with KWH Exim, where the power flowing from the solar cell system to the grid can be calculated as power sold to the grid provider, however, customers without KWH Exim will cause problems, namely they are not counted as power sold because KWH does not record the power coming out of the load direction. To the grid, so it becomes a loss for solar cell owners.

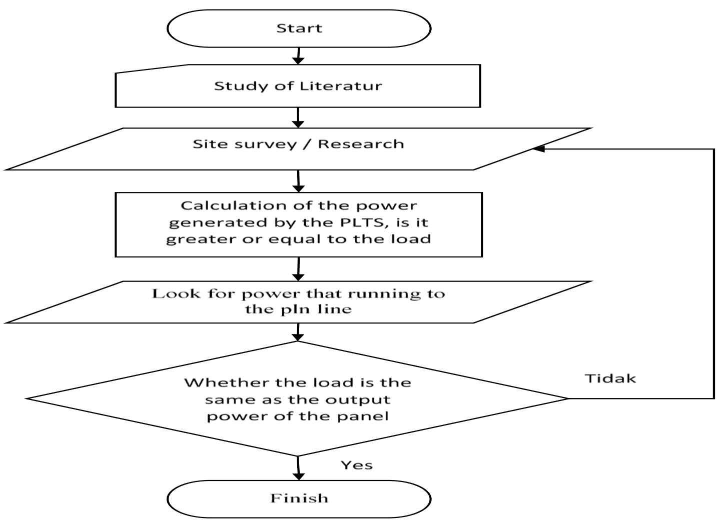
In addition, customers without KWH Exim are currently not allowed to export power to the grid. In the end, the customer cannot use the solar cell whenever there is a fluctuation in the load which drops drastically below the output power of the inverter in the on grid system.

2. THEORETICAL BASIS

Reference is made by writing [order number in the bibliography] eg. [1], [1,2], [1,2,3]. Bibliography citations must be in the Bibliography and Bibliography must have citations in the manuscript. References cited for the first time in manuscript [1], must be in bibliography number one, those cited second appear in bibliography number 2, and so on. Bibliography in order of occurrence of citations, not in order of last name. The bibliography only contains references that are actually cited in the manuscript.

3. RESEARCH METHODS

Based on the partner problems that have been described, here I provide solutions to problems related to the high expenditure of electrical energy that must be borne. The solution offered is the installation of PLTS to reduce the absorption of electric power from PLN by installing controlled ongrid PLTS. The stages used are in accordance with the flow chart in Picture 1.



Picture 1. Flowchart of activity implementation

The stages of implementing community service activities are:

1. Literature Study
   This stage is the earliest stage in the activity to determine all aspects including what must be recorded, and what is the most important part of this research so that the activities carried out are not wrong and in accordance with what you want to examine.

2. Islamic Boarding School Location Survey,
   This stage is carried out to obtain primary data on potential installation of solar cell panels and secondary data regarding the current conditions of activities and the latest needs for electrical energy. To obtain secondary data PP Fajrul Iman Patumbak Deli Serdang was obtained through interviews with the administrators of the boarding school and several students to find out problems related to electricity and energy. The electricity loading data in PP Fajrul Iman Patumbak can be seen in Table 1. Because the installed solar cells will only reduce the use of electricity during the day, we must know which loads will be used during the day. The load used during the day is shown in Table 1.

No.	Place	Equipment	Capacity (w)	Quantity	Duration (Hour)	Time (A/N/MN)	Energy (kWh)
1	Home and Hall	Lamp	45	1	12	N	0,54
2	Bathroom		25	4	12	AN	1,2
3	Hall		10	10	12	N	1,2
4	Hall		12	12	12	N	1,728
5	House	Fan	20	2	16	AN	0,64
6	Hall		50	3	4	AN	0,6
7	House	Rice Cooker	400	2	20	AN	16
8		Dispenser	40	1	24	AN	0,96
9		AC	746	1	10	AN	7,46
10		TV	40	1	12	AN	0,48
11		Kulkas	80	1	24	AN	1,92
12		Laptop	60	1	6	AN	0,36
13		Charger	15	4	2	AN	0,12
14		Printer	20	1	4	AN	0,08
15		Wash machine	400	1	6	AN	2,4
16		Water Pump	400	1	10	A	4
17	Hall	Water Pump	400	1	10	AN	4
18		Lamp	25	20	12	N	6

19	Girls Dorm		45	4	12	N	2,16
20		Lab. Comp	12	150	6	A	10,8
21		Iron	1	350	5	A	1,75
22		Fan	1	20	16	AN	0,32
Total							64,718
						A : Afternoon	
						N : Night/ Noon	
						AN : Afternoon - Night	

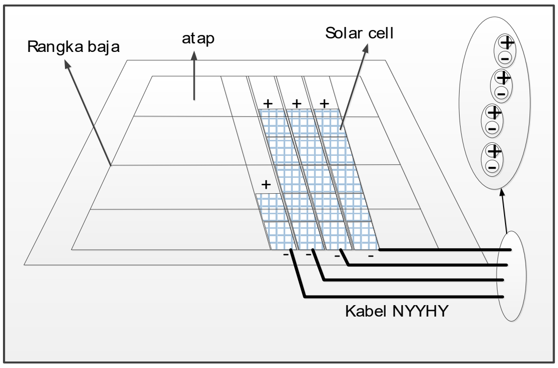
Table 1. Installed Electrical Load

3. Calculation of Power generated by PLTS
   Calculation of the solar cell capacity required by the location where the research is installed. The solar cell panels to be installed are 17 pieces of 100 WP each. The solar cell panel installation scheme is shown in Figure 1.
   Wattpeak calculation
   The amount of power generated by solar cell panels is calculated by the equation: (Nafeh, 2009)

Table 2. Daytime Electricity Load (07.00-17.00)

No.	Place	Equipment	Capacity (w)	Quantity	Duration (Hour)	Energy (kWh)
1	Home and Hall	Lamp	45	1	0	0
2	Bathroom		25	4	5	0,5
3	Hall		10	10	0	0
4	Hall		12	12	0	0
5	House	Fan	20	2	12	0,48
6	Hall		50	3	4	0,6
7	House	Rice Cooker	400	2	10	8
8		Dispenser	40	1	12	0,48
9		AC	746	1	6	4,476
10		TV	40	1	8	0,32
11		Kulkas	80	1	12	0,96
12		Laptop	60	1	4	0,24
13		Charger	15	4	2	0,12
14		Printer	20	1	4	0,08
15		Wash machine	400	1	6	2,4
16		Water Pump	400	1	10	4
17	Hall	Water Pump	400	1	10	4

18	Girls Dorm	Lamp	25	20	6	3
19			45	4	0	0
20		Lab. Comp	12	150	6	10,8
21		Iron	1	350	5	1,75
22		Fan	1	20	12	0,24
Total						42,446



Picture 2. Schematic of Solar Cell Panel Installation on the Roof

The area of the solar cell required for the load is:
PV area:E_L/(G_av._PV.TCF._out)
E_L: Load power to be served (42,446)
G_av: Average daily solar energy input throughout the year (4.5 kWh/m2/day)(Aryza, 2017)
_PV: Monocrystalline panel efficiency (0.18)(Rahman, 2021)
TCF: Temperature correction factor (0.8) (Alamsyah, 2003)
_out: The output power efficiency of solar cell panels (0.75)(Nafeh, 2009)
So obtained:
PV area:42.466/((4.5)(0.18).(0.8).(0.75))=42.466/((0.486))=87.3 m^2
This means that to meet the needs of all loads, a minimum of 87.3 m^2 of monocrystalline solar cells is needed and if the area of the solar cell is less than that, then the power of the solar cell will not be sufficient, let alone excess.
The area of the solar cell panels used in this program is 171.030.69=12.08 m^2

To find the power generated by solar cell panels in this program, you can use the formula above, namely:
E_L=PV area.G_av._PV.TCF._out
E_L=(12,08).(4,5)(0,18).(0,8).(0,75)
E_L=5.87 kWH
The power that can be fulfilled by the solar cell is 5.87/42.446100%=13.8%
Meanwhile, inverter and SCC capacity is not needed because it uses an inverter that is integrated with SCC and MPPT. The capacity of the integrated inverter is 2200 VA, meaning that the power generated by the solar cell is still below the capacity of the inverter.To find the power generated by solar cell panels in this program, you can use the formula above, namely:
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Solar Panel Installation Installation
The tools needed for installing solar panels are monocrystalline solar modules (100 Wp), integrated inverter, MPPT and 2000 Watt solar charge controller, 2x2.5 mm NYYHY cables, 2x2.5 mm NYM cables, panel boxes, solar panel modules, terminals, MCB AC 10 A, CT power control, Galvalum 0.7 channel C, MDS bolt, Cable Ties MC4 connector. Installation of solar panels begins with making system block diagrams, system circuits and flowcharts.

Picture 3. System installation scheme

The solar cell installation was carried out on the roof of the Islamic boarding school dormitory, above the pesantren leadership house, by the Team Leader lecturer and students as well as light steel installation expert assistants. The first step in installing a solar cell system is to install elbow clamps on the four corners of the frame/box on the panel module and then install the solar module holder. The solar cell module holder uses 0.7 channel C galvalume material with a height of 50 cm which is tightly mounted on the roof. Laying the solar module on a flat mount and given a wide frame to hold the panel firmly on a sloping roof.

The panel installation is divided into 4 groups, namely five panels each installed in series with 3 groups and the remaining 1 group only has 2 panels. This is done so that the output from the panel in the control box below can be regulated.


Picture 4. Panel installation on a galvanum frame

After installation, 4 cables representing 4 groups of solar panels on the roof are connected with the panel terminals. At this terminal, the output distribution is divided into 100 V, 100 V, 100 V and 40 V. This output voltage can be used as an alternative switch and charge storage for the remaining power. The output from this panel goes to the integrated inverter, MPPT and SCC which function to regulate the process of converting electricity produced by solar panels and optimizing the power that is distributed to the load. After it is installed, then the output of the integrated inverter which consists of phase and neutral cables is connected to the MCB AC 10 A and then connected to the phase and neutral cables in the home installation network. Next, a CT clamp limiter is installed on the integrated inverter output phase wire and connected to the control terminal inside the inverter. Its function is to limit the output of the solar cell panel to the installed load so that no power flows to the PLN.

After that it is also used to charge the battery as a second backup which can be taken from the remaining unused load or solar panel output. This battery is a medium used to store the electric charge generated by solar modules. The battery is connected to another, smaller inverter which is a device for converting the DC current from the battery to AC current with a maximum voltage of 220 volts. The inverter used is Souer 350 W. From the inverter it produces AC current for small and emergency loads such as lights and CCTV

power supplies.

Picture 5. Integrated Inverter Installation

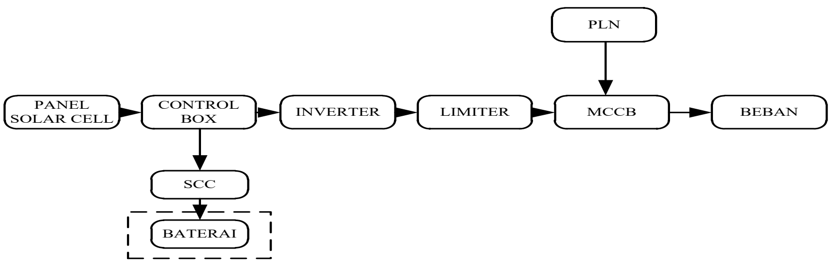
The solar charge controller and inverter circuit is connected to a 2 Ampere AC MCB, the terminal to the load and the house electrical installation wire is installed with a CT clamp as a power limiter from the solar cell panel automatically.

4. RESULTS AND DISCUSSIONS

From the results of installing solar panels, the conversion of solar energy into a source of electricity is used to save or reduce electricity bills. Electricity bills that have the effect of reducing the value of more or less, which previously amounted to 2,600,000 rupiah per month, has now become approximately 1,800,000 rupiah. A total of 17 pieces of 100 WP solar cell panels installed on grid with dual output storage method and controlled power sharing. These results prove that the installation of solar cells can be used to reduce spending on electricity rates during the day. In this case, pesantren managers can directly observe the solar cell panel installation process from start to finish, starting from installing the solar panels on the roof, assembling the solar charge controller circuit, inverter, battery, and the limiter system.

From the PLTS test data, it can be seen that the output voltage of the solar panels is around 318.8V340.8V when all the panels are connected in series. However, the output voltage of the solar charger controller is more stable, which is an average of 13.5 V. This situation is the same every hour. This happens because the solar charger controller contains a voltage and current regulator circuit. Therefore, charging the battery every hour will always be stable so that overcharging will not occur. So even though solar panels produce a larger nominal voltage, the result is still stable so it doesn't damage the battery.

The process of distributing power to the network remains in accordance with the load requirements because of the limiter protection so that a balance of power can be obtained and the unused residue can be stored in the battery.



Picture 6. Block Diagram Technology Implementation

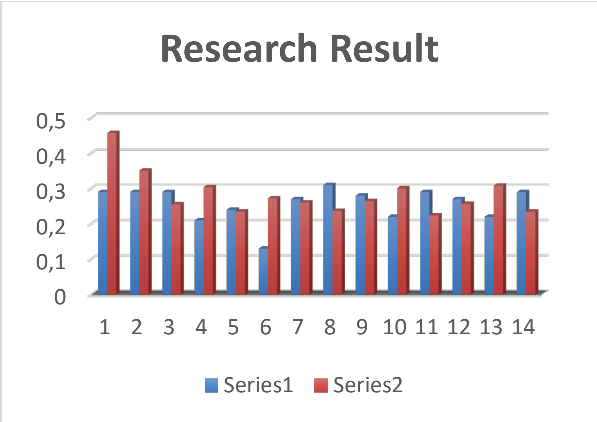
The installation of 17 pieces of 100 Wp solar panels has been successfully carried out at the Fajrul Iman Modern Islamic Boarding School. With the installation of solar cell panels, the use of PLN electricity by Islamic Boarding Schools will decrease so that the difference in expenses can help the Islamic Boarding School's cash flow and be utilized for more useful operational purposes, the Fajrul Iman Islamic Boarding School community is able to utilize and manage solar energy by using solar cell panels to generate electricity. That can be utilized and monitoring its performance on the solar panel. This dedication has raised the

spirit of Islamic boarding schools as educational institutions that can become pioneering institutions for the use of new and renewable energy.
The following are the results obtained from the solar cell:

SOLAR CELL					PLN		Sum Result
NO.	Time	VOLTASE (V)	CURRENT (I)	POWER (P)	CURRENT (I)	POWER (P)	PLN CURRENT*220/1000
1.	10.40	285	1	0,29	2,079 (Without SolarCell)	=>224	0,45738
				0,29	1,594 (light 4 on)	=>224	0,35068
				0,29	1,161 (Light 2 on)	=>224	0,25542
2.	10.47	281	0,8	0,21	1,383	=>222	0,30426
3.	10.52	282	0,9	0,24	1,067	=>224	0,23474
4.	11.00	279	0,5	0,13	1,239	=>222	0,27258
5.	11.10	285	1	0,27	1,183	=>224	0,26026
6.	11.20	281	1,1	0,31	1,076	=>224	0,23672
7.	11.30	285	1	0,28	1,203	=>227	0,26466
8.	11.40	281	0,8	0,22	1,367	=>222	0,30074
9.	11.50	282	0,9	0,29	1,019	=>224	0,22418
10.	11.55	285	1	0,27	1,167	=>224	0,25674
11.	12.00	281	0,9	0,22	1,403	=>222	0,30866
12.	12.30	285	1	0,29	1,067	=>224	0,23474

0,29	0,45738	0,74738
0,29	0,35068	0,64068
0,29	0,25542	0,54542
0,21	0,30426	0,51426
0,24	0,23474	0,47474
0,13	0,27258	0,40258
0,27	0,26026	0,53026
0,31	0,23672	0,54672
0,28	0,26466	0,54466
0,22	0,30074	0,52074
0,29	0,22418	0,51418
0,27	0,25674	0,52674
0,22	0,30866	0,52866
0,29	0,23474	0,52474

In the graph below, the blue bar shows the value for the power in the solar cell, while the red one shows the results of multiplying and dividing the PLN current which has been measured using the formula: Source Current (I) *220/1000.



Picture 7.Graph research result

5. Suggestion

My advice, as a researcher and creator of this journal, is to add that the PLTS system can be accessed via a mobile or smartphone application to monitor how solar cells are developing in the morning, afternoon or evening.

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