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by

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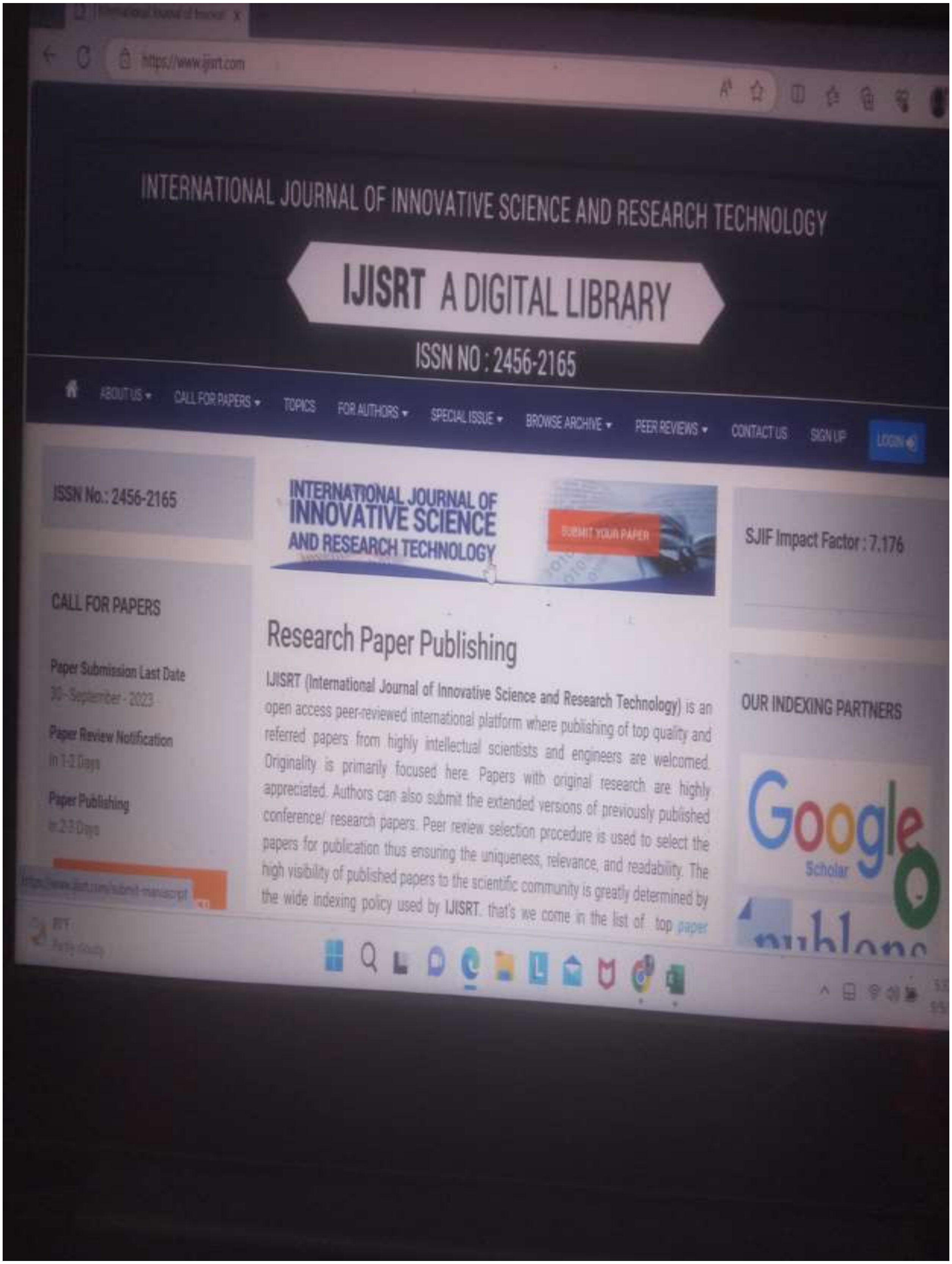
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Economic Planning Analysis of MHP PLTMH using Pico-Hydro Turbine: Hundreds of watts - 5 KW

IndraRoza[1], Junaidi[2], Faisal Irsan Pasaribu[3], Weriono[2], SoniHestukoro[4]
[1]Department of Electrical Engineering University Harapan Medan
[2, 4]Department of Machine Engineering University Harapan Medan.
[3]Department of Electrical Engineering University Muhammadiyah Sumatera Utara
[4]Department of Machine Engineering Poletecnic Negeri Medan

Abstract:-Micro hydro is used for power plant installations that use water energy. Water conditions that can be utilized as electricity generating resources have certain flow capacity and specificity of the installation. The greater the flow capacity and height of the installation the greater the energy that can be utilized to generate electrical energy. Data at a location is as follows: Q = 39.9 m3 / s, Hn = 24 m and η = 0.5. So, the magnitude of power potential (P) is: 4.69 Kw with Pico-hydro turbine specification between 5 KW, To build a PLTMH with an installed capacity of 1 kW, an initial cost of Rp 4 million is required. Micro hydro lifespan designed is 10 years at a cost. Operational Rp. 1 Million / year. So the total cost becomes Rp. 10 million. Therefore, the average cost (Rp) per day is Rp 3836 / day, while Cost (price) per kWh is determined by the average daily cost and the amount of electric energy generated per day (kWh / day). Energy per day is determined by the amount of installed power and power factor1. If the power factor is assumed to be 12, then the price of electric energy per kWh is Rp 320 / kWh.

Keyword:-Anlalisis, Planning Ekonimis PLTMH, Pico-Hydro Turbine, 5 kW.

I. INTRODUCTION

Pyco hydro power plant (PLTMH) is one form of alternative energy that is very possible to be developed in countries with widespread water sources, such as Indonesia. Di rural areas generally have the main irrigation channel serves to dance rice fields and also potentially to be used as a powerhouse. [1] The energy utilized from water to generate electrical energy is the potential energy of water. That is energy possessed by water due to its position. The position in question is the height of the water surface to the turbine shaft to the turbine shaft in the powerhouse. Water that has the altitude is flowed so that it has kinetic energy as the velocity of the flowing water. This kineticenergy is used to rotate. In this process there is a change of kinetic energy owned by water into mechanical energy. Furthermore, the mechanical energy is used to rotate the generator. In the generator there is a change of mechanical energy into electrical energy as a result of the presence of a magnetic field in the generator.[2]Photographic Conditions in Seirampah Sub-districts are often flooded and many studiesonavailable discharge and how much energy and power are generated at the site. So the focus of research researchers do lie in the calculation of available water discharge and the amount of energy and power generated that can be utilized to make a good PLTMH and meet the needs of the community [3]Micro Hydro Power Plant(PLTMH), commonly called Micro hydro, is a small-scale power plant that uses hydropower as its driver, for Example irrigation channels, rivers or natural waterfalls, by utilizing the height of the head (in meters) and the amount of water debit (m3 / sec) [4].

II. THEORETICAL BASIS

A. Working Principles of PLTMH

The working principle of PLTMH is simple:
a certain amount of water dropped from a certain height drives the existing mill on the MHP Turbine, then the Turbine's rotation is used to drive the Generator (an electrical generator). " So the PLTMH changes the power of motion that comes from water into electricity.

The energy used to drive the turbine is derived from two ways: With Head: utilizing a different height of the water surface (potential energy of the river) No Head: utilizing river flow (river kinetic energy). Head = vertical distance / the height of the fall of water The bigger head will generally get better because the water required is less and the equipment is getting smaller, and the turbine is moving at high speed. The problem is the pressure on the pipe and the strength of the pipe connection must be strong and carefully observed.

B. Output power generated by PLTMH

- Large-hydro: Power above 100 MW
- Medium-hydro: Between 15 MW -100 MW
- Small-hydro: Between 1 MW - 15 MW
- Mini-hydro: Between 100 KW-1 MW

- Micro-hydro: Between 5 KW - 100 KW
- Pico-hydro: Hundreds of watts - 5 KW

C. Turbines

Turbines are used to convert kinetic energy water energy into electrical energy. Modern turbines are equipped with ELC to stabilize the rotation so that the rotation will remain stable even in excessive water currents.

The selection of turbine technology in mini-micro hydro power plant development mainly lies in the selection of the main components of turbines and generators. This is due to the area to be installed mini-micro hydro power plant has a specific characteristic. The choice of turbine-powered type depends on head and water discharge. For high altitude mountain areas, high head turbine types are more suitable for use while in flat areas with large water discharges can use a type of turbine canal drop low head turbin.

D. Type of Turbine

- Large-hydro: Power above 100 MW
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E. Generator

Generally there are two types of generators used in PLTMH, ie synchronous generator and induction generator.

synchronous generators work at variable speeds. In order to keep the speed of the generator fixed, the electronic governor speedometer is used. An instrument or mechanism that senses a parameter and automatically controls it and maintains it at a specified level

This type of generator can be used directly and does not require another power grid as an initial driver. In the induction generator there is no need for a system of voltage regulation and speed. However, this type of generator can not work alonebecause it requires an electrical network system as the initial driver.

This type of generator is more suitable for areas that have been passed through the grid system (Grid System

F. Measurement Height of Water (Head)

Determination of the discharge and head on the MHP has a very important meaning in calculating the potential of electric power. As in figure 2. The discharge variable is "represented" by the average number of dry months in a year. This means that sought for areas with a small number of dry months or even no dry moons are the same. Measurement of water discharge (Q) river basically there are many methods of measuring the flow of water. For large-scale water-conversion systems, debit measurements can take years. As for small-scale water energy conversion systems the measurement time can be shorter, for example for a few different seasons only. (WIBAWA, U. 2006). The degree of slope represented by the schematic gradient indicator, the more italic the area, the more likely it is to find enough heads for the MHP.

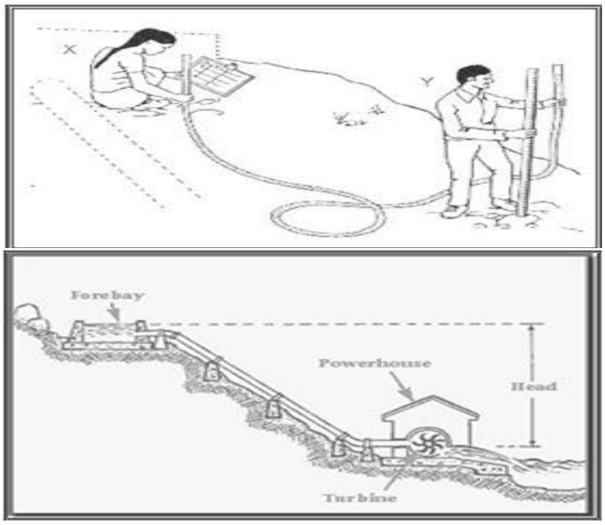

Figure 1 Measurement of water falling height

The average schematic gradient is formulated as follows:. (WIBAWA, U. 2006)

$$I = \frac{h_1 - h_2}{A} \quad \text{... (2.1)}$$

Where :

h1 = Elevation of highest point (m)
h2 = Elevation of lowest point (m)
A = Area Area (m2)

G. Measurement of Water Debit

There are many methods of measuring water discharge. Large-scale water-conversion systems of debit measurements can take years. As for small-scale water energy conversion systems the measurement time can be shorter, for example for a few different seasons only. . (WIBAWA, U. 2006) Enhances the river surface area, and river flow velocity can be carried out as following measurement steps: (SUBROTO, I 2002).

a. River depth measurements were performed at different points X1 - Xn (as shown in Figure 2.).
b. River width (l) is 10 m.
c. Calculate the average depth, using the formula:

$$x_{rata} = \frac{\Sigma x}{n} \quad \text{................................... (2.2)}$$

d. The width is obtained by multiplying the average depth by the width of the river, ie:

A = X (average). L .... (2.3)

Measuring river flow velocity (v), measurement steps:. Look for a straight section of the river about 20 meters long, and have no current to stop the life of the buoy. (Subroto, 2002)
A. Tie a buoy then drifted from the point t0 - t1 as shown in Figure 2 below.

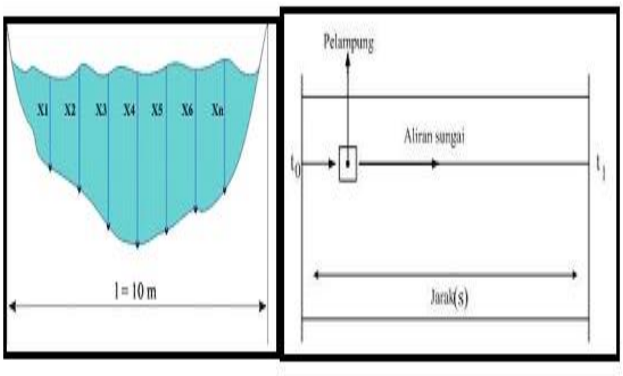

Figure 2. a. Measurement of River Surface Area
b. Measurement of River Flow Velocity

The greater the flow capacity and height of the installation the greater the energy that can be utilized to generate electrical energy. Based on the output produced, hydroelectric power. Mini-hydro: Power above 100 kW, below 1 MW
The conversion equation can be written as follows:

Input power = Outgoing power + Loss (Loss) .... (2.4)

Or
Output power = Incoming power × Conversion efficiency......... (2.5)

The above equations are usually used to describe small differences. The incoming power, or the total power absorbed by the hydro scheme, is the gross power, Pgross. Power whose benefits are delivered is clean power, Pnet. If the efficiency of the scheme is Eo, then the equation can be written as:

Pnet = Pgross × EokW .... (2.6)

The gross power is the gross head (Hgross) multiplied by the flow of water (Q) and also multiplied by a factor g, where g = 9.8 m / s2, so the basic equation of the power plant is:

Pnet = g × Hgross × Q × EoKw .... (2.7)

with head in meters, and water discharge in cubic meters per second and the value of Eomer is a function of civil construction, penstock, turbine, generator, control system, network, and transformer and can be expressed mathematically as multiplication of E (civil construction) × E (penstock) × E (turbine) Typical values of those parameters are given in tablel 1.

Parameter	Nilai	Keterangan
E(konstruksi sipil)	1.0 - (panjang saluran × 0.002 ~ 0.005)/ H_{gross}	
E(penstock)	0.90 ~ 0.95	tergantung pada panjangnya
E(turbin)	0.70 ~ 0.85	tergantung pada tipe turbin
E(generator)	0.80 ~ 0.95	tergantung pada kapasistas generator
E(sistem kontrol)	0.97	
E(jaringan)	0.90 ~ 0.98	tergantung pada panjang jaringan
E(trafo)	0.98	

Table 1. Typical Value of Eo Parameter

E (civil construction) and E (penstock) are commonly reckoned as Head Loss (Hloss). In this case, the above equation is changed to:

Pnet = g × (Hgross-Hloss) × Q × (Eo - E (civil construction) E (penstock) kW .... (2.8)

This simple equation is at the heart of all power plant design.

2.8 Power generated on Micro Hydro

The amount of hydropower available from a water source depends on the size of head and water discharge. In relation to the water reservoir, the head is the height difference between the water level in the reservoir and the water level out of the waterwheel / water turbine. The total energy available from a water reservoir is a potential energy of water:

E = m.g.h .... (2.9)

Where,

m = water mass (kg)
g = acceleration of gravity (m / s2)
h = head / height of water (m)
Power per unit time (E / t), so the equation is the energy above can be expressed as:

P = E / t = (m / t) gh .... (2.10)

Since (m / t) = ρQ then,

P = ρQgh.................. .... (2.11)

Where,

P = power (watts)
ρ = density of water (kg / m3)
Q = water discharge (m3/s)

III. RESEARCH METHODS

Fig. 3 Riset Field

From the results of field research in district irrigation seirampahserdangbedagai district in the can: (9)

NO	S = Distance (m)	t = Time (Second)	V = Velociti(m)
1	6,6	2,30	2,87
2	6,6	2,52	2,62
3	6,6	2,61	2,53
4	6,6	2,31	2,78

Table 2:

Average velocity V = (V1 + V2 + V3 + V4) / 4 = (2.87 + 2.62 + 2.53 + 2.78) = 2.7 m / sec

No	Panjang (m)	Kedalaman (m)	Luas (m^2)
1	6,6	0,5	3,3
2	6,6	0,48	3,17
3	6,6	0,46	3,03
4	6,6	0,40	2,64
5	6,6	0,40	2,64
		Total luas	14,78

Tabel 3:

From the results of the table then the cross section (A) = 14.78 m2. To find the flowing water debit Q = V x A = 2.7 m / sec x 14.78 m2 = 39.9 m3 / sec

The analytical approach used is generally parametric Zuhal, 1981). Theoretically the power that can be generated by PLTMH is done by approaching:

$$P = 9{,}8 . \rho . Q . H \quad ....(3.1)$$

Where :

ρ: The period of water type (kg / m3)
Q: Debit of deep water (m3 / dt)
H: Height of falling water in (m)

The theoretical power of the PLTMH mentioned above, will be reduced after going through turbines and generators, formulated as follows:

$$P = 9{,}8 . \rho . Q . H . eff_T . eff_G \quad .... (3.2)$$

Where :
eff_T: Turbine Efficiency between (0.8 to 0.95)
eff_G: Generador Efficiency (0.8 to 0.95)

Estimated connected load (Subroto, i. 2002).

$$P_T = \sum_{n=1}^{n} n . P \quad .... (3.3)$$

Where: n = number of subscribers

P = Power on each customer (Watts)

The speed of the rotating field in the synchronous generator is expressed by the equation: (Theraja, Bl. 2001).

$$n_s = \frac{120 . f}{p} \quad .... (3.4)$$

Where :

ns = rotary field velocity (rpm)
f = Frequency (Hz)
p = Number of poles of induction motor
The rotational speed of the rotor is not equal to the speed of the rotating field, the difference is expressed by slip:

$$s = \frac{n_s - n_r}{n_s} \times 100\% \quad .... (3.5)$$

Where :

s = slip
ns = stator rotational velocity (rpm)
nr = rotational speed of the rotor (rpm)
And the maximum power generated is formulated:

$$P = I_M x V_M \quad .... (3.6)$$

And efficiency is written:

$$Eff = \frac{P_{OUT}}{P_{IN}} x100\% \quad .... (3.7)$$

IV. RESULTS AND DISCUSSION

A. Technical Calculations

The potential of micro hydro power can be calculated by the power equation
ket:
P = 9.8 x Q x Hn x η
P = Power (kW)
Q = flow discharge (m3 / s)
Hn = Head net (m)
9.8 = the gravitational constant
η = ef overall contents.
Data at a location is as follows: Q = 39.9 m3 / s, Hn = 24 m and η = 0.5. Thus, the magnitude of the power potential (P) is:

P = 9.8 x Q x Hn x η
= 9.8 x 39.9 x 24 x 0.5
= 4692.24 W
= 4.69 Kw

B. Economic Accounting

The investment value of Micro Hydro Power Plant construction per kW installed according to the calculation of Yayasan Mandiri - ranging from Rp. 8 million to Rp. 16 million. Meanwhile, the cost (price) of electricity per kWH is calculated based on initial cost and operational cost. The initial cost component consists of

1. Civil building costs,
2. The cost of electrical and mechanical facilities and the cost of other support systems.

The components of operational costs are:
1. Maintenance costs,
2. The cost of replacement parts,
3. Labor costs (operator) and other costs used during usage.

To build a PLTMH with an installed capacity of 1 kW, an initial cost ofRp 8 million is required. Pico hydro lifespan designed is 10 years at a cost. Operational Rp. 2 Million / year. So the total cost becomes Rp. 20 Million. Thus, the average cost (Rp) per day are:

Rp / day = initial cost + operating expenses / usage life (year) x number of days / year = Rp 4 million + Rp 10 million / 10 years x 365 days / year = Rp 3836 / day

Cost (price) per kWh is determined by the average cost per day and the amount of electric energy generated per day (kWh / day). Energy per day is determined by the amount of installed power and power factor1. If the power factor is assumed to be 12, then the price of electric energy per kWh2 is:

Price / kWh = Daily cost / Electrical energy generated (kWh / day) = Daily cost / Power installed (kW) x Power Factor
= Rp 3.836 / day / 1 kW x 12 (hours / day) = Rp 320 / kWh

V. CONCLUSIONS

- It does not require fuel and little maintenance, so the cost to run the PLTMH is low, and in many cases, bring benefits to the local economy.
- It is a durable and robust technology.
- Making it relatively easy, so it can be made by everyone
- Data at a location is as follows: Q = 39.9 m3 / s, Hn = 24 m and η = 0.5. Thus, the magnitude of the power potential (P) is: 4.6 Kw
- Spesikasi turbine Pico-hydro Hundreds of watts -KW
- To build a PLTMH with capacity installed 1 kW, required initial cost Rp 8 million. Micro hydro designed lifespan is 10 year with fee. OperationalRp. 2 Million / year. So the total cost becomes Rp. 20 Million. Thus, the average cost (Rp) per day is Rp 3836 / day
- The cost (price) per kWh is determined by the average cost-average per day and the amount of electrical energy that generated per day (kWh / day). Energy this day determined by the amount of installed power as well power factor1. If it is assumed a power factor magnitude 12, then the price of electric energy per KWhis Rp320 / kWh.

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