THE IMPLEMENTATION OF SOLAR POWER SYSTEM USING CAPACITY OF 1300 VA

Suprianto[1], Muhammad Rusdi[2] , Nisfan Bahri[3], Md Zin Hassan[4] , Faraziah Hassan[5], Noor Azlina Ahmad[6]
[1,2,3]Politeknik Negeri Medan, Departement of Electrical Engineering, Medan 20155
[4,5,6]Politeknik Nilai, Negeri Sembilan
[1]suprianto@polmed.ac.id

ABSTRACT

The renewable electricity source that can be owned and made in every electricity consumer home in Indonesia is the Solar Power Plant but research relating to the use of solar cells for household electricity is still not much. This research aims to design a solar cell system for 1300 VA household electricity needs and determine the characteristics of the quantities of electricity as well as knowing the cost savings in using PLN electricity after using solar cell electricity. This research can provide scientific studies in order to reduce dependence on PLN electricity supply. Thus, if many electricity consumers use this design system, PLN electricity providers will be able to significantly save fuel oil, gas and coal so that people will be far from the threat of electricity crisis. This research method uses the experimental method of designing and measuring to find out the characteristics of the electrical quantities so as to get a good and and appropriate design. The equipment used is solar cells, solar charge controllers, inverters, household electrical loads, electrical quantities measuring devices, temperature gauges and light intensity, battery systems and control panels. The results showed that the electric power service using a solar cell system with 8 units of 100 Ah batteries and 20 units of 100 Wp solar panels can serve electricity loads for 24 full hours continuously for weather conditions that are not more than two consecutive days in weather conditions cloudy with an average of 5166 watt-hour electricity services per day, or equivalent to 2 homes of 900 VA PLN electricity consumers. The cost that can be saved in one month is equal to the PLN electricity bill of Rp. 300,000.- measurement results starting at 6:10 a.m. to 6:50 p.m. show the intensity average of the solar radiation 52307 lux with an average temperature of 36^0C able serving the electrical load and charging electrical energy in batteries with an average loading for 24 hours of 232 Watt.

***Keywords**: solar cell; electric quantity; load; savings.*

1. INTRODUCTION

Solar cells as the main tool for electricity generation can generate electricity for household electricity needs. How can solar cells with fluctuating solar light intensity serve household electricity loads, how much is the capacity of solar cells to be able to serve the electricity load of 1300 VA, what are the characteristics of solar cell electricity quantities, how much are the savings costs by using solar cell systems, all it becomes important to be understood further through a research activity entitled "The Implementation of the Solar Power System Using the Capacity of 1300 VA". The research is oriented to products that have a direct economic impact in the near future for the community and the government, namely for the community not to pay fuel costs and electricity bills. For the government, if the results of this study are applied on a scale of more uses, it can save fossil energy consumption and save operational costs and electricity subsidies by the government to the community.

2. LITERATURE REVIEW

The development of solar cells shows impressive evolution over the last few years. This technology has been largely tested in laboratories using integrated devices. The performance of photovoltaic solar cells perovskite is evaluated in tropical weather conditions. Specifically, two perovskite modules with active areas of 17 and 50cm2 were created, encapsulated and tested. and commercial silicon panels as a reference, the two technologies are evaluated for 500 hours by connecting I-V measurements with atmospheric variables measured every minute during sunny weather to get the average performance and efficiency of solar cell equipment, graphically visualizing the characteristics of solar cells in various atmospheric conditions . The results show that the power delivery and short circuit current of the two technologies are linearly correlated with atmospheric variables. In addition, the open circuit voltage of perovskite technology shows nonlinear behavior and improved performance with temperatures at high irradiance (Velila,E., Ramirez,D., Uribe,J.I., Montoya, J.F. and Jaramillo, F. 2019). The threat of global warming on earth makes it necessary to find alternative energy sources. The search for renewable and cheap energy is the subject of several current studies, and the discovery of solar cells is one of the breakthroughs towards reliable alternative energy (Khalil, A., Ahmed, Z., Touati, F. and Masmoudi, M. 2016). Solar cells are an important part of optical devices because of their ability to convert solar energy into electrical energy. While the use of solar cells to provide electricity is still at an early stage, accounting for only about 1.5% of electricity supply using solar cells from electricity demand worldwide, solar cells are used continuously and increasing every year, further research in all aspects of solar cell installations , from material to devices to the system continues (Rand, B.P., 2017). Systems using a 308V DC microgrid voltage for household appliances (internal DC) are modified to operate on 48V DC from the DC distribution line. The electrical system using universal and induction motors for the BLDC (Brushless DC) motor is proposed because it is very efficient with minimum electro-mechanical and no loss of energy conversion. The proposed DC system reduces the power conversion stage, thereby reducing power losses and increasing overall system efficiency. For this reason conventional AC systems can be replaced by DC systems that have many advantages both in terms of cost and performance (Kamran, M., Mudassar,M. and Bilal ,M. 2017). Electricity consumption profile data that includes details on electricity consumption can be generated with a bottom-up load model. In this model, the load is built from basic load components which can be household or even individual equipment. This research presented a simplified bottom-up model to produce realistic domestic electricity consumption data every hour. This model uses the input data available in reports and statistics. The results of the analysis show that the resulting load profile correlates well with real data. In addition, three case studies with generated load data show several opportunities for demand-side management. With this scheme, the daily peak load can be reduced by an average of 7.2%. and the peak load on annual peak days can be averaged with a peak reduction of 42% and a sudden loss of 3-hour burden can be compensated with an average load reduction of 61% (Jukka, P. 2005). The design for photovoltaic (PV) systems provides electricity needed for households. Radiation data and typical household electrical load data at the site are taken into account during the design steps. System reliability is quantified by loss of load probability. A computer program is used to simulate the behavior of a PV system and numerically find the optimal combination of PV arrays and battery banks to design stand-alone photovoltaic systems in terms of reliability and cost. this study calculates the annual life cycle costs and annual unit electricity costs. Simulation results show that the value of the probability of loss of load can be met by several combinations of PV arrays and battery storage. The uniquely developed method determines the optimal configuration that meets load demands with minimum costs (Bataineh,K., Dalalah, D. 2012).

3. RESEARCH METHOD

This research method uses experimental research methods, namely by designing solar power plants. then make observations and measurements on solar power generation systems such as currents, voltage, temperature and intensity of solar radiation. Measurement of temperature and intensity of solar radiation is done by placing a measuring device next to the photovoltaic module. Measurements were made for 120 hours.

This research uses the following equipment:

- 20 units of solar modules with a total capacity of 2000 Wp.
- 8 units of 12V 100 Ah VRLA Battery.
- 1 unit of SCC (Solar Charge Controller) 60 ampere.
- 1 unit of Inverter 2000 W.
- 3 units of DC digital multimeter
- 1 units of AC digital multimeter
- 3 units of digital voltmeter
- 1 unit of luxmeter
- 1 unit of digital temperature gauges

4. RESEARCH ANALYSIS

This research was conducted by designing a solar power generation system with a capacity of 2000 Wp photovoltaic modules and 24 volt 400 Ah batteries. The intensity of solar radiation, temperature and some other electrical quantities are obtained from the results of research by measuring using several measuring instruments including ammeter, voltmeter, multimeter, luxmeter and digital temperature gauges. This research was conducted for five consecutive days ie on 22 January 2020 measurements were made for charging as well as loading from 07:00 to 23:50 local time. January 23, 2020 measurements were taken for loading from 00:00 to 07:00 local time. January 24, 2020 measurements were taken for charging as well as loading from 00:00 to 23:50 local time. January 25 2020 measurements are made for only loading without charging from 00:00 to January 26 2020 at 07:30 local time and January 26 2020 from 07:40 to 17:20 local time only for charging batteries by the photovoltaic module

Table 1. the intensity of the solar radiation, temperature and electrical quantities on January 22, 2020

Time	Photovoltaic Current (ampere)	Photovoltaic Voltage (volt)	Inverter Current (amp)	Inverter Voltage (volt)	Charging Current (amp)	Battery Output Current (amp)	Battery Voltage (Volt)	Alternating Current (ampere)	Alternating Voltage (volt)	Load Power (Watt)	The intensity of the Solar Radiation (Lux)	Temperature (° C)
07.00	0,7	28,2	9,07	24,4	0	8,37	24,7	1,16	225,9	191,5	2950	25
08.00	14,8	33,8	10,99	24,9	4,19	0	24,9	1,33	226,2	241,4	32600	31,3
09.00	17,1	31,2	7,71	25,7	10,3	0	25,4	0,94	225,6	167	43100	37,3
10.00	39,9	31,2	7,32	27,2	33,34	0	26,2	0,96	226,3	120,4	84000	42,5
11.00	17,2	31,2	8,51	26,1	8,91	0	26	1,03	226,4	192,1	34500	36,4
12.00	14,4	31,6	8,44	26,2	5,16	0	26	1,03	226,3	192,8	31900	36,8
13.00	29,1	34,1	5,2	28,2	23,43	0	27,6	0,81	225,8	115,5	60500	44

Time	Photovoltaic Current (ampere)	Photovoltaic Voltage (volt)	Inverter Current (amp)	Inverter Voltage (volt)	Charging Current (amp)	Battery Output Current (amp)	Battery Voltage (Volt)	Alternating Current (ampere)	Alternating Voltage (volt)	Load Power (Watt)	The intensity of the Solar Radiation (Lux)	Temperature (° C)
14.00	21,1	36,4	5,34	28,3	15,61	0	27,1	0,82	226,7	122,7	49500	48
15.00	11,9	31,6	5,33	27	6,33	0	26,8	0,81	226,5	117,2	25500	36,3
16.00	9,8	38,1	1,98	27,2	7,64	0	27,1	0,26	228,1	38,3	18700	41,7
17.00	5,7	36,3	2,26	27,2	3,64	0	26,5	0,31	228,2	44,8	12600	32,8
18.00	2,4	33,9	8,36	25,5	0	5,92	25,7	1,04	226,4	181,6	4200	30,2
19.00	0	0,46	14,9	24,7	0	15,21	25,4	1,98	226,6	328,7	-	-
20.00	0	0,02	11,54	24,7	0	11,85	25,3	1,55	226,6	251,4	-	-
21.00	0	0,03	12,52	24,6	0	12,74	25,1	1,71	226,4	273,8	-	-
22.00	0	0,03	12,77	24,5	0	13,04	25	1,73	226,2	278,2	-	-
23.00	0	0,03	12,16	24,4	0	12,46	24,9	1,66	226,5	264,4	-	-
23.50	0	0,03	12,77	24,3	0	13,04	24,1	1,73	226,1	277	-	-

Table 2. the quantities of electricity on January 23, 2020

Time	Photovoltaic Current (ampere)	Photovoltaic Voltage (volt)	Inverter Current (amp)	Inverter Voltage (volt)	Charging Current (amp)	Battery Output Current (amp)	Battery Voltage (Volt)	Alternating Current (ampere)	Alternating Voltage (volt)	Load Power (Watt)
00.00	0	0,03	11,97	24,3	0	12,28	24	1,57	226,5	258,1
01.00	0	0,03	11,29	24,3	0	11,8	24,1	1,49	226,1	241,4
02.00	0	0,03	10,35	24,1	0	10,67	24,6	1,33	226,5	219,6
03.00	0	0,03	10,28	24,1	0	10,68	24,6	1,32	226,3	218,3
04.00	0	0,05	10,28	24,1	0	10,6	24,5	1,32	226,1	217,3
05.00	0	0,04	11,2	23,9	0	11,55	24,4	1,46	226,7	237,5
06.00	0	0,05	12,78	23,8	0	13,09	24,3	1,7	227,1	271
07.00	0, 1	27,4	13,96	23,7	0	13,23	24,2	1,88	226,6	296,5

Table 3. the intensity of the solar radiation, temperature and electrical quantities on January 24, 2020

Time	Photovoltaic Current (ampere)	Photovoltaic Voltage (volt)	Inverter Current (amp)	Inverter Voltage (volt)	Charging Current (amp)	Battery Output Current (amp)	Battery Voltage (Volt)	Alternating Current (amp)	Alternating Voltage (volt)	Load Power (Watt)	The intensity of the Solar Radiation (Lux)	Temperature (° C)
0.00.00	0	0,4	12,3	24,6	0	12,6	24,9	1,68	226,8	227	-	-
1.00.00	0	0,4	11,33	24,5	0	11,64	24,9	1,47	226,7	224,4	-	-
2.00.00	0	0,4	11,1	24,5	0	11,48	24,8	1,45	227,0	240,2	-	-
3.00.00	0	0,4	11,01	24,4	0	11,33	24,7	1,45	226,3	237,1	-	-
4.00.00	0	0,4	11,79	24,2	0	12,03	24,6	1,51	227,1	251,9	-	-
5.00.00	0	0,4	11,56	24,2	0	11,89	24,5	1,50	226,3	248,7	-	-
6.00.00	0	0,6	14,49	24	0	14,85	24,4	1,98	226,5	311,1	-	-

Time	Photovoltaic Current (ampere)	Photovoltaic Voltage (volt)	Inverter Current (amp)	Inverter Voltage (volt)	Charging Current (amp)	Battery Output Current (amp)	Battery Voltage (Volt)	Alternating Current (amp)	Alternating Voltage (volt)	Load Power (Watt)	The intensity of the Solar Radiation (Lux)	Temperature (° C)
7.00.00	1,2	25,1	30,01	23,5	0	29,18	24	3,04	224,6	635,9	5200	25,4
8.00.00	15,2	39,8	5,63	25,1	9,42	0	24,9	0,76	226,3	111,2	39200	30,6
9.00.00	30,8	31,9	5,58	26	25,17	0	25,6	0,79	226,4	120	69100	38,1
10.00.00	22	31,5	5,78	26	16,15	0	25,6	0,79	226,2	121,6	42400	37,6
11.00.00	18,8	31,8	8,55	26,6	10,72	0	26,2	1,03	226,2	191,8	39100	38,7
12.00.00	39,9	32,1	7,13	27,3	32,88	0	26,7	0,92	225,9	160,7	98000	42,6
13.00.00	39,1	32,2	4,25	28,1	35,96	0	27,3	0,71	226,1	89,2	105600	45,2
14.00.00	18,8	36,2	4,14	27,1	13,06	0	26,7	0,70	225,7	88,4	96000	42,4
15.00.00	14,8	37,7	4,55	27,2	36,83	0	27,1	0,73	226	95,5	89500	44,9
16.00.00	11,4	38	4,39	27,2	7,34	0	27,1	0,73	226,2	94,4	70300	41,5
17.00.00	9,9	31,3	5,04	26,9	4,23	0	26,9	0,75	226,2	108,9	19900	32,9
18.00.00	2,3	30,8	6,77	25,6	0	4,53	25	0,84	226,1	137,1	6300	30
19.00.00	0	10,8	16,11	24,9	0	16,47	25,4	1,93	225,5	360,3	-	-
20.00.00	0	0,3	17,73	24,6	0	18,03	25,2	2,17	226,3	393,8	-	-
21.00.00	0	0,4	17,44	24,6	0	17,83	25,1	2,15	226,1	387,4	-	-
22.00.00	0	0,4	17,62	24,4	0	17,96	24,9	2,15	225,5	388,8	-	-
23.00.00	0	0,4	10,99	24,5	0	11,3	24,9	1,46	226,7	237,1	-	-
23.50.00	0	0,4	15,24	24,3	0	15,62	24,7	1,79	226,2	333,3	-	-

Table 4. intensity of solar radiation, temperature and the quantity of electricity from 25 to 26 January 2020

Time	Photovoltaic Current (ampere)	Photovoltaic Voltage (volt)	Inverter Current (amp)	Inverter Voltage (volt)	Charging Current (amp)	Battery Output Current (amp)	Battery Voltage (Volt)	Alternating Current (ampere)	Alternating Voltage (volt)	Load Power (Watt)
25/01/2020 00.00	0	0,4	15,40	24,3	0	15,71	24,7	1,8	226	335,1
25/01/2020 01.00	0	0,3	7,96	24,5	0	8,24	24,7	0,99	226,2	164,6
25/01/2020 02.00	0	0,5	7,76	24,4	0	8,06	24,7	0,97	225,8	160,5
25/01/2020 03.00	0	0,4	7,78	24,4	0	8,08	24,6	0,98	226,1	161,2
25/01/2020 04.00	0	0,4	7,78	24,3	0	8,05	24,5	0,98	226,6	160,6
25/01/2020 05.00	0	0,3	7,74	24,3	0	8,04	24,5	0,97	226,1	159,7
25/01/2020 06.00	0	0,4	11,04	23,9	0	11,19	24,5	1,49	226,8	234,8
25/01/2020 07.00	0	37,3	8,32	23,9	0	8,69	24,5	1,03	226,4	171,2
25/01/2020 08.00	0	41,7	5,35	24	0	5,64	24,5	0,74	226,1	103
25/01/2020 09.00	0	39,9	5,71	23,9	0	6,01	24,5	0,75	226	110,7
25/01/2020 10.00	0	38,9	4,78	23,9	0	4,97	24,4	0,71	227	88,6
25/01/2020 11.00	0	38,5	4,95	23,9	0	5,2	24,4	0,72	226,4	92,3
25/01/2020 12.00	0	37,9	5,01	23,9	0	5,2	24,4	0,72	227	94
25/01/2020 13.00	0	38,2	5,72	23,8	0	5,92	24,1	0,77	226,6	109,9
25/01/2020 14.00	0	38,5	5,90	23,7	0	6,1	24,2	0,77	226,6	114,5

Time	Photovoltaic Current (ampere)	Photovoltaic Voltage (volt)	Inverter Current (amp)	Inverter Voltage (volt)	Charging Current (amp)	Battery Output Current (amp)	Battery Voltage (Volt)	Alternating Current (ampere)	Alternating Voltage (volt)	Load Power (Watt)
25/01/2020 15.00	0	39,0	7,25	23,6	0	7,53	24,1	0,9	227,3	145,9
25/01/2020 16.00	0	39,1	6,62	23,6	0	6,39	24,1	0,84	225,9	134,5
25/01/2020 17.00	0	39,6	23,73	22,8	0	24,2	23,1	2,28	224,7	496,9
25/01/2020 18.00	0	37,9	7,71	23,4	0	8,18	24	0,94	226,7	160,6
25/01/2020 19.00	0	8,8	15,28	23,0	0	15,41	23,8	1,9	227	316,3
25/01/2020 20.00	0	0,4	14,86	22,8	0	15,12	23,1	1,96	226,7	308,6
25/01/2020 21.00	0	0,3	15,15	22,7	0	15,48	23,5	1,97	227,1	312,3
25/01/2020 22.00	0	0,6	14,42	22,1	0	14,87	23,4	1,85	227,1	296,4
25/01/2020 23.00	0	0,7	12,68	22,6	0	13,13	23,3	1,62	226,1	260,5
26/01/2020 00.00	0	0,4	8,39	22,6	0	8,63	23,2	0,99	225,8	164,1
26/01/2020 01.00	0	0,4	8,27	22,6	0	8,59	23,1	0,99	225,9	162,6
26/01/2020 02.00	0	0,6	8,26	22,4	0	8,53	23	0,98	225,7	161
26/01/2020 03.00	0	0,4	8,35	22,3	0	8,67	22,8	0,99	226,1	162
26/01/2020 04.00	0	0,4	8,32	22,1	0	8,61	22,1	0,98	225,4	161
26/01/2020 05.00	0	0,4	8,47	21,9	0	8,78	22,5	0,99	226,2	162,1
26/01/2020 06.00	0	0,6	9,52	21,7	0	9,79	22	1,13	225,6	180,7
26/01/2020 07.00	0,8	26	9,7	21,3	0	8,79	21,6	1,13	225,9	182,9
26/01/2020 07.30	9,1	28,8	9,75	21,4	0	6,2	21,6	1,13	225,5	183,8

Table 5. the intensity of the solar radiation, temperature and electrical quantities on January 26, 2020

Time	Photovoltaic Current (ampere)	Photovoltaic Voltage (volt)	Charging Current (amp)	Battery Voltage (Volt)	The intensity of the Solar Radiation (Lux)	Temperature (° C)
07.40	4,8	31,2	4,02	22,2	10440	27,4
08.00	8,7	32,4	8,17	22,1	17600	29,8
09.00	27,91	31,6	27,94	23	55000	35,8
10.00	26,9	31,7	27,32	24,1	46800	36,8
11.00	37,8	29,9	35,13	24,1	82600	42,4
12.00	29,2	30,8	30,02	24,9	55800	39,7
13.00	39,8	31	40,03	25,5	92000	43,5
14.00	29,1	31,7	28,21	25,5	53400	37,6
15.00	39,9	31,8	38,20	26	88800	43,3
16.00	17,1	31,5	17,16	25,5	29300	35,1
17.00	2,3	30,3	1,97	25,4	4390	30,1
17.20	1,8	30,1	1,60	25,3	3320	29,1

Table 6. Data on household electricity needs

House Number	No	Load	Watts	Qty	Hours per day	Days / week used	Weekly Watt hours
House 1. with the capacity of 900 VA	1	Porch Lights	20	1	12	7	1680
	2	Living Room Lights	26	1	5	7	910
	3	Front Room Lights	14	1	5	7	490
	4	Back Room Lights	24	1	5	7	840
	5	Center Room Lights	23	1	5	7	805
	6	Kitchen lights	23	1	12	7	1932
	7	Side Porch Lights	14	1	6	7	588
	8	Home Rear Lights	26	1	6	7	1092
	9	Refrigerator	90	1	24	7	15120
	10	Rice Cooker	400	1	0,4	7	1120
	11	Blender	250	1	0,08	7	140
	12	Iron	350	1	0,5	7	1225
	13	Fan	90	1	0,3	3	81
	14	Washing machine	330	1	0,4	7	924
	15	TV	24	1	2	7	336
	16	Laptop	46	1	2	5	460
House 2. with the capacity of 900 VA	1	Porch Lights	18	1	12	7	1512
	2	Living Room Lights	20	1	5	7	700
	3	Front Room Lights	23	1	5	7	805
	4	Back Room Lights	35	1	5	7	1225
	5	Center Room Lights	21	1	5	7	735
	6	Kitchen lights	40	1	6	7	1680
	7	Bathroom Lights	21	1	12	7	1764
		Total hours per day			135,68		
		Average hours / day			5,899		

Table 7. The calculation results

Things to look for	Value	Unit	Explanation
Total weekly watt-hours of AC Load (Wh)	36164	watt-hours	For two houses
Average total watt-hours per day	5166	watt-hours	Total weekly watt-hours Divided by days per week
Average amp-hours per day (Ah / d)	215	Ah	Average total watt-hours per day divided by d.c nominal voltage (24 Volt)
Baterry Bank Size Required (Ah)	439,7	Ah	$\frac{\text{Average amp hours per day}}{\text{inverter efficiency (0,9) x battery efficiency(0,85) x DoD(0,8)}} x \text{ days of autonomy (1,25)}$
Battery qty based on voltage from 12v 100 Ah each to supply 24 V	8,8 ≈ 9	Units	$\frac{\text{Baterry Bank Size Required}}{\text{Battery Ah}} x\ 2$
Solar Panel KIT 100 watt, with capacity per day (5 - 6 hrs)	17,22	Units	$\frac{\text{Total Load watt hours per day}}{\text{100 W x 3 hours}}$

Things to look for	Value	Unit	Explanation
Total solar panel kit required	17	Units	17,22 units ≈ 17 units of 100 Wp solar panels

5. DISCUSSION

The discharging and charging of the battery by the photovoltaic module on January 22, 2020 starts at 07:00 local time and ends at 23:50 local time. This charging and loading lasts for 16.83 hours with an average power served by a solar power plant of 191.3 wat. battery voltage at the time of initial loading was 24.7 volts with a current loading of 191.5 watts. Battery voltage at the end of loading at 23:50 local time of 24.1 volts with 277 watts. This means that the battery voltage with a loading time of 16.83 hours for an average power service of 191.3 watts has a voltage drop of 0.6 volts. Battery charging starts at 00:00:00 Local time in the morning on 23/01/2020 until the morning at 07:00 Local time or the length of loading is 7 hours. The average power served for 7 hours is 242.7 Watt with maximum loading occurring at 6:30 local time of 301.3 watts and minimum loading occurs at 03:40 local time with a load of 217.2 watts. The average battery voltage for 7 hours of loading is 24.3 volts with maximum voltage occurring at 01:50 Local time until 03:00 Local time while the minimum voltage occurs at 00:00:00 Local time until 00:30:00 Local time with a loading of 254 Watt, this is due to the power service at that time is greater with the loading at the next hour. The average battery output current during 14.5 hours of loading is 13.01 Amperes. The maximum current occurs at 36.54 Amperes at 6:40 am Local time with a loading of 738.1 Watts. The minimum loading occurs at 17:10 at 1.15 Amperes with a loading of 127.7 Watt. The loading on the PLTS battery only occurs at night while in the morning until the afternoon in general the loading is carried out by solar cells. Battery voltage at the time of initial loading of 24.9 volts with 227 Wattt loading with an inverter DC current of 12.3 Amperes. Battery voltage at the end of the loading is 24.7 volts with 335.1 Watt loading with a 15.4 Ampere inverter DC current. The average battery voltage for 24 hours of loading is 25.48 volts.

The loading takes place for 2 days, starting at 00:00:00 local time on 01/25/2020 until 07:30 local time on 26/01/2020 or lasting for 31.3 hours of loading without charging the solar cell. The average power served for 31.3 hours amounted to 176.9 Watt with the biggest loading of 528.8 Watt. Battery voltage at the time of initial loading of 24.7 volts in a state of a power load of 335.1 Watts, after 33.1 hours of battery voltage loading took place at the end of loading was 21.6 volts with a power loading of 183.8 Watts. Since there is no effect of sunlight intensity on the battery voltage, the effect of the increase and decrease in load is followed directly by the increase and decrease in battery voltage. Charging the battery by a solar cell current lasts for 9.67 hours which causes the solar cell battery to be filled with 3.1 volts from the initial voltage state without charging 22.2 volts at 07:40 local time and then increases to 25.3 volts without loading at 17:20 local time. During charging by solar cell current the maximum voltage of the solar cell battery is 26.1 volts and the lowest is 22.1 volts. The average flow of solar cells generated during charging for 9.67 hours is 26.2 Amperes with the maximum charging current by solar cells occurring at 14:50 local time which is 55.8 Amperes with the intensity of sunlight of 120030 Lx. The smallest solar cell charging current is 1.8 Amperes, which occurs at 17:20 local time with an intensity of 3320 Lx. Loading is not done to find out how much the ability of the intensity of sunlight in charging the battery through the photovoltaic module. Adding a 3.1 volt battery voltage to a 24 v dc battery voltage requires an average sunlight intensity of 52833 Lx with an average temperature on the surface of the solar cell of 37.6 ^{0}C

The solar power generation system that is implemented uses 8 units of 12 volt 100 Ah batteries and uses 20 units of 100 Wp solar modules with a capacity of 2000 Watt to 4000 Watt Peak and a solar charge controller capacity of 60 Amperes. This is different from the results of calculations using 9 units of batteries and 17 units of 100 Wp solar modules. By reducing the number of batteries by 1 unit and increasing the number of 3 units of solar cells produces the same capability where the loading can be done for 1.25 days and loading for one day one night (24 hours) can be done without disconnection and alarm on the inverter system. Thus the use of PLN electricity is not needed in January 2020 only when there is cloudy weather for more than 2 consecutive days predictably will reduce the ability of power services by PLTS for the use of PLN electricity is still used to anticipate cloudy weather for more than 2 consecutive days participate. Cost savings that can be done by implementing PLTS using the capacity of 1300 VA is equal to the payment of PLN bills if not using PLTS electricity on an average monthly range of Rp.310,000. - If rounded to Rp.300,000.- then electricity payments can be saved at Rp300 .000.- every month.

6. CONCLUSION

Electric power services using a solar cell system with 8 units of 100 Ah 12 volt batteries that are installed in series and parallel with a working voltage of 24 v and a total current of 400 amperes and 20 units of 100 Wp solar panels batteries that are installed in series and parallel can serve household electricity loads for 2 houses with an installed capacity of 2 x 900 VA with an average electricity loading of 5573 per day Watt-hours. Costs that can be saved in the payment of electricity bills for 1 month on average Rp. 300,000.- assuming no cloudy weather occurs for more than 2 days continously . The average intensity of solar radiation per day 52307 lux with an average temperature of 36^0C is able to serve the electrical load and charging electrical energy in batteries with an average loading for 24 hours of 232 Watt.

7. ACKNOWLEDGMENTS

This research will not be able to run if there is no support from various parties. On this occasion the author would like to thank the institution Politeknik Negeri Medan and Politeknik Nilai Negeri Sembilan who provided support for enthusiasm, motivation, direction and funding in this research. The authors thank the research funding assistance provided by POLMED and PNS with a total grant of Rp 167,933,333.- once again the authors thank Politeknik Negeri Medan (POLMED) and PNS (Politeknik Nilai Negeri Sembilan)

8. REFERENCES

[1] Khalil, A., Ahmed, Z., Touati, F. and Masmoudi, M. 2016. Review on Organic Solar Cells. In *13th International Multi-Conference on Systems, Signals & Devices*. (Leipzig, Germany, March 21-24, 2016), DOI = http://doi.org/10.1109/SSD.2016.7473760

[2] Jukka, P. 2005. A Model for Generating Household Electricity Load Profiles. *Int. J. Energy Res*. 30, 5 (July 2005), 273–290. DOI= https://doi.org/10.1002/er.1136

[3] Velila,E., Ramirez,D., Uribe,J.I., Montoya, J.F. and Jaramillo, F. 2019. Silicon Comparison and Competitive Advantages at Different Irradiances, Sol. Energy Mater. Sol. Cells. 191, (March 2019), 15-20. DOI = https://doi.org/10.1016/j.solmat.2018.10.018

[4] Rand, B.P., 2017. special issue on advanced solar cell technology. *J. Opt*. 19, 12 (November 2017). DOI = https://doi.org/10.1088/2040-8986/aa98b7.

[5] Kamran, M., Mudassar,M. and Bilal ,M. 2017. DC Home Appliances for DC Distribution. *Journal of Engineering & Technology*. 36, 4 (October 2017). DOI = https://doi.org/10.22581/muet1982.1704.12

[6] Bataineh,K. and Dalalah, D. 2012. Optimal Configuration for Design of Stand Alone PV System. *Jurnal of SGRE* , 3, 2 (May 2012). 139-147. DOI = http://dx.doi.org/10.4236/sgre.2012.32020