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Providing Clean Energy with Micro Hydro Power Plants (PLTMH) for Babakan Village, Banten

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ABSTRACT : Electrical energy is a vital need to support daily life in various sectors such as industry, housing and government. In Indonesia, the majority of electrical energy is still produced from fossil fuel plants, which have significant environmental impacts and limited resources. Therefore, the development of renewable energy is crucial to reduce dependence on fossil fuels. One promising alternative is the Micro Hydro Power Plant (PLTMH), which uses flowing water to produce electrical energy. This research focuses on the implementation of MHP in Babakan Banten Village, Bogor Regency, an area with the potential for abundant water flow throughout the year. This project aims to provide a reliable electricity supply for communities, most of whom do not yet have access to electricity from the national grid. This study includes the process of planning, assembling and testing the MHP system using field data such as river water discharge, land elevation (head) and other technical specifications. The measurement results show that the PLTMH with a generator capacity of 2 kW is able to meet the electricity needs of 18 houses in Babakan Village, Banten. System testing shows good operational stability with optimal turbine rotation at full load and results in accordance with planning. It is hoped that the implementation of this PLTMH will not only increase accessibility to sustainable electrical energy, but will also have a positive impact on the welfare of local communities. Utilization of locally available natural resources not only reduces dependence on conventional energy, but also becomes a real example of the application of technology for sustainable development in remote areas of Indonesia

Kayword : Clean Energy Provision, Micro Hydro Power Plant (PLTMH), Power Plant

1. INTRODUCTION

Electrical energy is an important need to support daily activities. Industry, housing and government rely on electricity provided by the State Electricity Company (PLN) or industrial power plants. In Indonesia, electrical energy sources come from fossil fuels and renewable energy. Fossil fuel plants use limited resources such as coal and natural gas, the processing of which has a negative impact on the environment. Continuous use of fossil fuels will deplete these resources (Setiawan, 2021). Therefore, research is needed to utilize renewable energy alternatives that are cheap, easy and sustainable.

Water has a very important role for human survival in various aspects. Apart from meeting human needs, water can also be used as an energy source to generate electricity (Suriadi, 2023). In Indonesia, there are many large and small rivers in Indonesia. This is opportunities for the development of electrical energy in areas especially areas where electrical energy is not yet various accessible (Ibrahim Nawawi, 2019).

Areas that still do not have access to electrical energy are classified as 3T areas (Disadvantaged, Frontier, Outermost). Rural areas in the mountains with large water potential

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are suitable for the construction of Micro Hydro Power Plants (PLTMH). Electrical energy in daily life is closely related to the economic conditions of a region. The use of electrical energy reflects the level of welfare of the area. However, some areas still do not receive electricity supply due to topographic conditions. To overcome this problem, alternative sources of electrical energy are needed, such as utilizing the abundant water flow in the area by building small-scale power generation facilities that suit the local topography. (Ibrahim Nawawi, 2019)

Micro hydro, which means "small" and "water," refers to small-scale power plants that use water as a driving force. Technically, micro hydro has three main components: water as an energy source, a turbine, and a generator to convert mechanical energy into electrical energy. Micro Hydro Power Plants (PLTMH) utilize irrigation canals, rivers or natural waterfalls by using the height of the waterfall (head) and water discharge to drive turbines and rotate generators (Wie, 2018). Apart from natural geographic aspects, head height can also be increased by building dams to increase the water level. The water is then flowed through pipes to the generator building which is usually built on the river bank. (Suriadi, 2023)

PLTMH, with a capacity of under 100 kW, is very suitable for many rural areas in Indonesia that are close to rivers. By utilizing this local potential, it is hoped that village energy needs can be met, reducing dependence on the national electricity grid and anticipating rising energy costs. PLTMH uses hydropower from irrigation canals, rivers or natural waterfalls, utilizing the height and flow of the water. (Ibrahim Nawawi, 2019)

The availability of water in Babakan Village, Banten is very abundant throughout the year, so the provision of PLTMH in this village is the right choice of new renewable energy because it has the highest potential compared to other energy. Apart from that, this is the right solution to overcome the shortage of electricity supply in this village which does not yet have electricity from PLN. Of course, the water flow rate used must meet minimum standards such as continuity and certain reliability values, namely the chance that the water flow rate will be achieved must be 90% to 95%. The process of analyzing water availability is very important because later the water discharge will be combined with the height of the ground surface (head) in order to determine the potential electrical power that can be generated. (Junaidi, 2023)

Providing clean energy with PLTMH aims to provide free, easy, cheap and sustainable electricity for the villagers of Kampung Babakan Banten because the majority of the village population does not yet have electricity from PLN. Therefore, it is necessary to provide alternative energy sources using the abundant natural resources of Babakan Banten Village, in the form of water.

2. METHOD

Activity Location

The 2024 IT-PLN Engineering Student Association Community Service activity program will be held in Babakan Banten village, Sirnajaya village, Kec. Sukamakmur, Kab. Bogor. With a distance of ±100 KM from the PLN Institute of Technology. With a travel time of 6 hours by motorbike.

Activity Location Survey

Babakan Banten village has limited access to electricity. Based on survey results, it is known that Babakan Banten village has 20 houses and the majority of houses in the village are not yet electrified by PLN. As far as is known there is only one house that is electrified by PLN and the houses that are not. Electricity is supplied by PLN using a simple PLTMH made by local residents with unstable electricity output. The surrounding community uses a simple MHP because the environmental conditions of Babakan Banten Village itself have quite high potential for use in the use of PLTMH. This is in accordance with the geographical conditions of Babangan Banten village which is located in the mountains. The data collected is in the form of water discharge, water flow rate, dam volume, and land surface elevation (head).

3. INTRODUCTION

Electrical energy is an important need to support daily activities. Industry, housing and government rely on electricity provided by the State Electricity Company (PLN) or industrial power plants. In Indonesia, electrical energy sources come from fossil fuels and renewable energy. Fossil fuel plants use limited resources such as coal and natural gas, the processing of which has a negative impact on the environment. Continuous use of fossil fuels will deplete these resources (Setiawan, 2021). Therefore, research is needed to utilize renewable energy alternatives that are cheap, easy and sustainable.

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Areas that still do not have access to electrical energy are classified as 3T areas (Disadvantaged, Frontier, Outermost). Rural areas in the mountains with large water potential are suitable for the construction of Micro Hydro Power Plants (PLTMH). Electrical energy in daily life is closely related to the economic conditions of a region. The use of electrical energy reflects the level of welfare of the area. However, some areas still do not receive electricity supply due to topographic conditions. To overcome this problem, alternative sources of electrical energy are needed, such as utilizing the abundant water flow in the area by building small-scale power generation facilities that suit the local topography. (Ibrahim Nawawi, 2019)


Figure 1. Simple windmill of the people of Babakan Village, Banten.

Figure 2. HMM Community Service Committee discussing with the head of the local household.

Figure 3. The Community Service Committee conducted a survey of the PLTMH installation location .

Water flow potential surveys as a reference in planning and constructing Micro Hydro Power Plants (PLTMH) are carried out using several method stages, namely:

- Determining the location for making PLTMH.
- Measuring river water discharge
- Analyze and calculate the potential power produced.
- PLTMH Scheme and Control Panel

So with these three stages the survey method carried out will be described as follows.

a. Determination of the location for making PLTMH

Determining the location for the construction of the PLTMH is carried out by following the river flow which is quite fast. Because to be able to rotate the PLTMH turbine, a sufficient flow of water or a fairly heavy water flow is required. After the PLTMH construction location has been found which has the potential for high water flow, confirmation is carried out with the village residents, firstly for approval for development there, and that the water flow remains stable throughout the season, even during the dry season.

b. Measuring water discharge

River water flow discharge measurements were carried out manually twice, the first time during the survey, namely measuring the river water flow discharge using leaves as a floating material for testing. The river path is straight and does not have turbulent flow that hinders the passage of the float used as a measurement medium. The buoy is tied and drifted from one point to another as shown in the picture below. (Sukamta, 2013).

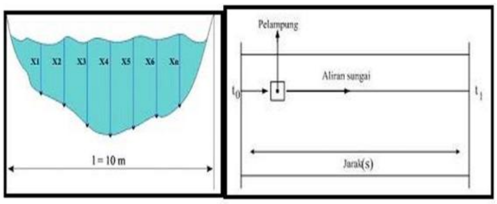

Figure 4. with use stopwatch

This is done 5 times in a row and then recorded time travel lifebuoy the (t 0 – t 1) with use stopwatch. Make it count time travel average from lifebuoy the, that is:

t average = (sigma t) / n

River water flow velocity (v) is obtained by dividing distance river (s) with time travel average from lifebuoy the, that is:

(t 0 – t 1), v = s / t average

Once the area and speed of the river flow are known, then big debit on the river can be analyzed:

Q=A.V (1)

Where:

Q = Water discharge (m3/s)

A = Penstock cross-sectional area

(m2)

V = Water Flow Speed (m/s)

c. Analyze and calculate the potential power produced

The data from the water potential survey is processed to determine the amount of power that can be generated using the equation

$P = \rho \, . \, g \, . \, Q \, . \, Heff$ (2)

Where:

P = generated power (Watts)

ρ = density of water = 1000 kg/m 3

g = gravity = 9.81 m 2 /s

Q = discharge (m 3 /s)

Heff = effective height (m)

d. PLTMH Scheme and Control Panel

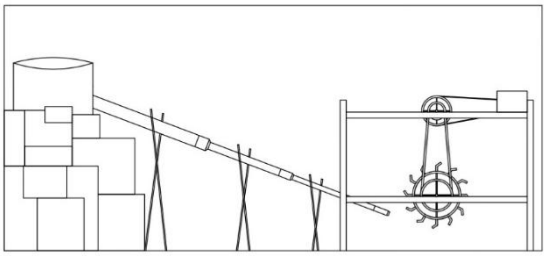

Figure 5. Schematic image of MHP

Planning and Implementation of the PLTMH Prototype includes several designs, namely; PLTMH Prototype design, PLTMH Prototype design, PLTMH Frame, planning of dam water sites, water turbines, generators, rapid flow pipes (penstock), and pipe support construction.

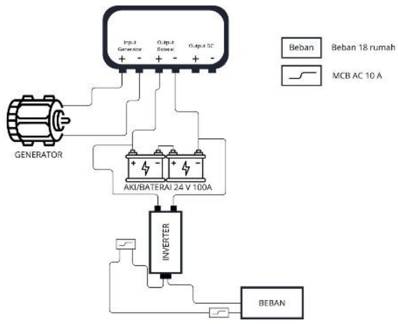

Figure 6. Electric Circuit Schematic Image

The electrical energy that has been generated through the generator is distributed to the controller to ensure that the system or device works as desired, from the controller it is channeled to the battery or battery, the distribution of electrical energy from the battery is via an inverter which converts DC (Direct Current) direct current into alternating current. Behind AC (Alternating Current) , there is an electronic device called MCB (Miniature Circuit Breaker) which functions to protect electrical circuits from damage due to overcurrent or short circuit .

4. RESULTS AND DISCUSSION

After coordinating with the local community, it was agreed that a water turbine would be provided and a dam built for a Micro Hydro Power Plant with a generator capacity of 2 kW. The dam will have an average size of 3.85 m x 3.45 m with an average depth of 0.8 m and an output volume of 9.5304 m³. The electricity load for 18 houses reaches 1280 watts. The water turbine used was originally of pelton design, but due to several limitations in making pelton blades, the turbine was changed to semi-pelton. The turbine is installed with a rapid pipe inclination angle of 12 degrees and a pipe length of 19.4 m, and a ground surface elevation of 5.84 m. An 8 inch diameter pipe is used to suck water from the still pool dam. Two reductions were made to increase water pressure: first from an 8 inch pipe to 6 inches, then from 6 inches to 4 inches, and ending with a 3 inch diameter nozzle that directly sprayed water onto the turbine blades. On an 8 inch pipe, there are two holes to reduce pressure so that the pipe does not burst.

PLTMH water turbines use iron material formed through a bending process, with hollow iron supports to ensure structural strength. Turbine blades are made of Aluminum Composite Panel (ACP), equipped with iron supports on each blade. Iron is coated with paint to prevent corrosion due to constant exposure to water. ACP was chosen for its three main advantages: light but strong, corrosion resistant, and easy to shape and cut to produce precise and efficient blade designs. This turbine has a thickness of 2 mm, a diameter of 1200 mm, and a width of 300 mm. The turbine shaft measures 1200 mm long with a diameter of 30 mm. The turbine is equipped with 12 blades to maximize the rotation resulting from the nozzle water flow.

Specification from generator Which used is as following:

- Max output: 2 KW
- Phase: 3
- Outputs Voltage: 220-240 volt
- Round: 2000 RPM
- Model: HA-SH202
- Brand: Mitsubishi

Picture 7. Manufacture of water turbines

Figure 8. Making a water turbine frame

Picture 9. Generators 2 kW

- **Assembly And Installation System Generator Electricity Power Microhydro (PLTMH)**

After the design process and identification of each component, the process of installing the generator mount and water turbine mount is carried out. This process was carried out in Babakan Banten Village, Sirnajaya Village, District. Sukamakmur, Kab. Bogor. The river dam is 3.8 m long and 3.45 m wide. The river has relatively the same discharge throughout the seasons each year based on information obtained from village residents. In Figure 7, the construction of the dam and installation of penstocks is carried out, and in Figure 8, the process of installing stands for the water turbine and generator is carried out.

Figure 10 Making the Dam and Installing the Penstock

Figure 11. Generator mount installation 3 kW and water turbines

- **Testing System Generator Electricity Power Microhydro (PLTMH)**

After installation, a testing phase is carried out on the PLTMH system with full load to evaluate the quality of the equipment that has been made. Testing includes measuring the voltage, current and power produced, both entering and leaving the battery. The main indicators observed are the stability of voltage, current and power. If it is unstable, repairs need to be made to the PLTMH system circuit.

The data obtained includes actual water flow discharge, validation of planning calculations, with a water discharge of 123.4 liters/second. The average turbine rotation at full load (1080 watts) reaches 1600 RPM, and the average generator pulley rotation is 2200 RPM. Based on these data, the turbine rotation is optimal for turning a 2 kW generator. Optimal battery charging occurs at a voltage of 13.2 volts, with an average power of 120 watts when all the lights are turned on and several switches are used to charge the cellphone battery.

Figure 12. Testing output voltage, power and current and measuring Pulley RPM

Figure 13. Pulley RPM measurement with a Tachometer

5. CONCLUSION

The construction of a PLTMH in Babakan Village, Bogor Regency, is an effective alternative to meet electricity supply needs, especially at night. This makes an important contribution to the continuity of residents' daily activities, which can now be run with electricity generated from this Community Service project. The impact will be on the welfare of the community in Babakan Village, Banten, Regency. Bogor, could increase because electricity is a major need in regions with developing economies. Increasing the need for electrical energy supplies also has the potential to improve the welfare of society as a whole. The availability of sustainable and reliable electricity is also very important, especially in the context of education and the economy.

6. SUGGESTION

This activity can be implemented in other locations that face similar problems, such as uneven or insufficient PLN electricity supply. Community Service Activities can be an important step in optimal development planning to increase student implementation of the Tri Dharma of Higher Education, which implements the knowledge that has been learned at the university.

GRATITUDE

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