THE POTENTIAL DEVELOPMENT OF WATER FALL AS A SOURCE OF ENERGY POWER STATION IN WEST KUTAI

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Abstract

One way to stimulate the development of the borderland's economy of the West Kutai region is by developing the micro hydro power station of the existing waterfall in the region. The development of micro hydro power plant is important for households accessibility where situated in remote area and lack of assesibility to the source of oil and gas as fuel for generator to produce electric power. Particularly for the region in which the price of oil is very expensive, the generator machine of power station would be very expensive and risky due to the lack of oil supply. To develop the energy resource from waterfall could overcome the problem lack of energy resource.

To get an optimal estimation of the power station project, detail information of water high plunge, area of coverage, pipeline construction system and the electrics transmission need to evaluate.

Key words: *waterfall; micro hydro power plant*

1. Introduction

The instruction of the Indonesian President to conduct a save energy expressed the needs of developing new alternative source of energy for this country.

River and its water flow is one of the natural resource that has a great potential to generate an electric power. It has a great potential for developing a micro hydro power station as one found in the West Kutai region.

To get an optimal potential of development it is important to conduct a preliminary study on water run and its quality, this includes; high plunge of water, water catchhment area, fast pipe band and the possible electrics transmission lines. Some possible development of Micro hydro Power Plant in borderland is :

a) the existence of water and water fall resources in the region
b) reliability of technology that provides an energy for more than 15 year period
c) The construction of Micro hydro Power Plant is environmentally friendly and renewable
d) It has a high cost efficiency (70-85 %).

These indicators imply that the development of power station is possible from technicall point of view, but these are not a single guideline for the development. There are some social aspects need to be considered before the construction of the micro-hydro power station is conducted. This will be; the ability of local people to pay the cost of consuming electric energy produced from micro hydro, the possibility of handing over the operation of power station to the hand of the local people, and the existing knowledge of the local people on operation of power station which crucial for the project post construction.

All of these factors need to evaluate before the construction of power station is taking place.

Current status of energy source in the region

The existing electric resource in the border area of West Kutai generated from the use of generator machines which are fuel consumptive. It makes the selling price of the electric power produced from genset is very expensive, and in particular when the price of the fuel is very high due to the problem of transportation and access to the source of fuel. This could be one main reason why the use of waterfall for energy power station is crucial for the region.

It is important to make a feasibility study to evaluate the technology and capacities of exploring micro hydro project. Measuring the capacity of water fall power, water catchment area, fast pipe band as well as transmission pipe band.

Social aspect also has to study in the form of acceptance of the community to the micro hydro project.

Micro-hydro term explains that water will be used as a source of power to run the generator, and micro means the scale which can only be produced a small amount of energy such as 100 watt. Technically, micro-hydro has three special components, these are ; water, turbine and generator. Water fall will be used as a source of power to operate generator by making the canal flows through the rotate machine of the turbine.

The picture below shows the process of transforming water flow to operate the generator and produces the electric power.

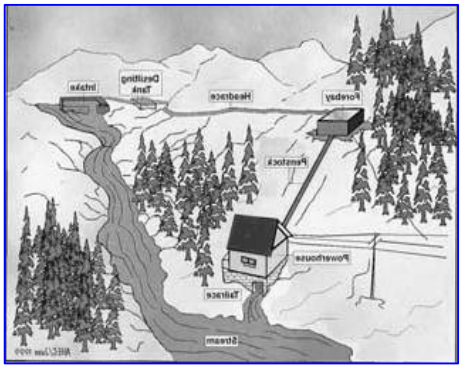


Figure1. Micro hydro Power Plant Components.

The components of microhydro

The picture show major component of the microhydro power (Boldness Graph 1985). The graph associated with the production of electric from microhydro consist of :

- **D*iversion Weir and Intake*** D*iversion Weir* functioning to move water through opener in part of riverside (from intake opener) into a Settling Basin.
- ***Settling Basin*** is used to remove sand particles of water. Function of Settling Basin is very important to protect next components of sand impact.
- ***Headrace*** follow contour of hillside to take care of elevation of canal water.
- ***Head tank,*** Function of ***Head tank*** is to arrange the difference of output of water between a penstock and headrace, and for final dissociation of dirt of water like sand and woods.
- ***Penstock*** connected by Penstock at a lower elevation to a water wheel, known as Turbine
- *Generating house,* representing the center generator can be planned by the size of 3 x 4 m or 4 x 4 m depending on the condition of in field. The generating house will be organized by equipments of electrical

– mechanic, consist of : Turbine, mechanic system and Rotation Generator of hilt of wheel used to turn around a appliance of mechanical (like a hulling of seed, mangle of oil, wood lathe etcetera), or to operate a electrics generator, Machines or appliances, got energy by hydro scheme, referred Load and control panel

- *Distribution system and transmission.* The distribution of Micro hydro Power energy doesn't need transformer for the lift on and lift off of tension for the distance of distribution and transmission up to maximum 3 km. The loose of power during distribution was assumed maximum 5% where transmission system use the tension 220 V / 380 V

A microhydro need two major component of water debit and fall height to produce energy. The equation of conversion is :

Output Power = Input Power × Efficiency Conversion

The equation above is usually used to depict small difference. Input Power, or is total absorbent power by hydro scheme, is gross power, $\mathbf{P_{gross}}$. Power, which its benefit is sent by Netto Power, $\mathbf{P_{net}}$. All efficiency referred as $\mathbf{E_o}$.

$$P_{net} = P_{gross} \times E_o \; KW$$

Gross Power its Gross **head** ($\mathbf{H_{gross}}$) which multiplied with water debit **(Q)** as well as multiplied with factor (**g = 9.8**), so that equation of base of power station [is] :

$$P_{net} = g \times H_{gross} \times Q \times E_o \; kW \; (g=9.8)$$

Where **head** in **meter**, and **water debit** in **meter cubic per second** And **Eo** divided as follows:

$$Eo = E_{\text{civil construction}} \times E_{\text{penstock}} \times E_{\text{turbin}} \times E_{\text{generator}} \times E_{\text{control system}} \times E_{\text{line}} \times E_{\text{trafo}}$$

$E_{\text{civil construction}}$ **and** E_{penstock} is which ordinary to be reckoned as"**Head Loss** ($\mathbf{H_{loss}}$)/ losing of height. In this case, equation above altered to equation following.

$$P_{net} = g \times (H_{gross} - H_{loss}) \times Q \times (E_o - E_{\text{civil construction}} - E_{\text{penstock}}) \; kW$$

2. Development Program of Micro hydro Power Plant

In general the system layout of Micro hydro Power Plant consist of run river off, exploiting surface current (river). Micro hydro Power Plant consist of building of intake - weir, carrier drain, basin and Head tank, fast pipe, generating house and dismissal drain. Basic development of Micro hydro Power Plant started from determination of location of intake, how current will be brought to turbine and determination of generating house place for high fallout (peaceful and optimum head) of floods.

In general, the installation of Micro hydro Power Plant represent power station of direct river stream representing accumulating basin type (big barrage). Building construction of intake to take direct water of river in the form of barrage (draught intake) as long as wide of river or direct divide river current without equipped barrage building. Location of Intake has to be selected carefully.

Location of Intake have to have river ground which relatively stable. Ground of unstable river easy to cause the erosion the surface compared to lower river ground of building base of intake; this matter will pursue current enter intake. River base in the form of rock plate coat represent stable place. Place where inclination of its small river, generally have river base which relative stabilize.

One of the problems which is often happened at installation of micro hydro Power Plant is the damage a building intake which caused floods. Its often

happened if the building is placed in the riverside. Part of river bank is easily eroded by flood. Mean while part of river side can be deteriorated by the mud and wrote whiel can make the water difficult to run to the machine.

Every development of micro hydro made a pitch for maximum head. It caused some consequences of generator house location (house power) residing at place as low as possible. For security reason the generating house floor have to be higher compared to water level of river. Data and information of height surface of river when flood season is important to determine for the location of generator.

3. Data Sets

Some important information have to be analysed in the construction of micro-hydro power station, these consist of;

- Wide of dry river moment 40 cm
- Wide of river moment rain 200 cm
- Deepness of dry river moment 50 m
- Deepness of river rain moment 63 cm
- Speed of dry water moment: 2,046 m / s
- Speed of water rain moment 1,2 m / s
- Distance waterfall to river $\pm$ 0.7 Km
- Distance waterfall to district center: 5 km *Straight line*
- Situation vegetation around waterfall:bush, garden, secondary forest, and primary forest.
- Wide of river $\pm$ 3 M
- Distance of turbine to generating house $\pm$ 125 m

Table 1. The calculation of debit turbine energy and mean

No	Debit (Q) (m^3/Sec)	High of water fall potentiall y (H) (m)	Water specific mass (ton/m^3)	Effesiansi (η)	Grafitasi (m/sec^2)	Energy generating potency. (P) (kw)
1	0,503875	10	1	0,5	9,81	24,715069
2	0,396175	20	1	0,5	9,81	38,864768
3	0,305175	50	1	0,5	9,81	74,844169

Resume

From the calculation obtained above, the capacity of Micro hydro Power Plant for the river of Dare is equal to 74,8 KW (efficiency 50 - 60%).Technically the construction will not be affected by flood.

The energy obtained can generate energy for the household by;

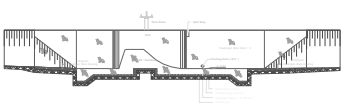
0,9 x 74,8 KW = 67,32 KW

Hence, every house will get:

67,32 KW : 316 house = 0,213 KW or 213 Watt.

The distance between turbine house to load center is approximately 15 Km and the distance between transmitted pillars is maximum 40 m, therefore the amount of required pillar is 15.000 m/ 40 m = 375 pillars. With the same distance of power distribution of 15 km, the required voltage transformer step-up will be 100 KVA. This is important to prevent the lost of power (voltage) in the transmission process.

Dam Intake



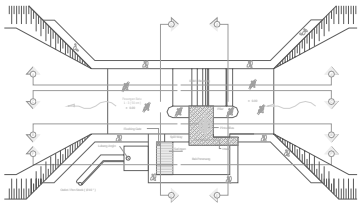


Figure 2. Retaining Wall & Wing Wall).

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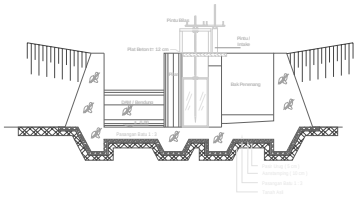

Figure 3 Intake, Settling Basin, Head tank and Spillway.

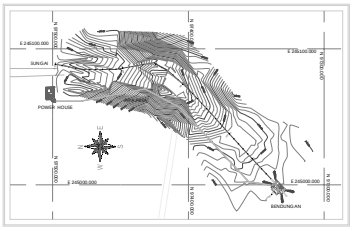

Figure 4. Penstock pipe

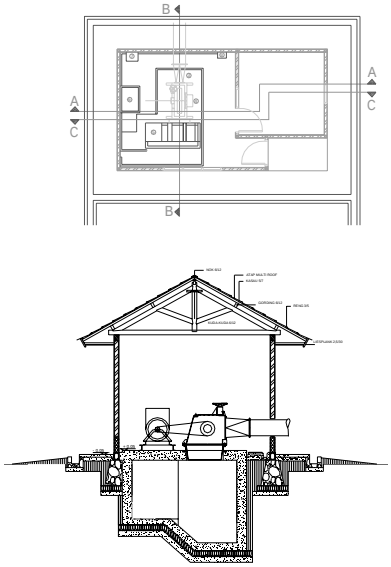

Figure 5. Generating house.

4. Socio-economic condition of the project area

The existing electric facility was able to serve 10 of 400 households found in the area, and the number of inhabitant in the region was 4.622 or 1.067 families.

Number of households have crab machine is 100 families, 2 households have chainsaw, and 60 households have small shops, 3 village cooperatives exist as economy stimulators in the region.

This indicates that the development of power station has a huge potential as an agent of economic development in the region. Therefore, the development of Micro hydro Power Plant in the region is very crucial in stimulating the village economy development. The assessment of local people willingness to cooperate with the development of micro hydro power plant can be determined as follows:

Society will ready to be involved, direct or indirectly in the project. The participation is expected in the operation and the maintenance of the project as well as in the maintenance forest in the river bank area of the water fall.

Society will be commited to take part in the maintenance of the drainage area of river as a source of waterfall. Preventing from the deforestation as well as from soil erosion which might affects the flow of the waterfall.

The observation reveals that the management of micro hydro power plant would be beter if the local people is involved. Local people needs training for the technical aspects of the power station management and maintenance, therefore the operation of the power project could overcome by the local communities.

5. Conclusion.

From technical aspect it can be concluded that waterfall power station development can generate 74,8 KW of

electric energy, which provides 200 watt for each household of 316 houses in the region.

The society is ready to take part in the development of waterfall power station project, direct or indirectly, for both in the operation as well as in the maintenance of the project.

Society is also expected to participate in the management of water catchment area, its forest, and the waterfall condition.

REFERENCES

Chapallaz, J.M; Eichenberger, P; Fisher, G. 1992. *Manual on Pumps used as turbines*. Brounschweig.

Haryono, 1995. *Kleinwasser-kraftwerk fuer Borneo. Fachhochschule Darmstadt*

_____. 2007. Energi terbarukan.net.

Joachim, H. 1999. *Kleinwasserkraft-werk mit kreisel Pumpe im Turbin Betrieb*. Fachhoch-schule Darmstadt.

Tempo (14 Desember 2004). *PLN NTB akan Bangun Empat Pembangkit Listrik.*

Universitaet Stutgart.1997. *Kleinwasser -kraft praxis und actualle entwicklung.* institute fuer stroemungsmechanik und hydraulische Stroemungmachinen. Stuttgart.