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Planning for a Microhydro Power Plant (PLTMH) in Raja Jaya Village, Penukal District, Penukal Abab Lematang Ilir Regency

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Abstract: *The need for electrical energy is increasing, especially in rural areas, so building an environmentally friendly energy power plant such as a micro hydro generator can be used to produce electrical energy. This PLTMH planning aims to help the community produce environmentally friendly electrical energy and overcome frequent power outages. The research discusses determining the type of turbine, water discharge, turbine power and generator power at (PLTMH). The water discharge (Q) value of 2.67 m3/sec is the water discharge during the rainy season. From the calculation results, it can generate 25.65 kW of electrical energy, the type of turbine used is an open flume propeller type turbine, the planning of a micro-hydro power plant with a turbine power capacity of 60 kW and a generator of 50 kW greatly influences the power that will be produced by the turbine, which This means that the greater the water discharge, the greater the power generated by the turbine, conversely, if the water discharge is small, the power produced by the turbine is relatively small.*

Keywords: *Turbine, Generator, Turbine Power*

1. BACKGROUND

One of the basic needs of modern society, both for daily activities and business, is electrical energy. Fossil fuels such as petroleum and coal are still used as sources of electrical energy in Indonesia. However, the potential of renewable and new energy has not been fully exploited. (Putra, Giriantari, & Setiawan, 2023)

In accordance with the mandate of Law No.30/2007, which was amended to become Presidential Regulation no. 79/2014, the Indonesian government targets 23% growth in the development of new and renewable energy by 2025 through the relevant ministries.(Anam, Sunaryantiningsih, & Yuniahastuti, 2022) in support policy energy green Indonesian government. The aim of this program is For do transition from material burn fossil energy new renewable in system Indonesian energy. Apart from that, policy This continue the termination program generator electricity power steam, also known as a termination program generator electricity power steam, with consider principle justice and balance.

The absence of electricity is called a blackout. Overloading, short circuits, damage to cable networks or other parts of the distribution system, or damaged electrical substations can be a source of technical problems. In providing electricity services, PT. PLN (Persero) is trying to maintain customer safety and security, especially during the

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current rainy season. To maintain customer safety, PLN must cut off electricity (blackout) under certain conditions. Many things can cause electricity to be cut off during the rainy season. First, electrical substations are under water, and flooding can occur if there is enough rain. In certain situations, electricity must be stopped temporarily. This is done to avoid electrical shocks that endanger customers and to reduce the possibility of larger electrical disturbances. Then, fallen trees are another factor that can cause electricity to be cut off, apart from flooding. Third, intense rainfall can also cause landslides, which can destroy networks and stop electricity supplies. Fourth, the rainy season with lightning can also cause electricity distribution disruptions. Lightning strikes on distribution transformers and the PLN network are one of the most frequent sources of electrical disturbances.

Raja Jaya Village is in the Regency Penukal Abab Lematang Ilir and has 1452 residents living in 309 houses. Raja Jaya Village often experience blackout electricity, which hinders activity inhabitant. Generator electricity power Microhydro is very important Because can works as source power reserve moment blackout electricity happen.

While the need for electricity is increasing in rural areas, environmentally friendly micro-hydro generators can be used to produce electricity through dam channels in Raja Jaya Village, Penukal District, Penukal Abab Lematang Ilir Regency. The water potential in Penukal District is very high during the summer and rainy season, and rainfall in Penukal District has increased in the last five years reaching an average of 208.5196 mm per year so it can be believed that the dam channel in Raja Jaya Village will never lack energy. water (http://palikab.bps.go.id)

2. THEORETICAL STUDY

According to the Big Indonesian Dictionary, "mikrohydro" comes from the words "mikro", which means "small", and "hydro", which means "water." The term "PLTMH" refers to electricity generating installations that use water energy with a small water flow.(Wie & Agung, 2018)

Microhydro power plants (PLTMH) are small-scale power plants that use hydropower such as waterways, rivers or natural waterfalls. The basic principle of PLTMH is to utilize the potential energy of water flow at a distance of falling height

(head) to produce usable power. It is a system that converts energy from height and flow (potential energy) into mechanical and electrical energy.(Juliana, Weking, & Jasa, 2018)

The three main components of microhydro technically are water, turbine and generator. Water that has a certain capacity flows through a certain channel via a rapid pipe to the installation house. Inside the installation house, the water flowing through the rapid pipe hits the windmills on the turbine, which produces mechanical energy through the rotation of the turbine shaft. Next, the rotation of the turbine shaft will rotate the generator to produce electrical energy.(Ardo, Emidiana, & Perawati, 2022)

PLTMH Working Principles

According to Ihsan, M. (2022) The main principle of microhydro is to utilize the potential energy of water flow at a certain distance from the power plant location. The microhydro scheme requires two components: water discharge and water fall height (head). It is a system that converts energy from height and flow (potential energy) into mechanical and electrical energy. The working principle is that water flows into a water turbine, which then turns the blades. The energy produced from the rotating blades is sent to the generator, which then converts the motion energy into electrical energy. Figure 1 shows a schematic of the working principle of microhydro.

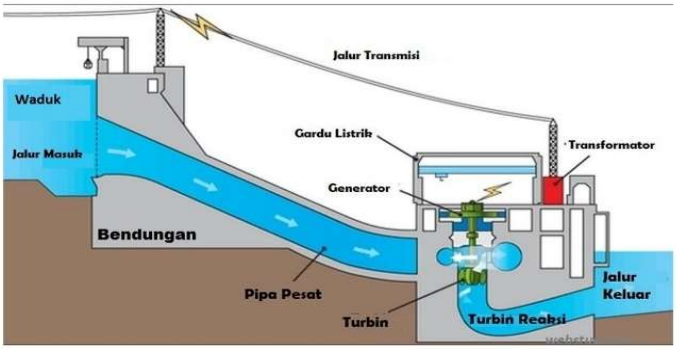


Image of PLTMH Working Principles

So, to calculate the power generated by the PLTMH, it can be written using the following equation:

$$P = \rho \times g \times Q \times H \times \eta$$

Where:

P = Power generated by PLTMH (Watts)

ρ = Density of water (Kg/m3)

g = Gravity (9.81 m/s2)

Q = Water Flow Discharge (m3/s)

H = Height (m)

η = PLTMH System Efficiency, PLTMH System Efficiency is generally 0.85

PLTMH components

According to Azzam. & Erianto (2019) , PLTMH generating systems usually use river surface water flow (runoffriver). The PLTMH system components consist of:

1. Water supply structures: Many MHPs use dam channels and plunge structures to provide water. The PLTMH planned in our planning uses a dam channel.
2. Carrier channel (*Headrace*)

   The carrier channel is part of the system (PLTMH) which functions as a channel that flows air from the intake building or settling tank to the settling tank. This channel also functions to stabilize the air flow, so that the water distributed can be used effectively and efficiently.
3. Headtank (Calming Tank)

   The function of the stilling tank is to accommodate the water channel from the dam channel as a reserve for the shortage of utilized water discharge, which is displayed through a rapid pipe.
4. Penstock pipe

   In PLTMH, the calculation of effective fall height (net head) is carried out by taking into account head losses according to the penstock design.
5. Sewer (tailrace)

   One part of the PLTMH, the exhaust channel channels the air discharge that comes out of the water turbine to then be discharged into rivers or irrigation canals. This channel must be the same or larger than the intake channel to anticipate rapid changes in discharge.
6. Generator House (Power House)

   The power house is an important component of the power plant (PLTMH). The main function of the power house is as a place for equipment where electrical and mechanical components are installed.
7. Turbine

   The turbine is component important in system microhydro Because accept energy potential of water and change his become energy rotation (mechanical). Energy mechanic This Then twist axis turbine to the generator.

8. Generator

   The generator produces electrical energy from the mechanical energy produced by the turbine rotation.

Dam

Dam deflect water flow. Purpose of creation dam is For raising and controlling river water levels so that elevation water level is sufficient For redirected into the intake.

A number of classification differentiate type dam. Dam differentiated become four type based on function: water reservoir, diversion dam, controller floods and dams multipurpose. Dam shared into two types based on aspect hydraulics: permissible dams overflowed by water (overflow dam) and the dam that is its source No yes overflowed by water (non-overflow dam). Based on the materials used, the dam differentiated become dam style heavy, dam with buffer, dam with buffer .

To channel water from the dam to conveyor channels, stilling basins and penstocks, the intake construction is usually made with sluice gates to carry out sediment flushing.(Firmansyah, Utomo, & Purnomo, 2014)

3. RESEARCH METHODS

Study This will use approach qualitative descriptive For analyze and explain condition planning (PLTMH) on site study. Interview with people in society local or nara source carried out on location study besides do observation. The research will be carried out at the Raja Jaya Village Dam, Penukal District, PenukalAbab Lematang Ilir Regency. So, the research discusses determining the type of turbine, water discharge, turbine power and generator power at (PLTMH).

In writing this thesis, the author conducted research at the Raja Jaya Village Dam, Penukal District, PenukalAbab Regency Lematang Ilir, South Sumatra

Image of Microhydro Power Plant Research Location Map

4. RESULTS AND DISCUSSION

General description of the Raja Jaya Village Dam Channel

Raja Jaya Village is a village located in the Penukal District, PenukalAbab Lematang Ilir Regency, South Sumatra Province. Raja Jaya Village itself has a population of 1,452 people with 309 houses , a distance of 87 km to the west from the capital of South Sumatra.

The Raja Jaya Village Dam channel is located between settlements and local community plantation land. Physically, the dam's water flow comes from the Penukal river which is not far from the dam. The dam data can be seen in the following table:

Table of Dam Measurement Results

No.	Dam Data	Meters
1	Length of Dam building	100
2	Dam Height	4
3	Sluice width	1
4	Height of spillway building (pillway)	2

Image of the Raja Jaya Village Dam Channel

PLTMH Specifications

Table under This show possible specifications set For Raja Jaya Village Microhydro Power Plant, District Penukal, Regency Penukal Abab Lematang Ilir, based findings study previously.

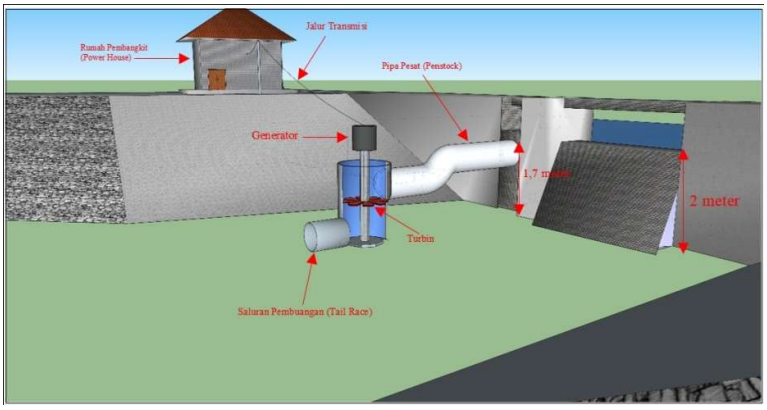
Table

Results of calculations of PLTMH power capacity

Raja Jaya Village, Penukal District

PenukalAbab Lematang Ilir Regency

Parameter	Symbol	Mark	Unit
Turbine type	*Propellers*	-	-
Type	*Open flume*	-	-
Debit	Q	2.67	m3/sec
Head	H	2	m
Dam flow speed	V	1.08	m/s
Turbine speed	N	1500	Rpm
Turbine efficiency	η_T	0.80	Faction
Mechanical transmission efficiency	η_{TR}	0.90	Faction
Generator efficiency	η_G	0.80	Faction
Turbine power capacity	Pt	60	kW
Generator power capacity	P.G	50	kW



Detailed design drawing of PLTMH

Analysis

The results of surveys, measurements and calculations have been carried out done during the planning process can used For plan generator electricity power microhydro.

With planning tall fall (head) 1.7 meters, water discharge can be reached 2.67 m3/s, according to measurement field. When conditions dam dry and still is down rain, this discharge happen. the data show that turbine can produce power 35.62 kW.

The turbine used in this research is an *open flame type propeller turbine* which is considered very suitable for low fall heights with a turbine efficiency of 0.80%. From the power produced by this turbine, a generator that is suitable for use can be determined, namely the *Suneco Hydro generator* with an output capacity of 50 kW, the power that the generator can generate, with a generator efficiency of 0.80% and a turbine shaft and generator shaft efficiency of 0.90%. So the power that can be produced by the generator is 25.65 kW.

This existing power will be given to the community in Raja Jaya village. The control system plan used is an electric power controller, because it is considered the most suitable for use in the Raja Jaya village PLTMH and is easy to understand by the local community.

Based on the results of calculations that have been carried out, the Raja Jaya village dam has the potential to build a micro-hydro power plant system. Even though it is not that big, at least this generator plan can turn on the power for lighting during a power outage in Raja Jaya Village, Penukal District.

5. CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the analysis and calculations that have been carried out, at the dam in Raja Jaya Village, Penukal District, Penukal Abab Lematang Ilir Regency, it can be concluded:

1. According to calculation, flow dam in Raja Jaya Village, District Penukal, Regency Penukal Abab Lematang Ilir can produce energy electricity of 25.65 kW when Rain Keep going down. Dam own 4 meters high, tall The effective water fall is 1.7 meters, and the available discharge is 2.67 m3/sec.
2. For PLTMH planning in Raja Jaya Village, District Penukal, Regency Penukal Abab Lemtang Ilir, type an open flume type propeller turbine is used. Turbine type This No need tall high fall and is considered very suitable with characteristics Raja Jaya Village dam.

3. Based on calculations that have been made carried out, researchers can find planning For generator electricity power microhydro which has capacity Power 60 kW turbine and 50 kW generator.
4. Influential debit big to power that will be produced by the turbine. Compare straight, here means that the more lots of water discharge, increasingly big possibility generated power turbine, but if the water discharge is more small, then generated power turbine more A little.

Suggestion

so that planning for micro-hydro power plants can be used effectively in the future and suggests that generators and turbines can produce greater output as a result of the increase in population which automatically consumes more power. and it is recommended to add a discussion regarding economic costs to provide an idea of how much it costs to build the PLTMH.

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