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UTILIZATION OF A PICO HYDRO POWER PLANT AT AL-IKHLAS ISLAMIC BOARDING SCHOOL IN MALANG REGENCY

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Abstract

Al-Ikhlas Yatim Dhuafa Islamic Boarding School is ± 12.6 km from Malang City. If you look at it geographically, the location of this community service program is located at coordinates 7°58'27.0"S 112°48'14.8"E. To support activities in this tourist area, electrical energy is really needed, especially for lighting facilities and charging electronic equipment. This Community Service Program will be implemented between April and November 2022 with activities in the form of building a pico hydro power plant in the Al-Ikhlas Yatim Dhuafa Islamic Boarding School area, Singosari District, Malang Regency. In carrying out this community service program, there is one activity partner, namely the Al-Ikhlas Yatim Dhuafa Islamic Boarding School with a total of 6 personnel. The results of this community service program are the installation and operation of a pico hydro power plant with a capacity of 1000 watts. This pico hydro power plant can meet electricity needs in the Islamic boarding school area with a total power of around 450 watts. In order for the pico hydro power plant to operate according to its capacity, it is necessary that the operation and maintenance of the system equipment be carried out correctly and on a schedule. For this reason, the transfer of knowledge and skills to work partners, namely the management of the Al-Ikhlas Yatim Dhuafa Islamic Boarding School, has been carried out.

Keywords: Community Service Program, Electrical Energy, Lighting Facilities, Equipment Charging, Pico Hydro Power Plant

INTRODUCTION

The location of this community service activity is located in the Al-Ikhlas Yatim Dhuafa Islamic Boarding School area, Dusun Biru, Gunungrejo Village, District. Singosari, Malang Regency, East Java. The construction of a pico hydro power plant is planned as an alternative energy source by utilizing the river flow around the cottage. Apart from that, this power plant can be used as a means of education for students regarding electricity generation from renewable energy sources.

In the Al-Ikhlas Yatim Dhuafa Islamic Boarding School area, there is a river that has the potential to be a source of environmentally friendly electricity generation. For the

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placement of the Piko Hydro Power Plant (PLTPH), a location located on the edge of a river or on land is chosen. This reason is due to consideration of several things such as when a flood occurs, maintenance and component repair. The installed power capacity at the PLTPH is planned to be 1000 watts. The output from the 1000-watt PLTPH will be connected to a controller panel where a charge controller will be installed, which functions as a regulator of the charging current on the battery to store the power produced from the generator.

Implementation of this Community Service Program aims to build, operate and sustainably maintain a Piko Hydro Power Plant system, with a capacity of 1000 watts. The output power from this power plant will be used for electricity needs in the form of lighting for kitchens, gazebos and classroom hallways, as well as as a means of charging electronic devices. This activity was carried out in Al-Ikhlas Yatim Dhuafa Islamic Boarding School Area, Dusun Biru, Gunungrejo Village, Kec. Singosari, Malang Regency, East Java was chosen as the location for the Community Service Program which will be implemented for 8 months, from April 1 to November 15 2023

Figure 1. Location of Community Service Activities

In accordance with the analysis of the situation and problems of partners at the Al-Ikhlas Yatim Dhuafa Islamic Boarding School, the need for electricity is important and the main thing needed, we offer a solution to the problem of electricity availability as follows:

1. An energy usage audit is needed in order to provide recommendations for energy saving efforts at the Al-Ikhlas Yatim Dhuafa Islamic Boarding School
2. Alternative electrical energy sources are needed in the Al-Ikhlas Yatim Dhuafa Islamic Boarding School area to reduce the cost of using electrical energy from PLN.
3. It is necessary to produce environmentally friendly power plants that do not have a negative impact on natural conditions.
4. An alternative energy source that can be developed is Picohydro Power Plant technology by utilizing the river flow that flows in the area around the Al-Ikhlas Yatim Dhuafa Islamic Boarding School.
5. The water resources available in the Al-Ikhlas Yatim Dhuafa Islamic Boarding School area make it possible to utilize the Piko Hydro Power Plant with a capacity of around 1000 watts.
6. Safe electrical installation planning is required and in accordance with SPLN or PUIL standards

IMPLEMENTATION METHOD

This Community Service Program is implemented through the construction of a pico hydro power plant to meet the electricity needs of Al Ikhlas Islamic Boarding School. The installed power is 1000 watts. In summary, the implementation method is divided into several steps as follows:

1. Analysis of electrical power requirements required for operational activities in the Al-Ikhlas Yatim Dhuafa Islamic Boarding School area.
2. Estimation of the potential power that can be generated from water flow around the Yatim Dhuafa Al-Ikhlas Islamic Boarding School area to calculate the estimated capacity of turbines and generators.
3. Build the civil construction needed for the construction of the Piko Hydro Power Plant
4. If the generator power potential is found to be smaller than the load requirement, a priority scale for the load that must be supplied is prepared.
5. The next step is to design a turbine that is suitable for the conditions existing in the river flow in the area around the Al-Ikhlas Yatim Dhuafa Islamic Boarding School. Turbine materials must be made of materials that are corrosion resistant. The work begins by measuring the energy potential of the water flow by referring to existing equations in the literature.
6. Determine the generator that matches the power and rotation of the designed turbine. The planned generator must have high flexibility, be efficient and be able to rotate at low speeds to match the turbine.
7. Generator testing at the Malang State Polytechnic Electrical Machine Laboratory. Testing includes testing open circuit characteristics, generator short circuit and load characteristics.
8. Turbine testing was carried out in the Al-Ikhlas Yatim Dhuafa Islamic Boarding School area.
9. Electrical installation design for energy supply needs in the Al-Ikhlas Yatim Dhuafa Islamic Boarding School area including battery requirements, charger controller and protection system.
10. Comprehensive implementation of work which includes: construction and installation of turbine-generators, installation of electrical panels in appropriate locations, as well as electrical installation work.
11. The construction and installation of this picohydro power generation system also takes into account the possibility of flooding. So a safe location for the dam, equipment and electrical installations is chosen when a flood occurs.

The overall work implementation of community service activities in the context of developing a pico hydro power plant in the Al Ikhlas Islamic Boarding School can be described as follows:

a) Construction of Pico Hydro Power Plant (PHPP) Dam and Canal

In the PHPP system, the dam built is a curved dam. The construction of the dam took 3 weeks and also included the installation of 2 sluice gates, each installed on the side of the dam and the input to the canal. The design and construction of canals and calming tanks in the PHPP system was carried out over 2 weeks. This aims to channel the water flow and settle the

soil content contained in the flowing water and also filter the existing waste.

Figure 2. Construction of the PHPP Dam

The dam that has been built has a pillar height of 1.3 m, pillar width of 0.7 m, dam length: 2.6 m, dam height of 1.1 m and dam thickness of 1.5 m.

Figure 3. Construction of the PHPP Canal

The dimensions of the canal and calming tank that have been built are canal length 3.7 m, canal depth 0.75m, length and width of calming tank 1 m, depth of calming tank 0.75 m.

b) Installation of PHPP Pipes and Turbine Tank

The design and installation of pipes in the PHPP system was carried out over 2 days. The purpose of installing this pipe is to drain the water that has flowed through the canal and collected in a calming tank which is then channeled into a penstock pipe which leads to the turbine intake.

Figure 4. Installation of the PHPP Pipes

Dimensions of the Penstock Pipe to the Turbine Intake have specifications: pipe length 16 m, Pipe diameter 6, Pipe slope angle 1.47^0.

Figure 5. Construction of the PHPP Turbine Tank

The dimensions of the turbine body that have been built are the length of the turbine body 2.3 m, the width of the turbine body 2 m, the depth of the turbine body 1.5 m.

c) Installation of a Vortex Turbine and 3 Phase AC Permanent Magnet Generator at a Piko Hydro Power Plant (PLTPH).

The dimensions of the vortex turbine that have been made are vortex turbine height 1.17m, vortex turbine width 0.69 m, vortex turbine length 1 m.

Figure 6. PHPP Vortex Turbine

In the Al-Ikhlas PPYD PLTPH system, a 3-phase AC permanent magnet generator was chosen with a rotor composed of 12 pole permanent magnets. Meanwhile, the stator is in the form of a coil winding which can produce a 3-phase AC voltage output. To get DC voltage, a bridge converter is installed which is placed on the outside of the generator. There are 5 terminals on the bridge converter consisting of 3 inputs and 2 outputs (+ -) with a full wave rectification method.

Figure 7. Installation of a 3 Phase AC Generator

The following generator specifications for the PLTPH system include Rated Voltage (V) 12V/24V/48V, Rated Speed (rpm) 500 rpm, Maximum Power (Pmax) 1000 watts, Rated Torque 8.0Nm, Weight 4.5/4.8 kg, Efficiency > 75%.

The power transmission system from the turbine shaft to the generator shaft uses a pulley and V-belt to transfer power between two parallel shafts. Installation of the transmission system uses a pulley diameter ratio of 5:1. The installation of the generator and turbine clutch is installed horizontally, because it follows the position of the generator shaft and turbine pulley, so that the resulting rotation can be maximized.

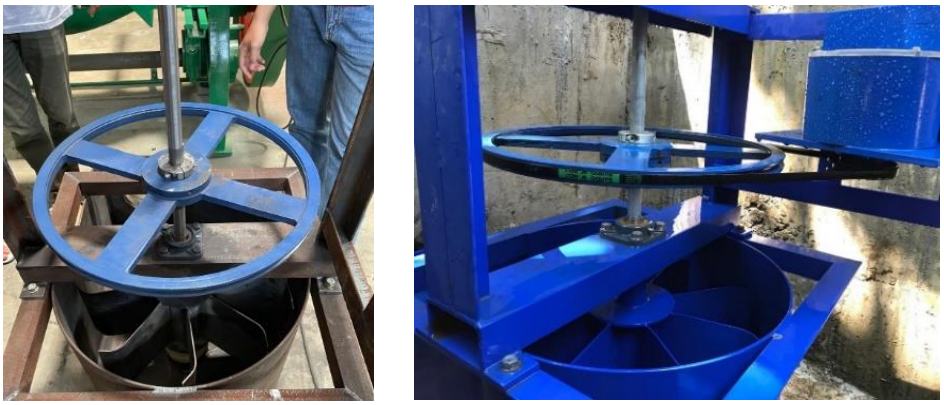

Figure 8. Installation of Vortex Turbine Clutch and Permanent Magnet Generator

d) Installation of Electrical Load Panels

On the main wiring loading panel there is a Buck DC-DC Converter which is used to change and reduce the DC voltage so that it is stable before entering the battery. Apart from that, there is a 16 A MCB to protect the output from the bridge converter and a Digital Power Meter to display information regarding the voltage and electric current passing through the system.

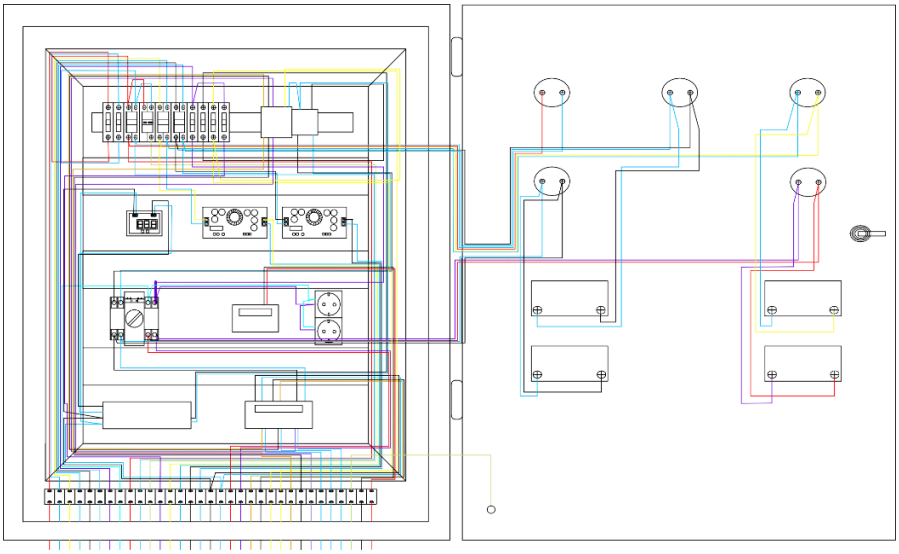

Figure 9. Electrical Load Panel

RESULTS AND DISCUSSION

The test results of the pico hydro power plant that has been installed at the Al Ikhlas Yatim and Dhuafa Islamic Boarding School can be seen in the following table.

Table 1. Electrical Load Measurement Data

Waktu	*Shaft Speed* (rpm)		Vin(V) DC-DC	Voltage (V)/AC	I in Batt (A)	I in DC-DC (A)	I out Beban (A)	Daya (watt)
	Turbin	Generator						
5 menit	77,7	370,5	30,04	26,03	22,61	2	27,73	721,811
10 menit	76	362	30,16	26,4	20,5	2,35	28,3	747,12
15 menit	77,6	370	30,14	26,6	13,9	2,3	27,86	741,076
20 menit	76,4	364	30,9	26,5	15,62	2,2	28,12	745,18
25 menit	76,5	364,5	30,87	26,6	16,9	2,12	28,14	748,524
30 menit	76,7	365,5	30,99	26,7	21	2	28,02	748,134
35 menit	74,8	356	30,03	25,8	19,26	1,92	29,47	760,326
40 menit	61,4	289	29,97	23,9	19,83	1,95	38,35	916,565
45 menit	61,8	291	31,2	23,95	13,11	1,96	38,3	917,285
50 menit	62,1	292,5	30,03	24,1	20,1	2,3	38,28	922,548
55 menit	64,9	306,5	30,01	24,3	20,24	1,93	36,4	884,52
60 menit	52,9	246,5	29,42	19,1	19,91	2	40,23	768,393
65 menit	61,9	309,5	29,85	24	19,82	1,75	34,32	823,68
Rata-rata	69,28	329,803	30,28	24,92	18,67	2,02	32,57	803,47

From the table above it can be seen that the average vortex turbine speed is 69.28 rpm which is equivalent to the average generator speed of 329.8 rpm. So, the average output power that can be produced by the installed electric generator is 803.47 watts.

The transfer of knowledge and skills to partners is very necessary in order to maintain the continuity of operation and maintenance of the pico hydro power plant system that has been built. To make this happen, direct training or training is carried out in the field involving partner party personnel, as shown in Figure 10.

Figure 10. Knowledge Transfer regarding the PHPP System to the Al Ikhlas Islamic Boarding School Personnels

After evaluating the results of training or field training, it was found that 5 partner personnel knew, understood and were able to operate and maintain pico hydro power plants

correctly (100%). Meanwhile, 1 personnel has not properly mastered how to operate and maintain pico hydro power plants (60%). The results of the Community Service Program activities that have been carried out include 3 main targets as listed in table 4 below:

Table 2. Achievements of the Community Service Program at the Al-Ikhlas Islamic Boarding School

No	Target	Results	Indicators
1	Construction and Installation of 1000 watt PLTPH	Achieved	The system works according to plan
2	Testing of the Piko Hydro Power Plant	Achieved	The system works according to plan
3	Transfer of Knowledge and Skills to Working Partners	Achieved	Partners understand how to operate and maintain the system (>90%)

Table 4 shows the results of the implementation of the community service program at the Al-Ikhlas Yatim Dhuafa Islamic Boarding School, Dusun Biru, Gunungrejo Village, District. Singosari, Malang Regency, East Java. There were 3 targets that were successfully achieved, including: (1) Construction and installation of a 1000 watt PLTPH in accordance with planning, both in terms of component specifications and estimated work time, (2) Testing of the Piko Hydro Power Plant resulted in the system being built being operable and produce the required electrical power in accordance with the plan, (3) Transfer of Knowledge and Skills to the Working Partners has been carried out and the results are that the partners understand how to operate and maintain the Piko Hydro Power Plant system (>90%).

CONCLUSION

Implementation of this Community Service Program has succeeded in building and installing a Piko Hydro Power Generation System with a capacity of 1000 watts. This pico hydro generator system has been able to meet electricity needs in the area of the Al-Ikhlas Yatim Dhuafa Islamic Boarding School, Dusun Biru, Gunungrejo Village, District. Singosari, Malang Regency, East Java for lighting and charging cellphone batteries and other electronic devices with a maximum total power of 450 watts. As an effort to sustain the program, knowledge and skills have been transferred in terms of operating and maintaining hybrid power generation systems to work partners, namely the management of the Al-Ikhlas Yatim Dhuafa Islamic Boarding School, Dusun Biru, Gunungrejo Village, Kec. Singosari, Malang Regency, East Java.

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