Microhydro potential in Gunung Pasang plantation Panti
Jember East Java

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Abstract. Gunung Pasang plantation is located in Panti-Jember. The Gunung Pasang plantation
actually already has a Francis type microhydro turbine with a power output of around 30 kW.
However, this power is still too small when compared to energy needs in plantations which can
reach 90 kW. The aim of this study is to find the potential of micro-hydro energy in the
Gunung Pasang plantation as a reference for developing micro-hydro energy in the plantation.
Potential studies are carried out by measuring the discharge using a current meter and
measuring the difference of elevation using a automatic level and altimeter. The result of
measurement of potential river flow discharge in the dry season is 0.202 cms. The difference in
elevation measured at the first point is 54.19 meters and the second point is 113.09 meters.
Microhydro power potential by taking a discharge 0.18 was calculated for the first point and
the second as 69.61 kW and 145.27 kW, respectively. Utilisation of potential power in
the second point was able to meet the electricity needs of the plantation. Economic feasibility
analysis is needed if the micro hydro potential is to be developed.

1. Introduction
Gunung Pasang Plantation (GPP) is located in the village of Kemiri, Panti District, Jember Regency,
East Java Province. Gunung Pasang Plantation is on the southern slope of Mount Raung. The
plantation area is planted with rubber and coffee. Plantations are also passed by rivers with flowing
water that always flows in every season.

The potential of micro hydro energy in Indonesia is quite large. This potential exists because of the
water flows. The water flow occurs because of differences in elevation [1, 2]. Gunung Pasang
plantations have francis-type microhydro turbines that are nearly a century old. Existing microhydro
turbines are used for mechanical energy directly for milling rubber during the day and are used for
electricity generation at night. Microhydro turbines that are already owned can produce about 30 kw of
power.

Microhydro turbine energy that has been owned has not been able to meet the energy needs in
gunung pasang plantations. Energy demand reaches its peak when processing coffee and rubber at
the same time about 90 kW. Processing rubber requires a lot of energy during milling which lasts about 12
hours per day. Coffee processing is only done during the coffee harvest season, which is around June
to October. The lack of energy generated by micro-turbine turbines in Gunung Pasang plantations is
met by generators using diesel fuel. The need for diesel fuel can reach more than 5000 liters in coffee harvest season.

Research on the potential of microhydro in Gunung Pasang plantations needs to be done to find out the potential of existing microhydro. Microhydro potential studies will show whether the existing microhydro potential will be able to meet the energy needs of the plantation if it is developed.

2. Microhydro Energy Potential

Water flows from high elevation to the low elevation. The potential energy possessed by water at an elevation is called the water's potential energy. The potential power of water is calculated by the following equation:

\[ P = E_f \times \rho \times g \times Q \times H \]

Where:
- \( P \) is power (Watt)
- \( E_f \) is hydraulic efficiency
- \( \rho \) is the density of water (998.203 kg/m\(^3\) in 20\(^\circ\)C)
- \( g \) is the gravity acceleration (9.807 m/s\(^2\))
- \( Q \) is discharge through the turbine (cms)
- \( H \) is head of water (m)[3, 4, 5, 6].

Microhydro potential is influenced by the head and discharge of water flow. High head and discharge will have high energy potential as well. Mountain area is the catchment area of the rivers that flow under it. Mountainous areas have high head potential with good water quality because they are not polluted. Gunung Pasang plantation has an elevation of around 500 m above sea level. High elevation and steep slope have high microhydro head potential. Micro hydro is an energy source that utilizes the potential of water power with a power value between 5 kw to 200 kW [4, 5].

The choice of the type of turbine that will be used for microhydro power plant is influenced by the discharge, head and its power potential. The selection of the turbine can be based on the turbine diagram as shown in fig. 1 [7, 8, 9].

![Figure 1. Turbine Card](image-url)
3. Method
The research survey of the micro-hydro potential in the Gunung Pasang plantation is located in Kemiri Village, Panti District, Jember Regency, East Java Province, Indonesia. The location is at an elevation of 500 to 700 m above sea level. The research began in July to October 2019. The survey included a survey of potential river flow discharges and elevation difference surveys. The equipment used for water discharge surveys is the Flowatch current meter, rollmeter and iron ruler. The equipment used for elevation difference surveys is Topcon AT-B2 automatic level telescope, telescopic levelling staff and Garmin GPS map 62S.

A potential water discharge survey was carried out in a river located around 1200 m from the factory location of Gunung Pasang plantation. The discharge survey begins by determining the location of the flow velocity measurement. River crossing is measured using a rollmeter and its depth is measured using an iron ruler. River flow velocity is measured using a current meter. River flow velocity measurements are carried out as shown in fig. 2.

![Figure 2. River flow velocity measurement](image1)

A potential water discharge survey was carried out in a river located around 1200 m from the factory location of Gunung Pasang plantation. The discharge survey begins by determining the location of the flow velocity measurement. River crossing is measured using a rollmeter and its depth is measured using an iron ruler. River flow velocity is measured using a current meter. River flow velocity measurements are carried out as shown in fig. 2.

![Figure 3. Elevation difference surveying](image2)
The height difference survey was carried out from the location of the factory to the location of river flow measurement. Measurements were made using automatic level and telescopic staff. Automatic level is used to aim at two locations, one lower and one higher so that the elevation difference can be known [3, 4, 10, 11]. The elevation difference survey was conducted as shown in fig. 3.

4. Result and discussion
A survey of potential river flows conducted at the Gunung Pasang plantation produces discharge data. River flow discharge is presented in graphical form as shown in fig. 4. River flow decreases over time through the dry season. The lowest river flow discharge occurs at the peak of the dry season which is 0.202 cms. The lower discharge occurs because there is no rain in the river catchment area. The lowest river water discharge is used to determine the potential of microhydro. Discharge potential obtained in the dry season will definitely be obtained in the rainy season. Rain in the catchment area increases the discharge of the river [2, 3, 4, 10].

![Figure 4](image.png)

**Figure 4.** Water discharge in the river

The measurement results for the elevation difference for the first point are 54.19 m. The location of the first point is about 720 m from the factory. The result of measurement of elevation difference at the second point is 113.09 m. The location of the second point is about 1222 m from the factory. The location of the first point is included in the medium head category. The location at the second point is included in the high head category [3, 4]. The location of the first and second points is shown in fig. 5.
Microhydro power potential can be determined based on the results of the measurement of potential discharge and the elevation difference that has been done. The type of turbine that can be used is based on the turbine selection diagram in fig.1. Based on fig.1 and by taking a discharge of 0.18 cms, the type of turbine that can be used is the pelton type. Pelton turbines have a power efficiency of around 90%. The generator also has an efficiency of around 90%. The mechanical efficiency of power transmission of around 90%, bringing the total efficiency to 72.9% [2, 3, 4, 8, 12]. The calculation result of microhydro power potential for the first point is 69.61 kW and for the second point is 145.27 kW. Utilization of potential power in the second point will be able to meet the electricity needs of the plantation. The microhydro potential exceeds the electricity needs of the plantation which reaches 80 until 90 kW.

Potential power at the first point is almost sufficient for energy needs for the plantation. Potential power at the second point will be able to meet the energy needs of the plantation. Economic analysis is needed if the potential development of microhydro will be applied. Economic analysis needed is benefit cost ratio, net present value and IRR [12, 13, 14]. The economic analysis can also compare microhydro electric plants with diesel engine generators. It can also be compared with PLN electricity sources.

5. Conclusion
The microhydro potential in Gunung Pasang plantations is 69.61 kW for the first point and 145.27 kW for the second point. Economic analysis is needed for the development of micro hydro on the plantation.

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