Microhydro Riam Transition as A Form of Green Energy in Batu Kacang Village, Dabo District, Lingga District Indonesia

Muhamad Mujahidin*, *Tonny* Suhendra, and *Rusfa* Rusfa

Faculty of Maritime Engineering and Technology, Universitas Maritim Raja Ali Haji, Indonesia

Abstract. The electrical energy crisis is a problem faced by the Batu Kacang Village Community, related to the high demand for energy distribution, The limited access to electricity for the people of Batu Kacang Village means that public facilities in the form of lighting have not been fully accommodated, The scope of the program is limited, this research does not reach far into the operational development, maintenance and further development stages of an innovative green energy system, Optimization of the green energy transition in this research will be measured by three indicators, namely, activity, productivity and sustainability, The method used is capacity building, observation of component performance and systematic recording of measuring data, experimental research methods referring to references related to Microhydro Power Plants, The results show, the initial voltage is 12 volts with a current of 0.34 amperes, at the 4th to the 8th hour the current in the battery remains stable, namely 0.32 amperes and there is a decrease in the current at the 9th hour with a current of 0.27 amperes. or a decrease in current of 0.05 amperes. In the following hours the battery current decreased continuously from 0.26 amperes to 0.13 amperes or a decrease of 0.13 amperes, from 0.13 decreased to 0.09 and decreased again to 0.05 in the 12th hour or decreased by 0.04 amperes. The final voltage on the battery is 8.0 volts or 66% of the battery's full capacity.

1 Introduction

The development of Microhydro Power Plants (PLTMH) is one of the development priorities implemented by the government which is directed at improving the economic and social conditions of rural communities. In such conditions it can be hoped that there will be an increase in the standard of living and welfare. Current problems, the conventional energy crisis is a problem faced by the Batu Kacang Village Community, related to the high demand for energy distribution, and The limited access to electricity for the people of Batu Kacang Village means that public facilities in the form of lighting have not been fully accommodated, through the green energy transition, as a potential use of village energy that can be used to generate small-scale electricity without relying on electricity from the State Electricity Company (PLN). Community involvement in the installation process is a long-term effort to increase the capacity of green energy to provide energy in the future, moreover, the community becomes more independent if damage occurs in the future, and is more creative in improving the existing green energy system and developing its potential. There is. The inclusive nature of this technical process is one of the main messages of this program [1]. The implementation of green energy technology

* Corresponding author : mujahidin@umrah.ac.id

certainly provides many opportunities to empower local communities while increasing welfare and productivity, but this implementation is also accompanied by many challenges in making the system sustainable.

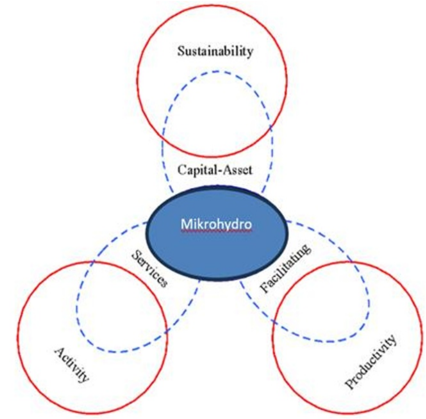

Fig.1. Bottom-up Process Framework
Source : LAKPESDAM-PBNU, 2017 [1]

description of the bottom-up process in question, namely starting with an approach to target households that assess the level of activity, productivity and sustainability related to renewable energy. The assessment is considered relevant considering the conditions of the community in different locations, so that knowing the urgency of the activity is seen from whether there is initiation and how the activity is implemented; while productivity refers to activities that reflect the reciprocal nature of their activities. and sustainability is an explanation of whether the activities carried out by the community have become assets. Practicing a bottom-up approach is synonymous with proceeding socially from below. This means that bottom-up is not individual or group, but together creates involvement starting to recognize, work and utilize activities developed from the Green energy transition. In this way, it is hoped that it will be able to provide contextual alternatives (according to space and time) for each different community condition to reflect the need for green energy [2].

2 Research Methods

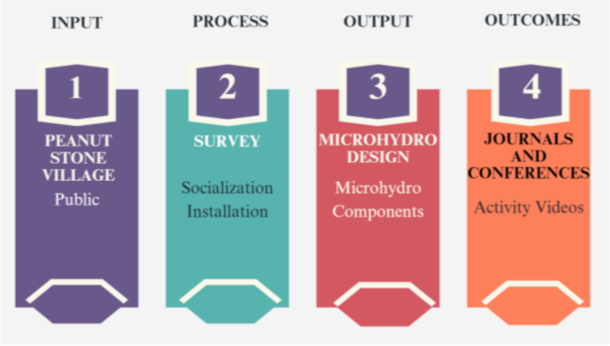

Fig. 2. Research Methods
Source : Mechanical Engineering Journal.Seyung, 2018 [8]

This research includes site survey, familiarization, system assembly and installation, and testing. Following is a detailed explanation of the technical implementation of its activities. A site survey was carried out for obtain initial information regarding topography, water resources and energy needs surrounding communities, as well as taking care of permits for the implementation of green energy microhydro [3]

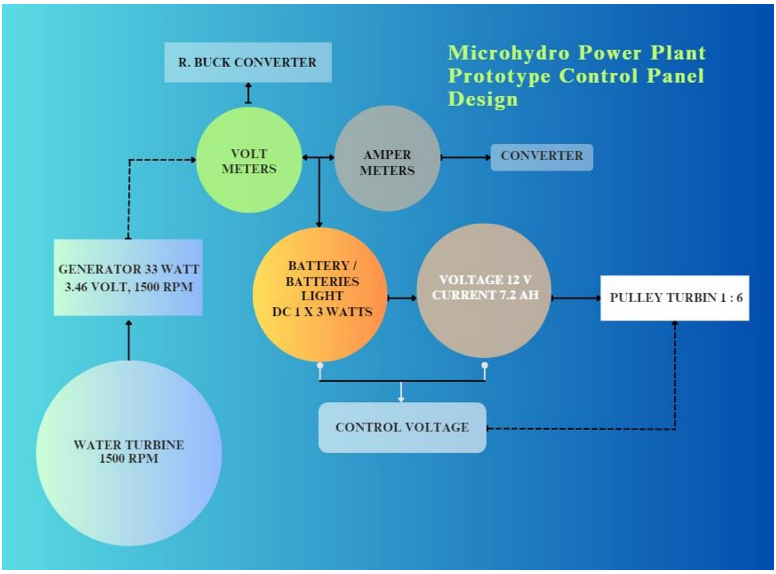

Fig. 3. concept of calculating turbine speed
Source : Journal of Mechanical Engineering-Nurhuda Ahmad, 2016 [7]

$N=[\frac{862}{D_1}]\sqrt{H}$
where;
D_1 = turbine diameter
H = Height of the rapid pipe [6]

Crossflow turbines have a high level of responsiveness to small hydropower sources with output power 750 kW. With a water fall height above 1 - 200 m and a water flow capacity between 0,02m^3/s - 7m^3/s [5]

3 Data Analysis

The specific speed between 70-80 m/s of a turbine is the rotational speed of the driving wheel which can produce an effective power of 1 BHP for every 1 meter fall height or with a formula that can be written [12]:

Ns.n.Ne1/2/Hefs.5/4……………………………………………………………………………………..…...(1.3)
where :
Ns = is the specific speed of the turbine
n = is the turbine rotational speed (rpm)
Hefs= is the effective fall height (m)
Ne = is the effective turbine power (HP)

The input power / hydro power formulation can be obtained by [8]:

$$P = \frac{1}{2} \rho. \quad Q. \quad V^2 \quad \text{……………………………………} (2.3)$$

where:

Pw = is hydro power (watts)
P = is the mass density of the fluid (1000 kg/m^3)
Q = is discharge (m^3/s)
V = is the speed of water flow (m/s)

To find out the output power produced by the turbine is obtained by:

$$P = T\omega \ (\text{Watt}) \text{……………………………} (3.3)$$

where :
T is torque (Nm)
ω is the angular speed of the turbine, (rad/sec)
by substituting the turbine rotation n (rpm) into Equation 2.3, then [4]

$$Pt = 0.105Tn \text{……………………………} (3.4)$$

Turbine efficiency is obtained by [1] :

$$\eta = \frac{P_t}{P_w} \times 100\% \text{……………………………} (2.5)$$

where:
Pt = is the shaft power (watts)
Pw = is hydro power (watts)

$$P = \frac{9{,}81 \times Q \times H \times \eta \times \rho \ Air}{1000} \text{……………………………} (2.6)$$

where:
P = Generated Power (kW)
9.81 = Gravitational Constant (m/s)
Q = Water Discharge (m^3/s)
H = Head Height (m)
η = System Efficiency
ρ Water = Density of Water (1000 Kg/m^3)

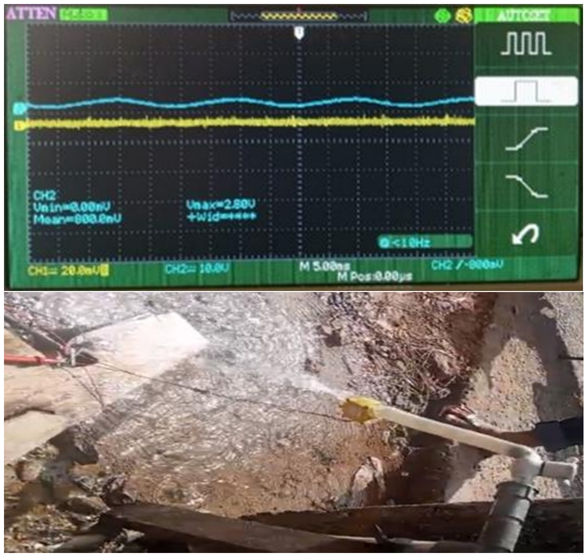

Fig. 4. Crossflow Turbine Prototype

Table 1. Generator Specification Data and Test Results

Parameter	Unit	Value
voltage	22.5	V
current	1500	rpm
loop	4	A

Source : Renewable Energy Agency, 2019 [13]

Water flow speed [9]:
$V = C\sqrt{(2gh)}$
$= 0.98.\ \sqrt{2}.\ (9{,}8\ m/s).0{,}8\ meters$
$= 0.98.\ 3{,}54$
$= 3.46$ m/s
Calculate the water flow rate
$Q = A.V$
$= 0.000506\ m^2 \times 3{,}46$ m/s
$= 0{,}00175\ m^3/s$
Q total = Q x 4 (jumlah pipa pesat)
$= 0{,}00175 \times 4$
$= 0{,}007\ m^3/s$

Generated power can use equation 2.6:
Assumed system efficiency of 80%
$P = \frac{9.81 \times Q \times H \times \eta \times \rho\ Air}{1000}$
$P = \frac{9{,}81 \times 0{,}007 \times 0{,}8 \times 0{,}8 \times 1000}{1000}$

$= \frac{43{,}94}{1000}$ = 0,043 kw = 43 watt
The power generated is based on the Test discharge as

Following [4]

$$P = \frac{9{,}81 \times Q \times H \times \eta \times \rho\ Air}{1000}$$
$$P = \frac{9{,}81 \times 0{,}0054 \times 0{,}8 \times 0{,}8 \times 1000}{1000}$$
$$= \frac{33{,}90}{1000}$$
= 0,033 kw
= 33 watt

Table 2. Test Results

No	Parameters tested	Testing at Height 0.8m	Unit
1	Water discharge	0.0054	m^3/s
2	Turbine Rotation Speed	169	rpm
3	Generator Rotation Speed	1220	rpm
4	Generator Voltage	18.27	volt
5	Generator Current	1.12	A

Source: Energy Research, 2018 [14]

Calculation of the load for a 1x3 watt LED lamp that can last for 12 hours. Testing the length of time the load can be used, after knowing the calculation of the length of time the load can be used, the next step is testing the duration of the load for 12 hours with a battery capacity of 7.2 Ah and a load of 1 LED lamp of 3 watts.

Table 3. Total Expenses

Burden	Load Capacity	Load Ignition Time	Total Load	Power Consumption (watt)
Lamp Led DC 12 volt	3 Watt	12 O'clock	1 unit	36

Source : IMIDAP, 2010 [11]

Table 4. Electrical Power

No		Time	Voltage(V)	Current(A)
1		06.30	12.0	0.34
2		07.30	11.7	0.33
3		08.30	11.6	0.33
4		09.30	11.4	0.32
5		10.30	11.2	0.32
6		11.30	10.7	0.32
7		12.30	10.6	0.32
8		13.30	10.5	0.32
9		14.30	9.9	0.27
10		15.30	9.5	0.36
11		16.30	9.1	0.13
12		17.30	8.6	0.09
13		18.30	8.1	0.05

Source : Arismunandar and Kuwahara, 2004 [10]

4 Results and Discussion

The initial voltage is 12 volts with a current of 0.34 amperes, at the 4th to 8th hour the current in the battery remains stable, namely 0.32 amperes and there is a decrease in current at the 9th hour with a current of 0.27 amperes or a decrease in current 0.05 amperes. In the following hours the battery current decreased continuously from 0.26 amperes to 0.13 amperes or a decrease of 0.13 amperes, from 0.13 decreased to 0.09 and decreased again to 0.05 in the 12th hour or decreased by 0.04 amperes. The final voltage on the battery is 8.0 volts or 66% of the battery's full capacity.

References

1. B. Nordell, Glob. Planet. Change **38**, 305 (2003)
2. Z. Li, Z. Li, C. Zuo, and X. Fang, Adv. Mater. (2022)
3. B. R. Ryu, P. A. Duong, and H. Kang, Int. J. Nav. Archit. Ocean Eng. **15**, 100524 (2023)
4. A. Miara, C. J. Vörösmarty, J. E. Macknick, V. C. Tidwell, B. Fekete, F. Corsi, and R. Newmark, Environ. Res. Lett. **13**, (2018)
5. L. Oularbi, M. Turmine, and M. El Rhazi, J. Solid State Electrochem. **21**, 3289 (2017)
6. A. Naveed Ul Haq, A. Nadhman, I. Ullah, G. Mustafa, M. Yasinzai, and I. Khan, J. Nanomater. **2017**, (2017)
7. P. Fragiacomo, F. Piraino, M. Genovese, O. Corigliano, and G. De Lorenzo, Energies **16**, (2023)
8. C. Ghenai, M. Bettayeb, B. Brdjanin, and A. K. Hamid, Case Stud. Therm. Eng. **14**, 100497 (2019)

9. S. E. Wortman, Sci. Hortic. (Amsterdam). **194**, 34 (2015)
10. S. Rajeshkumar and L. V. Bharath, Chem. Biol. Interact. **273**, 219 (2017)
11. M. Sun, L. F. Zhai, W. W. Li, and H. Q. Yu, Chem. Soc. Rev. **45**, 2847 (2016)
12. M. Barbouchi, K. Elamrani, M. El Idrissi, and M. Choukrad, J. King Saud Univ. - Sci. (2018)
13. M. N. I. Salehmin, S. K. Tiong, H. Mohamed, B. S. Zainal, S. S. Lim, N. H. Mohd Yasin, and Z. Zakaria, J. Ind. Eng. Chem. (2023)
14. G. Amy, N. Ghaffour, Z. Li, L. Francis, R. V. Linares, T. Missimer, and S. Lattemann, Desalination **401**, 16 (2017)