MINIHYDRO POWER PLANT (PLTMH)
BATU GAJAH 10 MW

Empus and Lau Damak Village, Bahorok District, Langkat Regency
North Sumatera – INDONESIA

EXECUTIVE SUMMARY

Infrastructure Development is one of today's main agenda of The Government of The Republic of Indonesia.

One of the development problems faced by the government today, especially in North Sumatera is the electricity crisis. Those occurred in North Sumatera is due to the lack of balance between its supply and demand. Based on the results of previous studies, projection of installed power capacity in North Sumatera by 2011 was 1873 MW with a very slow growth of installed power capacity of less than 1.75%, reached 2075 MW in 2015 and 2287 MW in 2017 using 5-year (2017-2022) rent MVPP. Far from government target to reach 2934 MW in 2020.

In an effort to overcome the shortage of electricity supply in North Sumatera, the government made increased construction of renewable power plant programs, among others by exploiting the potential of natural resources that come from river water.

In order to service/improve lighting (electricity) procurement to the public, the government gives opportunities to the private sectors and cooperatives to build renewable power plants. Electric power generated from power plants built by the private sectors will be sold to PT PLN (Persero) to meet the needs of the national electrical energy through Power Purchase Agreement (PPA) between PT PLN (Persero) with the developers.

To realize the program, PT Thong Langkat Energi (TLE) plans to build a Mini Hydro Power Plant (PLTMH) Batu Gajah 2x5 MW, which uses the water of Sei Wampu river which is located in the Empus Village, Bahorok District, Langkat Regency, North Sumatera Province.

Batu Gajah Mini Hydro Power Plant will be a sustainable hydro-electric power plant developed on the basis of a comprehensive feasibility study of the existing potencies in vital areas including topography, hydrology, geology, electricity, social, economic, culture, environment, basic design concept, construction cost plan and financial analysis.

PT Thong Langkat Energi (TLE) have signed Power Purchase Agreement (PPA) with PT PLN (Persero) on August 2nd, 2017.

This Power Plant is expected to be fully operational by 2021.

SUMMARY OF THE PROJECT

1. DESCRIPTION

a. Name of Project : **PLTM BATU GAJAH 2x5 MW**
b. Project Owner & Developer : PT Thong Langkat Energi (PT TLE)
c. Location of Project : Empus Village and Lau Damak Village
Bahorok District, Langkat Regency
Sumatera Utara Province
d. Coordinate of Weir : 3^{O} 26' 59.60" N – 98^{O} 11' 51.00" E.
e. Coordinate of Power House : 3^{O} 26' 59.00" N – 98^{O} 11' 49.50" E.
f. Name of River : Sei Wampu
g. Size of Catchment Area : 1835 Km^2
h. Dependable Flow : ± 85 m^3 /s
i. Net Height Fall Energy : ± 16.0 m
j. Generating Capacity : 2 x 5.0 MW

2. PROJECT STATUS

Power purchase agreement between PT Thong Langkat Energi (PT TLE) and PT PLN (Persero)

a. Memorandum of Understanding (MoU) : May 19th, 2017
b. Power Purchase Agreement (PPA) : August 2nd, 2017

3. POWER CAPACITY

The power capacity generated by PLTMH Batu Gajah is 10 MW.
The installed capacity is 2 x 5 MW

4. TOPOGRAPHICAL ASPECTS

In terms of topographical aspects, the geographical location of the weir of the PLTM is at position coordinates 3^{O} 26' 59.60" N – 98^{O} 11' 51.00" E and coordinates of the Power House is at position of 3^{O} 26' 59.00" N – 98^{O} 11' 49.50" E.

Elevation of the planned location of the weir is at EL + 77 m, the average slope of the river at the upstream of the planned weir is 0.00428 and at the downstream of the planned weir is 0.0052.

5. HIDROLOGICAL ASPECTS

a. *Size of Catchment Areas* : 1835 Km^2
b. *Dependable flow* : 85 M^3/sec
This discharge is average discharge provided at any time to turn the turbines.
c. Flood Debit
Flood Debit for return period $Q_{2\ years}$: 968.56 m^3/sec
Flood debit for return period $Q_{10\ years}$: 1190.41 m^3/sec.
Flood debit for return period $Q_{100\ years}$: 1905.80 m^3/sec.

d. Result of the *Flow Curve Duration* (FCD), then the probability of each turbine as follows;
   1. 1st turbine operates with a probability of 92.76 %
      Q1 Available = 42.5 m^3/sec
   2. 2nd turbine operates with a probability of 65.35 %
      Q2 Available = 42.5 m^3/sec

e. Reservoir of the PLTM is an artificial reservoir, this container serves to accommodate and store water.
   The volume of the storage pool is ± 3,400,000 (three million four hundred thousand cubic meters)

6. GEOLOGICAL ASPECTS

The building of the PLTM rests on hard rock.
Locations or the PLTM is in zone 3, the type of rock is Alluvial Formation and Tufa Toba rocks and seismic acceleration ranges between 0.8 m/s^2 - 2.4 m/s^2. Peak bed rock acceleration is 0.15 g.
At the planned location of the PLTM, there are 2 (two) types of units, formations, rock members namely:

a. Alluvium unit consists of clods of gravel, sand, and clay which are loose and incoherent. Clods of gravel are in the form of dacite, andesite and pumice rock fragments, which are hard and dense. The thickness of the Alluvial deposits on the planned construction location of the PLTM is between 3 meters - 5 meters
b. Toba Tufa Unit (Qvt) is in the form of Rhyodacite Tufa, which is hard, dense and compact, the thickness on the surface is between 5 to 30 meters. Observations in the field, this Tufa rock has undergone weathering processes into clay and somewhat compact sandy tuff. Tufa rock that has undergone weathering is prone to landslides. The thickness of this weathered soil varies between 5 to 15 meters.

7. ELECTRICAL ASPECTS

The power generated by the PLTMH Batu Gajah will be sent via Feeder Pepaya BG.2.

a. 20 kV Network
   The specification of 20 KV network is SPLN 41-8:1981 and SNI 04-3558:1994. AAAC (All Aluminum Alloy Conductor) consists of: 97.28% Aluminum minimum, ±0.5% magnesium and ±0.5% Silicon. Maximum Resistivity at 20^{O}C is 0.0328 ohm.mm^2/m

b. Electrical System
   Electrical system of PLTMH Batu Gajah with a power factor of 0.92 is going to supply a current of 996.14 A at a voltage of 6.3 kV or 313.78 A at a voltage of 20 kV to the Connection Point.

c. Own Usage
   Power of own usage is calculated as 100 kW.

d. Power Loss
   A power factor of 0.92 supplies a current of 996.14 A at a voltage of 6.3 kV or 313.78 A at a voltage of 20 kV to the Connection Point. Conductors used are A3C, 3 x 300 mm^2 for as long as 8.0 kms.
   1. Looses in the network:
      Δ P Line = 3 x 313.78^2 x 0.111 x 8 = 262.292 kW

2. Looses in the Transformer:
   Δ P Trafo = 2% x 10000kW = 200 kW
3. Δ P Total = 262.292 kW + 200 kW = 462.292 kW
4. Looses in the Transformer and network are 4.62%.
5. Power of own usage = 100 kW
6. Power loss until the transaction point
   P loss = 462.292 kW + 100 kW = **562.292 kW**

e. Connection Point

The location of this connection point is in Simpang Empus, Empus Village, Bahorok District, Langkat Regency, North Sumatera Province, exactly at the coordinates of $3^0$29'58.9" N – $98^0$11'24.9" E. The distance of the Connection Point to the Power House of the PLTMH Batu Gajah is as far as ± 8.0 Kms.

8. POWER GENERATED

a. The *suitable turbine* for PLTM Batu Gajah is Kaplan Turbine.

b. Power Generated

P_A = Ef.ρ.g.Qd.Hn

where:

1) P_A = Generated Power Capacity (MW)
2) Q_d = Design Discharge : 85 m^3/sec
3) H_n = Effective Height : 16 m
4) ρ = Mass Density of Water : 1.0 t/m^3
5) Ef = Efficiency = 0.91 x 0.85 : 0.773
6) **P_A** = 0.773 x 1.0 x 9.81 x 85 x 16
   = 10313.06 KW : 10.3 MW

c. *Installed Capacity* : **2 x 5.0 MW**

9. BASIC DESIGN

Basic Design of the PLTM among others civil buildings, other supporting facilities, among others:

a. This supporting facilities and infrastructures among others:
   Operational Office; Warehouse; Parking Lot; Mess and Employees Housing; Guardhouse; Entrance Road to the Project.
b. River Diversion/*Diversion Chanel*
   Design Discharge of Coffer dam $Q_{2\ years}$ = 1309.10 m^3/sec,
c. Coffer Dam
   Type of Coffer Dam is Clay, River Stone and Reinforced Concrete
d. The dam of the PLTM is Gravity Dam
   i. Type of the Dam is Gravity Dam
   ii. Height of Dam measured from base of foundation is 30.50 m
   iii. Height Energy (head effective) 16.0 m
   iv. Length of Dam Crest 70 m

e. Power House, Penstock, Hydromechanical, Mechanical and electrical among others
   i. *Power House*: Width 26 m, Length 47.20 m, Height 22.40 m
   ii. Wall Construction of Reinforced Concrete and River Stone Masonry, Roof Frame is Steel Construction
   iii. Tail Race
   Type: Open channel, reinforced concrete, Type Retaining Wall
   iv. Mechanical, Electrical and Network
   Turbine, Generator, Governor, Panel, Conductor Wire System to Connection Point, etc.

10. BUDGET PLAN

The construction execution cost of civil and Electromechanical Equipment cost of the PLTM among others:

Period of construction execution : 24 months.

Total of Construction Execution : **Rp. 238,357,617,445.00**

a.	Cost of Preparation Work	Rp.	25,890,599,200.00
b.	Diversion Tunnel	Rp.	6,805,718,514.29
c.	Coffer Dam	Rp.	2,549,117,341.22
d.	Penstock Work	Rp.	12,996,303,178.84
e.	Dam Work	Rp.	55,270,312,416.89
f.	Power House	Rp.	22,091,286,928.80
g.	Tail Water	Rp.	2,729,279,865.40
h.	Electromechanical Equipment	Rp.	90,000,000,000.00
i.	Interconection of PLTM	Rp.	13,025,000,000.00
j.	Construction Supervision	Rp.	7,000,000,000.00

11. FINANCIAL ECONOMIC

Age of Project is calculated for about 20 years,

a.	Capacity Factor	: 80%
b.	Annual Energy Production (GWh /Year)	: 71.42 %
c.	Interest of Loan calculated	: 14%
d.	Operations Period/Year	: 8760 Days
e.	Loan/Credit Period calculated	: 60 months
f.	Equity is 30% Project Investment	: Rp. 71,507,285,234.00
g.	Loan (credit) is 70%, Project Investment	: Rp. 166,850,332,212.00
h.	Selling Price/Weighted Average Price Year 1 to 8 Rp.1560x1.1Rp.	: 1716/kWh
i.	Selling Price/Weighted Average Price Year 9 to 20 Rp. 975 x 1.1Rp.	: 1072.5/kWh

j. Total Cash Inflows : Rp. 856,019,313,224.00

k. Project Feasibility, as follows:

i. *Internal Rate of Return (IRR)* : 23.01 %

ii. *Benefit-Cost Ratio (BCR)* : 3.59>1

iii. *Payback Period (PP)* : 6.29 Years

iv. *Return On Equity (ROE)* : 54.86%

12. ENVIRONMENTAL ASPECTS

The community has given its backing to the business plan and/or activities of the Mini Hydro Power Plant (PLTMH) on the condition that nothing interferes with the activities of the community.

13. MATERIAL

Construction materials for civil buildings, embankment sands, tide sands, gravels and clods, are available along the river, crushed stones of various sizes are available at the mine location in the vicinity of the PLTMH.

14. CONCLUSION

Following analysis of the aforementioned variables, the unequivocal conclusion is that PLTMH Batu Gajah 10 MW is a feasible investment.

CONTACT INFO

Mr. Widiyanto Saputro
Mail : wsaputro@arumbumi.com
wsaputro@gmail.com
Phone : +62 812 111 555 9
+62 812 98 100 100