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INSTALLATION OF A 10X100 WP SOLAR POWER PLANT AT AL-IKHLAS ORPHAN BOARDING SCHOOL, SINGOSARI DISTRICT, MALANG REGENCY

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Abstract

Solar power plants are efficient and environmentally friendly sources of renewable energy. Previously, a solar power plant with a capacity of 6 x 100 Wp had been installed at the Al-Ikhlas Orphan Boarding School, Singosari District, Malang Regency, but the power produced was not optimal. Therefore, the addition of solar modules with a capacity of 4 x 100 Wp is carried out. It is necessary to design and analyze solar power plants using pvsyst software to find out how effective the addition of solar panels is so that the total capacity is 10 x 100 Wp. This research includes the design and simulation of solar panels to optimize the system configuration, including the placement of solar panels, tilt angles, and orientation. The analysis is carried out by taking into account location data, equipment specifications, and local environmental conditions. The results of the study show that the design value of solar power plants using PVSYST software is: average annual radiation of 870 kWh/m², temperature value of 24.99°C, PV input power of 1667.2 Watts, output power of 1595.4 Watts, performance ratio of solar power plant 0.809, and efficiency value of 18.8%. After testing in the field, an average efficiency was obtained in sunny weather of 15.47% with an average voltage of 31.62 V, current of 20.03 A, and power of 651.18 Watts. The addition of solar modules significantly improves the energy production and efficiency of solar PV.

Keywords: Efficiency, Pvsyst, Renewable Energy, Simulation, Solar Power Plant

INTRODUCTION

The location of this community service activity is located in the area of the Al-Ikhlas Orphan Boarding School, Dukuh Biru, Gunungrejo Village, Singosari District, Malang Regency, East Java.

The planning for the construction of this solar power plant is planned as an alternative energy source by utilizing the sunlight around the cottage. In addition, this power plant can be used as a means of education for students related to power plants derived from renewable energy sources.

In the area of the Al-Ikhlas Orphan Boarding School, it is considered to have the potential

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to be an environmentally friendly source of power generation.

For the placement of the Solar Power Plant, a location was chosen on the roof of a 3-story building. The reason is due to the consideration of several things such as the length of exposure to sunlight, maintenance, and repair of components. The installed power capacity of the solar power plant is planned to be 10 x 100 wp.

The output from the 10 x 100 wp solar power plant will be connected to an inverter where it will channel energy from the solar power plant to the battery to store the power generated from the plant and part of it will be directly channeled to the load.

The implementation of the Community Service Program aims to build, operate and maintain a Solar Power Plant system in a sustainable manner, with a capacity of 10 x 100 wp. The output power from this power plant will be used for electricity needs in the form of lighting for student rooms, classrooms, and as a means of charging electronic devices.

IMPLEMENTATION METHOD

Place and Time. The area of the Al-Ikhlas Orphan Boarding School, Dukuh Biru, Gunungrejo Village, Singosari District, Malang Regency, East Java was chosen as the location for the Community Service Program which will be carried out for 8 months, from April 1 to November 15, 2024.

Target audience. The target audience of this community service program is the managers and students of the Al-Ikhlas Orphan Boarding School, as partners who provide land for the construction of solar power plants, as well as those who are tasked with continuing the operation and maintenance of the equipment and systems of this Solar Power Plant. Overall, the number of personnel from the partners is 13 people.

Service Method. In summary, the methods used in this Community Service Program include: 1) Analysis of electrical energy needs in supporting activities at the Al-Ikhlas Orphan Boarding School, 2) Calculation of electrical power potential by utilizing sunlight around the cottage area, 3) Calculation of the capacity of solar panels and inverters that will be used to generate electrical energy 4) Construction of solar power plants, 5) Installation of a hybrid inverter that is suitable for the geographical conditions of the Al-Ikhlas Orphan Boarding School by using specifications that are in accordance with the solar PV system 6) Determining the specifications of the solar power plant that are in accordance with the conditions there. 7) Solar panel testing includes open circuit test, closed circuit test against current and voltage and generated power output. Testing is carried out in the laboratory of electrical machinery of the State Polytechnic of Malang, 7) Testing of solar panels that have been carried out directly at the location of the solar power plant at the Al-Ikhlas Orphan Boarding School, 8) Determination of components to be installed in the solar power plant system 9) Design and installation of electrical installations and safety systems as well as load regulation of the Solar Power Plant system 10) Implementation of the work as a whole, including the construction of solar power plants, the construction of maintenance stairs, the installation of inverters and electrical panels and the installation of electrical installations at predetermined locations.

Success indicators. The success of this community service program can be seen from several indicators, including 1) The construction of a solar power plant with a capacity of 10 x 100 wp can be carried out according to the plan and time that has been determined, 2) The solar

power plant that has been built can be operated according to the plan, 4) The fulfillment of electrical energy needs in the area of the Al-Ikhlas Orphan Boarding School, especially for lighting and charging cellphone batteries and other electronic devices, and 5) The implementation of training related to the operation and maintenance of solar power plants to partners can be carried out properly and run according to plan.

Evaluation Method. The evaluation method of the implementation of this community service program is carried out through an analysis of the performance of solar power plants that have been built to meet the needs of electrical energy in the area of the Al-Ikhlas Orphan Boarding School. The performance of the plant can be known through the measurement of voltage, current, power output of solar PV, as well as the measurement of the capacity of batteries and inverters in supplying the needs of electricity loads. If no problems arise, the power plant that has been built has worked according to plan. In addition, the ability of partner personnel in operating and maintaining solar power plants that have been built, including methods for evaluating the success of this community service program.

RESULTS AND DISCUSSION

A. Construction of solar power plant frame

In the solar PV system, the area built is designed with a model installed on the roof of the building. The construction of the solar power plant lasted for 3 weeks and also included the installation of maintenance stairs and hybrid inverters to be able to distribute the solar power plant system. The solar frame uses aluminum rails, mid clamps, end clamps, and L-Feet to make it easier to install and maintain later.

Figure 1. Design and Construction of Solar Power Plant Frames

The installed frame panels have an overall length = 1.16 meters and width = 5 meters and are installed at a height of 1 meter so that they can absorb sunlight optimally.

B. Construction of Maintenance Stairs

The design and construction of maintenance stairs in the solar PV system was carried out for 2 weeks. This aims to prepare the stair material so that it can be installed properly.

Figure 2. Construction of Maintenance Stairs at Solar Power Plant

The size of the stairs installed is 4 meters high and along the stairs a circular safety is installed to provide safety in climbing the stairs and the footing of the stairs using thick iron plates so that the construction is stronger and easier to install.

C. Solar Panel Installation

The design and installation of solar panels on the solar PV system was carried out for 5 days. The installation of these solar panels aims to convert sunlight into DC electrical energy. This series of solar panel cable connections uses mc 4 and Y – Branch so that the distribution of electrical energy is maximized and safer.

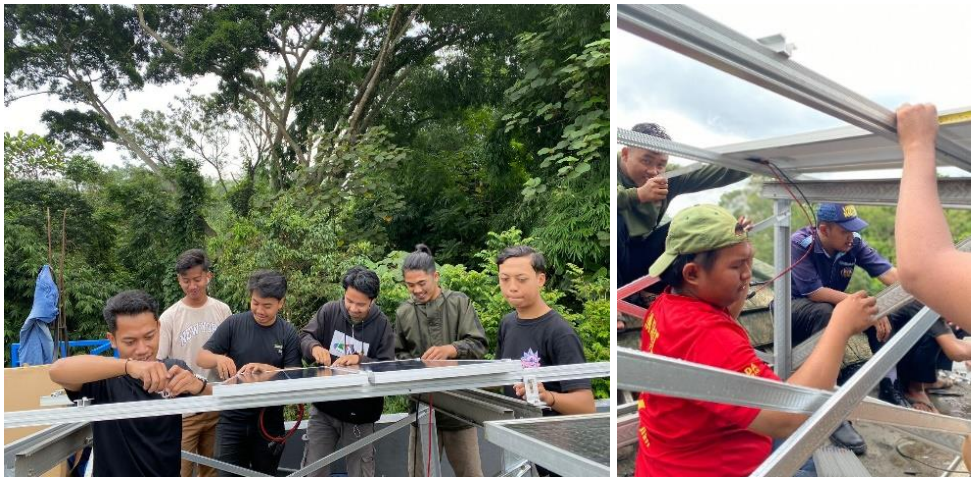

Figure 3. Installation of Solar Panels on Solar Power Plants

The dimensions of the solar panel have a length = 1.16 meters and a width of 4.5 meters and a slope of 12 degrees so that it can produce electrical energy optimally.

D. Installation of Hybrid Inverter in Solar Power Plant

Figure 4. Installation of Inverter in Solar Power Plant

In the installation planning of the Solar Power Plant, the inverter used is an HPS-3K inverter and the inverter power capacity is 2400 Watts. By using a hybrid system with PLN sources and batteries as backup supplies. Here are the inverter specifications: Power 2400Watt, Dimensions 255 x 90 x 350 mm, Hybrid inverter type HPS 3k, voltage from battery input 24 V, frequency: 50/60Hz, maximum pv input voltage: 80 Vdc, maximum charging current 50 A, maximum Vmp pv: 30-40 Vdc

E. Installation of Loads on Solar Power Plant System

In the loading of the solar power plant system distributed to a 3-storey building, this is considered quite effective in the use of electrical energy because it is used for lighting classrooms, student rooms, and other electronic devices.

Figure 5. Installation of Load Panels on Solar Power Plant

F. Solar Power Plant Testing

The results of the testing of the solar piko power plant that has been installed at the Al Ikhlas Orphanage and Dhuafa Islamic Boarding School can be seen in the following table.

Table 1. Solar PV Measurement Data

Power and Efficiency Calculation Results of Solar Module 10 x 100 Wp Connected Inverter							
Time	Temperature (^{0}C)	Iradiation (W/m^2)	Vmp (V)	Isc (A)	Pin (W)	Pout (W)	Efisiensi (%)
10.00	31,19	746,8	27,54	12,42	4884,35	342,05	8,8
10.15	34,79	762,3	28,12	12,61	4888,53	354,59	8,9
10.30	42,87	771,5	28,27	13,34	4896,36	377,12	9,4
10.45	42,91	810,3	28,44	13,68	4989,28	389,06	9,2
11.00	43,10	831,5	29,17	13,89	5281,07	405,17	9,3
11.15	43,23	849,9	29,63	13,55	5287,86	401,49	9,0
11.30	43,65	823,1	30,55	16,71	5334,84	510,49	11,9
11.45	43,20	874,7	31,38	18,22	5402,18	571,74	12,5
12.00	43,11	956,5	32,55	19,59	4466,75	637,65	12,8
12.15	42,68	962,6	32,86	24,32	4774,21	799,16	15,9
12.30	42,17	971,8	33,72	27,78	4813,88	936,74	18,5
12.45	41,96	976,3	34,21	28,22	5058,18	965,41	18,9
13.00	41,65	953,6	34,74	28,91	2997,85	1004,33	20,2
13.15	41,52	921,3	35,21	29,3	3366,38	1031,65	21,5
13.30	39,67	879,7	35,54	30,43	3541,77	1081,48	23,6
13.45	39,47	856,9	36,11	29,61	3641,47	1069,22	23,9
14.00	38,97	769,2	36,3	27,58	3688,97	1001,15	24,9
14.15	38,10	753,8	35,65	24,61	3704,11	877,35	22,3
14.30	37,98	731,1	33,42	21,86	3691,06	730,56	19,1
14.45	37,39	728,6	32,78	18,45	3762,05	604,79	15,9
15.00	36,79	657,2	30,25	17,28	1760,18	522,72	15,2
15.15	36,56	632,7	29,73	15,87	1819,17	471,82	14,3
15.30	35,78	583,6	28,91	14,22	1860,41	411,10	13,5
15.45	35,21	561,9	27,74	14,73	1861,45	408,61	13,9
16.00	33,89	533,5	27,58	13,56	1862,50	373,98	13,4
rata-rata	39,51	796,02	31,62	20,03	3905,40	651,18	15,47

From the table above it can be seen that the average voltage = 31.62 V, current = 20.03 A. So that the average output power that can be produced from the installed solar power plant is 651.18 watts.

G. Transfer of Knowledge and Skills

The transfer of knowledge and skills is urgently needed in order to maintain the sustainability of the operation and maintenance of the solar power plant system that has been built. To realize this, training or direct training in the field involving partner personnel, as seen in the picture below.

Figure 6. Field Training Process for Partners on Power Plants Surya at the Al-Ikhlas Orphanage Islamic Boarding School, Blue Hamlet, Gunungrejo Village, Singosari District, Malang Regency, East Java

After evaluating the results of the training or field training, it was found that 11 partner personnel have known, understood and are able to operate and maintain the solar power plant appropriately (100%). Meanwhile, 2 personnel has not mastered correctly (80%).

H. Final Results

The results of the Community Service Program activities that have been carried out include 3 main targets as listed in the table below:

Table 2. Achievements of Community Service Programs

No	Targets	Results	Indicators
1	Construction and Installation of Solar Power Plant 10 x 100 wp	Reached	The system works as planned
2	Solar Power Plant Testing	Reached	The system works as planned
3	Trafnsfer of Knowledge and Skills	Reached	Partners already understand how to operate and maintain the system (>85%)

The table shows the results of the achievements of the implementation of the community service program at the Al-Ikhlas Orphanage Islamic Boarding School, Blue Hamlet, Gunungrejo Village, Singosari District, Malang Regency, East Java. There are 3 targets that have been successfully achieved, including: (1) Construction and Installation of PLTS 10x 100 wp in accordance with the plan, both in terms of component specifications and estimated work

time, (2) Solar Power Plant Testing obtained results that the system built can be operated and produce the required electrical power in accordance with the plan, (3) The transfer of Knowledge and Skills to the Partner has been carried out and it has been obtained that thepartner understands how to operate and maintain the Solar Power Plant system (>85%)

CONCLUSSIONS

The implementation of this Community Service Program has succeeded in building and installing a Power Plant System Solar with a capacity of 10 x 100 wp. This solar power generation system has been able to meet the electricity needs in the area of the Dhuafa Al-Ikhlas Orphanage Islamic Boarding School, Blue Hamlet, Gunungrejo Village, Singosari District, Malang Regency, East Java for lighting and charging cellphone batteries and also other electronic devices with a maximum total power of 651.18 watt. As an effort to sustain the program, knowledge and skills have been transferred in terms of operation and maintenance of the hybrid power plant system to partners, namely the manager of the Dhuafa Al-Ikhlas Orphanage Islamic Boarding School, Dusun Biru, Gunungrejo Village, Singosari District, Malang Regency, East Java.

To increase the capacity of electrical energy sources in the region The Al-Ikhlas Dhuafa Orphanage Islamic Boarding School, Blue Hamlet, Gunungrejo Village, Singosari District, Malang Regency, East Java can be done by adding a Solar Power Plant (PLTS) considering the considerable potential for solar radiation in the area, an averageof a 900-11 00 W/m2.

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