



# A STUDY OF FINANCIAL FEASIBILITY OF MOANAMANI MICROHYDRO POWER PLANT (PLTMH)

(A CASE STUDY IN EKEMANIDA VILLAGE, MOANAMI DISTRICT,  
DOGIYAI REGENCY)

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## ABSTRACT

Micro Hydro Power Plants (PLTMH) with a capacity of <1MW are an alternative energy source to replace fossil fuels in remote areas, one of which is the PLTMH in Moanamani Distric, Papua Province, Indonesia, managed by PT. PLN (Ltd). Due to a construction collapse at the dam, the Moanamani Micro Hydro Power Plant is now sustaining damage that is harming other supporting facilities. Given the tight budget in the area, particularly in Dogiyai Regency, the goal of this study is to secure a capital finance and loan plan that can then be discussed by the pertinent stakeholders. This study analyzed the potentials of renewable energy and economic finance of the PLTMH, measuring the Net Present Value (NPV), Internal Rate of Return (IRR), Benefit Cost Ratio (BCR), Pay Back Period (PBP), and Break Event Point (BEP). The results showed that the debit of Tuka River could generate at least 65.50 kW of power and an annual energy of 50,546 kWh. The investment value of PLTMH at Moanamani Village was IDR 6,600,000,000, and the Cost of Goods Sold was IDR 336,384/kWh. Based on the economic calculation, the NPV of PLN Ltd was IDR 6,300,000,000, the NPV of the community was IDR 1,987,056,834, the IRR was -1,79%, the BCR was 0.32, the PBP was  $\pm$  20 years, and the BEP was  $\pm$  50 years. The development project of PLTMH with a funding scheme of 30% equity and 70% loan showed that the project was not financially feasible.

**Keywords:** PLTMH, Renewable Energy, Financial Feasibility

## 1. INTRODUCTION

Indonesia's electricity power, according to The Ministry of Energy and Mineral Resources (KESDM), has reached 98.86% of the population (Press Release of KESDM No. 642/Pers/04/ SJI/201). As of 2019, the national supply of electricity was derived from an energy mix dominated by fossil fuel (coal, oil, and gas) up to 87.68%, and the other 12.32% was renewable energy (Dewan Energi Nasional, 2020; (Kusuma, 2007). The proportion of renewable energy in the national energy supply is targeted at 23% in 2025 and 31% in 2050, as stipulated in the Indonesian Government Regulation (PP) No. 79 of 2014 on National Energy Policy. Papua is a province in Indonesia with the lowest electrification ratio – the ratio of the population with electricity access to the total population in a particular area. As of 2017, it was 48.74% ([www.esdm.go.id](http://www.esdm.go.id)). Also, in 2018, only 14% of the total power plant capacity in Papua was generated from renewable energy due to

the costly production of renewable energy-based power plant (Dewan Energi Nasional, 2019).

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The energy mix in Dogiyai Regency has been the main contributor to the power supply, particularly fossil fuel. It takes a solid development plan to minimize dependency on fossil fuels through renewable energy, in this case, water. Maximizing the potential of existing PLTMH can meet the need for energy of the local population while reducing dependency on diesel energy in Dogiyai Regency. However, the uniqueness of a social situation in a location can affect the sustainable electrification development (Isa et al., 2021). In addition, the topography in Dogiyai Regency is varied from flat ground to uneven, hilly, and mountainous land. Natural forests thrive in the regency, featuring a high gradient of rivers that which provide significant hydropower potential water power due to their high river discharge. Dogiyai Regency once had a hydropower plant to supply energy to the local people. However, the plant was severely damaged beyond repair, leaving the old dam unusable. The image of the dam is seen in **Figure 1.1**.



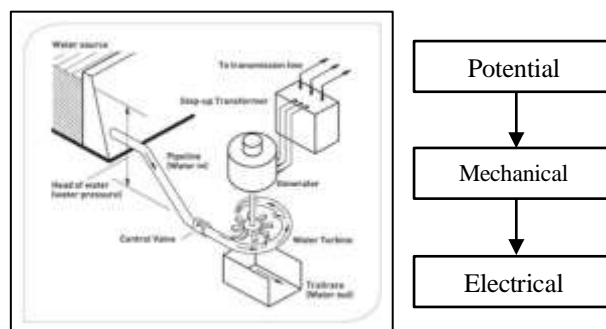
**Figure 1.1** The old dam of Tuka River, Moanamani

## 2. LITERATURE REVIEW AND RESEARCH METHODOLOGY

Renewable natural resources, such as water, forests, and solar energy, provide a perpetual, infinite supply for production. Non-renewable natural resources are those with a very limited supply for a limited time period. The source of energy is categorized into two based on the utilization: primary energy and secondary energy. Primary energy is the energy provided by nature in its natural form and has not undergone further processing. Secondary energy is primary energy that has gone through further processing (Ismail, 2013). Energy from the flowing or falling water can be harnessed directly by a proper machine to avoid the loss of generator efficiency. Recently, micro hydropower plants have gained more attention from the community as a promising source of renewable energy to supply electricity for households, agriculture, and communities in remote areas. A micro hydro power plant is a power plant that produces 5-100 kW power (Pasalli and Rehiara, 2014). This can be seen from the results of research conducted by Fifin Indarti, et. al. (2020), stating that the supply and demand graph for one month shows that the supply generated by the Blumbang PLTMH is around 24-26 kWh, where the Blumbang PLTMH is used to supply 4 neighbourhood and supply 74 houses.

### Analysis of The Potential Renewable Energy (Hydro Power)

Technically, a micro hydro power plant (PLTMH) harnesses the energy generated from the difference between water height and water debit per second of water flow in irrigations, rivers, or waterfalls. The water flow will rotate the turbine shaft to generate mechanical energy, which then moves a generator and produces energy. The higher the water discharge, the higher the power generation generated by the PLTMH. This can be seen in a study conducted by Hasibuan et. al. (2024) on the potential of rivers that will be utilized as a source of microhydro power plants (PLTMH) in Persada Tongra Village, Gayo Lues Regency, Aceh. The study produced a power generation of around 7.92 kW for a water discharge of 0.55 m<sup>3</sup>/s; a power generation of around 7.49 kW for a water discharge of 0.52 m<sup>3</sup>/s; a power generation of around 13.68 kW for a water discharge of 0.95 m<sup>3</sup>/s; and a power generation of around 16.71 kW for a water discharge of 1.16 m<sup>3</sup>/s. The mechanism of Micro Hydro Power Generation is shown in **Figure 2.1**.



**Figure 2.1** Mechanism of Micro Hydro Power Plant (Theraja, 2001)

The benefit gained by a micro hydro power plant is determined by the amount of power harnessed and the total energy generated every year. If the effective head is  $H_{eff}$  (m), the maximum debit of the turbine is  $Q$  (m<sup>3</sup>/s), and turbine efficiency and generator efficiency are  $\eta_t$  and  $\eta_g$ , then the power or energy generated by a micro hydro power plant is calculated with the following (Palintin *et al.*, 2020): The amount of energy generated based on dependable flow ( $Q_a$ ) and the effective head ( $H$ ).

1. Turbine efficiency,  $\eta_t = 0,77$
2. Generator efficiency,  $\eta_g = 0,85$

Electricity generation is calculated with the following equation:

1. Turbine power

$$P = g \times Q \times H_{eff} \times \eta_t \quad (1)$$

2. The power generator is calculated with the following equation:

$$P = g \times \text{turbine power} \times \eta_g \times \eta_M \times \eta_{sal} \quad (2)$$

where:

$P$  = the generated power (kW)

$g$  = gravity

$\eta_t$  = turbine efficiency (ppm)

$\eta_g$  = generator efficiency (rpm)

$\eta_M$  = transmission efficiency

$\eta_{sal}$  = channel efficiency

$\rho$  = water density = 1000 (kg/m<sup>3</sup>)

$Q$  = River flow (m<sup>3</sup>/s)

$H_{eff}$  = effective head (m)

This study calculated the Cost of Goods Sold (COGS), the cost paid to produce energy in a power house operation, to identify whether the power PLTMH produces electricity that is cheaper or more expensive. The COGS per kWh of a power plant can be identified by dividing all costs per year (C<sub>annual</sub>) and operational and maintenance cost (O+M) per year by energy production per year (8,760 hour) kWh. The projected electrical power capacity at the Dogiyai PLTMH is shown in **Table 2.1**. The formula to calculate COGS as reported by a previous study (Baldi, Maksum and Soekarno, 2015) is as follows:

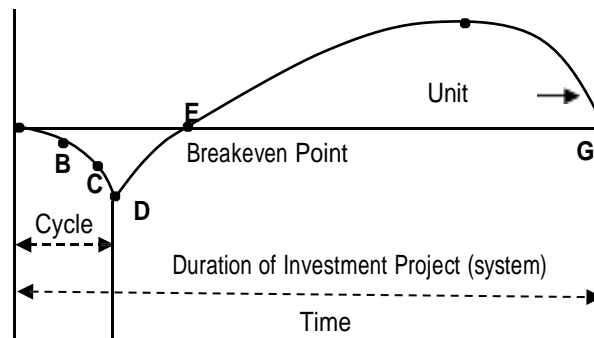
$$COGS \text{ per Kwh} = \frac{C_{annual} + (O+M) / year}{P_{net} \times 8760 \times PF} \times year \quad (3)$$

## Financial Analysis

The decision to invest a great amount of funding in hope for gaining years of long-term financial benefits often significantly impacts the sustainability of an enterprise. The general purpose of a private enterprise conducting financial analysis is to maximize the firm's wealth as measured from the increased share values. From the economic viewpoint, this analysis probes deeper into the whole benefits and costs imposed on the community. The cost and revenue profile for the project or investment term drawn up based on the cumulative components is illustrated in **Figure 2.2** below.

**Table 2.1** Projection of Power Capacity at PLTMH Dogiyai

No	Description	Symbol	Value
1	Estimated turbine efficiency	$\eta_T$	0,75
2	Estimated generator efficiency	$\eta_G$	0,90
3	Estimated mechanical transmission efficiency	$\eta_M$	0,93
4	Estimated water flow efficiency	$\eta_{sal}$	0,95



**Figure 2.2** Cost and Revenue Profile During The Duration of The Project/Investment (Soeharto, 1995)

Notes,

- A – B : Research and development
- B – C : Physical construction of project
- C – D : Work Capital
- D : Revenue of the production
- E : Breakeven point, total revenue (cumulative) equals with the costs
- D – E – F – G : Revenue minus production cost and other costs

### The Estimated Cash Flow

In financial analysis, cash flow refers to the cash budget, meaning the inflow and outflow of money, showing financial activities, needs to remain stable. According to Husnan & Muhammad (2000), a project cash flow is generally categorized into three parts: initial cash, operational cash, and terminal cash. The Cash Flow Chart for the Project Duration is shown in **Figure 2.3**.

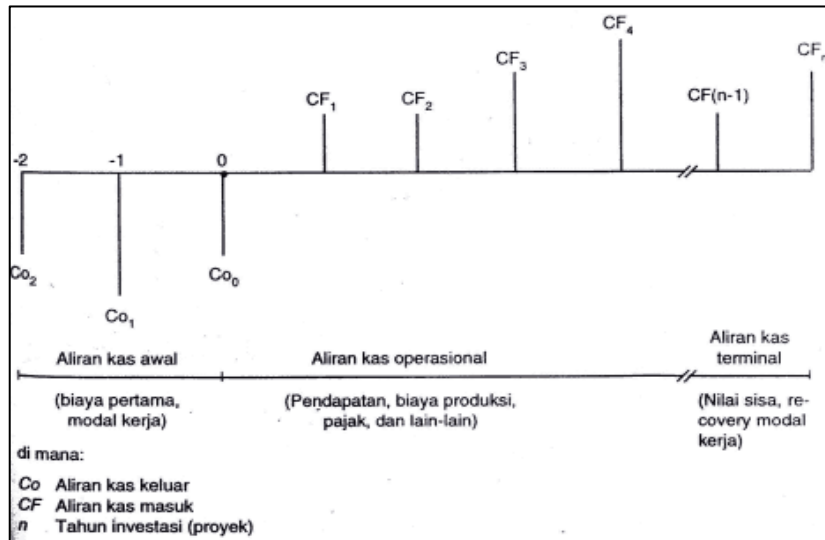
### Investment Costs

Investment cost is categorized into two main components: capital expenditures and annual expenditures (Kodoatie, J.R, 1996):

- (a) Capital expenditures , capital expenditures refer to all expenses incurred during the project duration, from the project pre-survey through the project completion. Capital expenditures include the costs of survey, civil construction, mechanical and electrical work, network distribution, and

indirect/unexpected expenses which may incur 5-15% of the total capital expenditures (Kodoatie, J.R, 1996),

- (b) Annual expenditures, annual expenditures are expenses incurred every year during the project duration, including interest rates, depreciation costs, and operational and maintenance cost,



**Figure 2.3.** Cash Flow Chat for the Project Duration (Soeharto, 1995)

- (c) Time value for money, future value is obtained by multiplying interest rate by the principal of the loan for the time period. While interest rate can be valued monthly, quarterly, biannually, or annually, Indonesian banking system also offers a loan with daily interest calculated from the annual interest rate. The formula of the Future Value (FV) is as follows:

$$FV_n = PV (1+i)^n \quad (4)$$

Where,

PV : Present Value

FV : Future Value

I : interest rate

n : period (n year)

- (d) Annuity, the present value of an annuity is defined as the complex annuity value of the present time with periodic payment or revenue (R) at an annuity time period (n). The formula of the annuity present value is:

$$PVA_n = R \left( \frac{(1+i)^n - 1}{i(1+i)^n} \right) \quad (5)$$

Where,

$PVA_n$  = present Value Anuity

R = payment or revenue of every period

i = interest rate

n = annuity time periode

### Financial Feasibility

- (a) Net Present Value (NPV), NPV refers to the gap between the Present Value of the benefit component and the Present Value of the cost component. The mathematical formula is as follows:

$$NPV = \sum_{t=0}^n CF_t(FBP) \quad (6)$$

Where,

CF<sub>t</sub> = Cash flow (benefit + cost)

FBP = Present Value Factor

The feasibility of an investment plan can be measured against a specific set of criteria in the NPV method, where NPV > 0 means the investment is profitable/ feasible, NPV < 0 means the investment is not profitable/ not feasible,

- (b) Internal Rate of Return (IRR), the IRR assumes that every net benefit of one year will automatically roll out to the next year, and it gains the same Rate of Return with the previous investment. The IRR value is calculated with the Trial-and-Error method that required unit *i* close to IRR.

$$IRR = i_1 + \frac{NPV_1}{NPV_1 - NPV_2} x (i_2 - i_1) \quad (7)$$

Where,

IRR = the targeted *Internal Rate of Return*

*i*<sub>1</sub> = *Internal Rate* (interest rate) for cash flow 1

*i*<sub>2</sub> = *Internal Rate* (interest rate) for cash flow 2

NPV<sub>1</sub> = *Net Pesent Value* of IR 1

NPV<sub>2</sub> = *Net Pesent Value* of IR 2

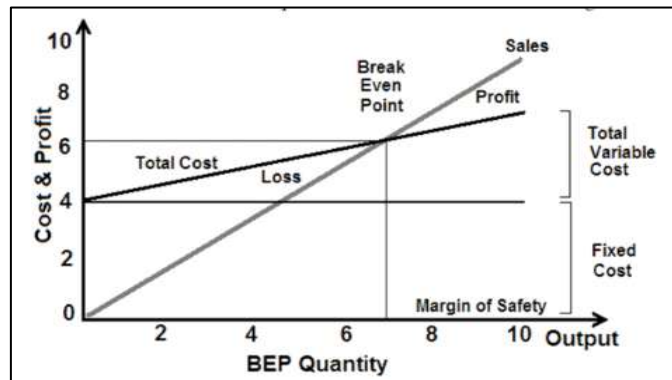
The investment plan is deemed feasible or otherwise with the following criteria: If IRR ≥ interest rate, the project is feasible, If IRR < interest rate, the project is not feasible.

- (c) Benefit Cost Ratio (BCR), the BCR analysis of a project is performed by considering the ratio of profit for the public community to the costs paid by the government. The math equation of BCR is as follow:

$$BCR = \frac{\text{Benefit}}{\text{Cost}} \quad (8)$$

The investment plan is deemed feasible or otherwise with the following criteria: If BCR ≥ 1, the project is feasible, ff BCR < 1, the project is not feasible.

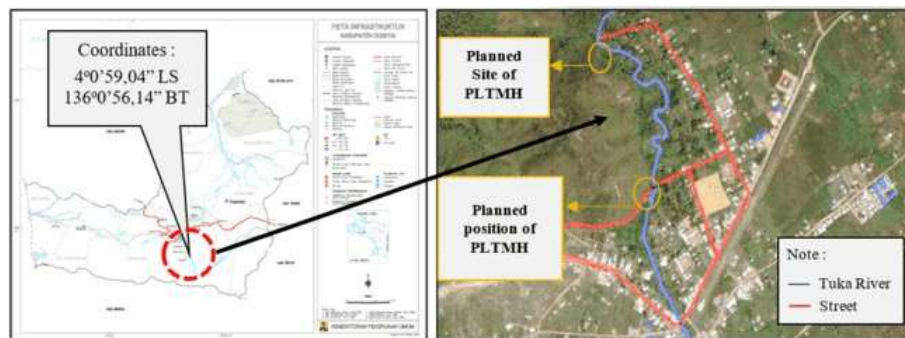
- (d) Pay Back Period (PBP), The feasibility of a business or project measured by the Payback Period is determined. If PP > economic life of a project, the project is not feasible. If PP < economic life of a project, the project is feasible.
- (e) Break Even Point (BEP), *Break Even Point* in production analyzes the quantity of goods produced or the amount of money and profit that must be generated to reach the break even point or to gain capital return. The Break Even Point graph is shown in **Figure 2.4**.



**Figure 2.4** Grafik Break Even Point (Giatman, 2006)

### 3. RESULTS AND DISCUSSION

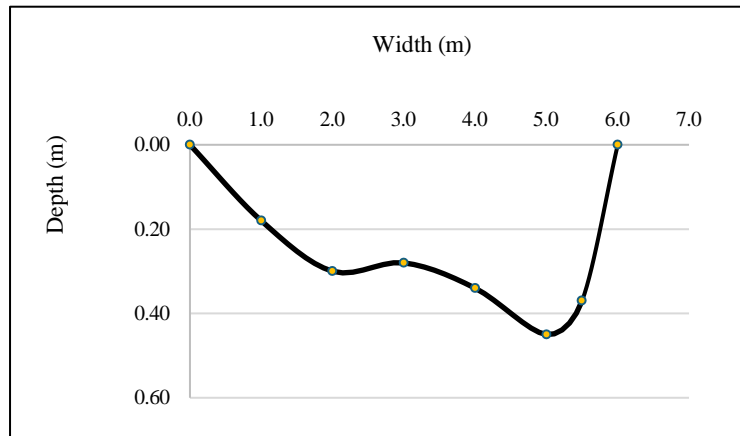
Geographically, the Hydro Water Power Plant (PLTMH) is located in Ekamenida Village, Moanamani District, Dogiyai Regency, Papua Province. Map of PLTMH Moanamani, Ekamenida Village, Dogiyai Regency is shown in **Figure 3.1**.



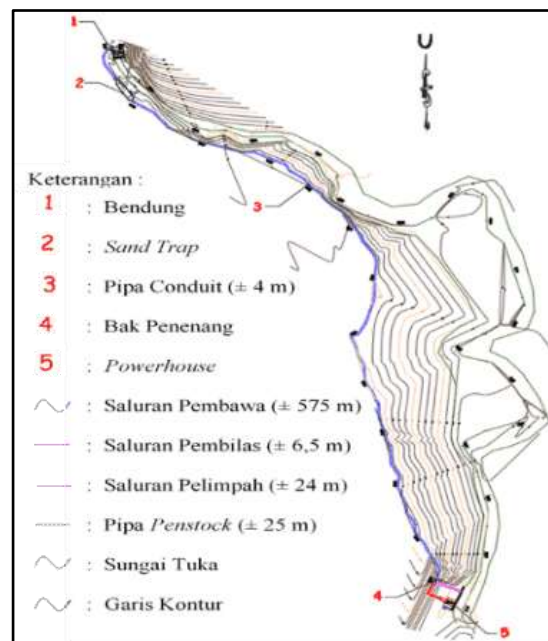
**Figure 3.1** Map of PLTMH Moanamani, Ekamenida Village, Dogiyai Regency

#### Hydrology of Tuka River

The current of Tuka River is a typical turbulence flow due to the normal currents with a wetted perimeter as shown in **Figure 3.2**. The ebb debit based on the velocity Tuka River tends to be a transitional flow due to normal flow conditions and has a wet cross section as in **Figure 3.3**. The instantaneous discharge is based on flow velocity measurements and produces a water discharge of 1.20 m<sup>3</sup>/s with an effective fall height of 7.20 m, so the theoretical power that can be generated is ± 63.56 kW.



**Figure 3.2** Wetted perimeter of Tuka River



**Figure 3.3** Planned site of supporting structures of PLTMH

### Design Criteria of PLTMH

PLTMH Moanamani is designed in a run off river system; the water harnessed for the power plant will not affect the function of the river. The design of civil construction is up to par with the standard design for mini hydro power plant, taking into account the type of dam and the configuration of its outlet.

### Power Capacity of PLTMH

The power capacity generated with water debit of  $Q_{80}$  is  $1,20 \text{ m}^3/\text{s}$  and the effective fall height is 7.20 m. Projection of estimated power capacity of PLTMH Muananmani shown in **Table 3.1**. The generated electric power was calculated with

the following equations:

(a) Turbine Power

$$\begin{aligned}
 P &= 9,81 \times \rho \times Q_d \times H_{eff} \times \eta_t \\
 &= 9,81 \times 1000 \times 1,20 \times 7,2 \times 0,75 \\
 &= 63568,8 \text{ W} = 63,56 \text{ kW}
 \end{aligned}$$

(b) Generator Power by flow

$$\begin{aligned}
 P &= \text{Daya Turbin} \times \eta_g \times \eta_M \times \eta_{sal} \\
 &= 63,56 \times 0,90 \times 0,93 \times 0,95 \\
 &= 50,546 \text{ kW} \approx 50546 \text{ W}
 \end{aligned}$$

**Table 3.1** Projection of Estimated Power Capacity of PLTMH Muananmani

No	Description	Symbol	Values
1	Design debit	$Q_d$	1,20 m <sup>3</sup> /s
2	Potential turbine power	$P_h$	63,56 kW
3	Estimated Net Head	$H_{eff}$	7,20 m
4	Estimated turbine efficiency	$\eta_T$	0,75
5	Estimated generator efficiency	$\eta_G$	0,90
6	Estimated mechanical transmission efficiency	$\eta_M$	0,93
7	Estimated water channel efficiency	$\eta_{sal}$	0,95
8	Estimated generation of electric power in the power house	$P_{el}$	50,54 kW

### Estimated Financial Analysis of PLTMH Moanamani

The basic components of the financial analysis of the Moanamani PLTMH project used as a simulation reference in this study are shown in **Table 3.2**.

**Table 3.2** Basic Components of financial analysis of PLTMH Moanamani Project

PROJECT DESCRIPTION	
Project name	: Micro Hydro Power Plant Project
Location	: Muanamani, Kab. Dogiyai, Prov. Papua
PROJECT TIMELINE	
Construction Period	: 2 years
Terms Proportion	: <u>1st year</u> <u>2nd year</u> 50%   50%
Economic Life	: 20 years
Base Year	: 2017
PROJECT FINANCING COST	
Project Finance	: Equity and Bank Loan
<b>Fund and Debt Portion</b>	: <u>Equity</u> + <u>Loan</u>
Loan and Equity Ratio	: 30% + 70%
<b>Loan</b>	

PROJECT DESCRIPTION	
Project name	: Micro Hydro Power Plant Project
Location	: Muanamani, Kab. Dogiyai, Prov. Papua
Interest Rate (r)	: 10% annual
Repayment Period	: 8 year
ECONOMIC FACTOR	
Indonesia Corporate Tax	: 1%
Indonesia IDR Inflation Rate	: 3,6%
Exchange Rate (IDR/USD)	: 13.500

Based on the direct costs and indirect costs calculation, the total cost (Capital Cost) of the construction project of Micro Hydro Power Plant (PLTMH) Moanamani are shown in **Table 3.3**. The production capacity of electricity power generated by PLTMH Moanamani is 50kW. However, the energy that can be distributed or sold to the customers is depreciated due to Capacity Factor of the generator and the Energy Loss in the transmission and distribution network. Accordingly, the Annual Power Sale obtained from the calculation are shown in **Table 3.4**.

**Table 3.3** The Capital Costs of PLTMH Moanamani

<b>Engineering Procurement and Construction</b>				: IDR	<b>5,380,985,065</b>
a)	Preparation	:	IDR	685,796,559	
b)	Civil Construction	:	IDR	2,784,758,045	
c)	Mechanical-Electrical Work	:	IDR	1,253,500,000	
d)	Transmission-Distribution Work	:	IDR	167,750,000	
e)	VAT 10%	:	IDR	489,180,460	
<b>Development Cost</b>				: IDR	<b>1.219.014.935</b>
a)	Land acquisition	:	IDR	500,000,000	
b)	Engineering 3.5%	:	IDR	188,334,477	
c)	Administration 2.5%	:	IDR	134,524,627	
d)	Overhead 3.0%	:	IDR	161,429,552	
e)	Unexpected cost	:	IDR	234,726,279	
<b>Total Investment</b>				: IDR	<b>6,600,000,000</b>

**Table 3.4** Power Production of PLTMH Moanamani

Power Production	
Gross Plant Capacity (GPC)	: 50,00 kW
Capacity Factor (CF)	: 80%
Availability Factor (AF)	: 98%
Own Energy Use (OEU)	: 3%

<b>Power Production</b>			
<i>Energy Loss</i>	( <i>EL</i> )	:	1%
<i>Nett Plant Capacity</i>	( <i>NPC</i> )	:	48,00 kW
<i>Annual Hour Production</i>	( <i>H</i> )	:	8.760 hours
<i>Annual Power Produce</i>		:	350.400 kWh
<b><i>Annual Power Sale</i></b>		<b>:</b>	<b>336.384 kWh</b>

$$\begin{aligned}
 \text{Revenue} &= \text{Total Tarif} \times \text{Annual Power Sale} \\
 &= \text{IDR } 681.76 / \text{kWh} \times 336,384 \text{ kWh / year} \\
 &= \text{IDR } 229,333,333 / \text{year (year 1)}
 \end{aligned}$$

The cash flow analysis of PLTMH Moanamani shows an inflow cash for operational and non-operational activities. The cash flow analysis of PLTMH Moanamani shows in **Table 3.5**.

### Financial Feasibility of PLTMH Moanamani

In analyzing financial feasibility, the Present Value is determined to calculated the Time Value of Money in the cash flow analysis. The results are presented in **Table 3.6**. The financial feasibility of the construction project of PLTMH Moanamani in this study used five criteria of investment evaluation: Net Present Value (NPV), Internal Rate of Return (IRR), Benefit Cost Ratio (BCR), Pay Back Period (PBP), and Break-Even Point (BEP).

**Table 3.5** Cash Flow of PLTMH Moanamani

<b>YEAR</b>	<b>Construction Period</b>		<b>Yearly Operation</b>	
	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>
	<i>1st year</i>	<i>2nd year</i>	<i>1st year</i>	<i>20th year</i>
<i>Cash In Flow From Operation Activity</i>	-	-	229,333,333	449,882,380
<i>Cash Out Flow From Operation Activity</i>	-	-	29,198,259	57,278,120
<b><i>CASH AVAILABLE FOR DEBT SERVICE</i></b>	-	-	<b>200,135,075</b>	<b>392,604,260</b>
<i>Cash In Flow Non-Operation Activity</i>	3,531,000,000	3,770,339,100	26,904,925	-
<i>Cash Out Flow Non-Operation Activity</i>	3,531,000,000	3,770,339,100	961,544,851	-
<b><i>CASH FLOW FROM NON-OPERATION ACTIVITY</i></b>	-	-	<b>(934,639,926)</b>	-
<b><i>SURPLUS / (DEFISIT)</i></b>	-	-	<b>(734,504,851)</b>	<b>392,604,260</b>
<b><i>BEGINNING CASH BALANCE</i></b>			-	(2,333,897,498)
<b><i>ENDING CASH BALANCE</i></b>			(734,504,851)	(1,941,293,237)

**Table 3.6** Financial Analysis of PLTMH Moanamani

YEAR	Construction Period		Yearly Operation	
	2017 1st year	2018 2nd year	2019 3rd year	2038 20th year
Equity Financing	(1,059,300,000)	(1,131,101,730)	(8,071,478)	-
Cash Flow Available for Equity	-	-	(734,504,851)	392,604,260
<b>Total Cash Flow</b>	<b>(1,059,300,000)</b>	<b>(1,131,101,730)</b>	<b>(742,576,329)</b>	<b>392,604,260</b>
Initial Outlay	(3,300,000,000)	(3,300,000,000)	-	-
Net Income	-	-	(68,914,179)	123,555,07
Depreciation	-	-	269,049,253	269,049,253
<b>Total Cash Flow</b>	<b>(3,300,000,000)</b>	<b>(3,300,000,000)</b>	<b>200,135,075</b>	<b>392.604,260</b>
<b>Accumulation</b>	<b>(3,300,000,000)</b>	<b>(6,600,000,000)</b>	<b>(6.399,864,925)</b>	<b>(875.839,352)</b>
YEAR	0	1	2	21
Discounted Rate	1,000	0,909	0,826	0,135
<b>∑ PV Outlay:</b>				
<b>IDR (6,300,000,000)</b>	(3,300,000,000)	(3,000,000,000)	-	-
<b>∑ PV Income:</b>				
<b>IDR</b>	-	-	165,400,888	56,324,796
<b>1.987.056.834</b>				

### Net Present Value

The evaluation criterion in Net Present Value establishes that if NPV is positive, the investment is feasible, but if NPV is negative, the investment is non-feasible. The NPV of PLTMH Moanamani is calculated as follows:

$$\begin{aligned}
 NPV &= \Sigma PV \text{ Income} - \Sigma PV \text{ Outlay} \\
 &= \text{IDR } 1,987,056,834 - \text{IDR } 6,300,000,000 \\
 &= - \text{IDR } 4,312,943,166 \text{ (not feasible)}
 \end{aligned}$$

### Internal Rate of Return

The evaluation criterion in the Internal Rate of Return establishes that if IRR is higher than the interest rate, the investment is feasible, but if IRR is lower than the interest rate, the investment is not feasible. Applying trial and error, we obtained Internal Rate of Returns as presented in **Table 3.7**. Table 8 shows that the trial-and-error analysis results in IRR value of PLTMH Moanamani is -1,79 %. This value is smaller than the interest rate of 10%; therefore, **the construction project is not feasible**.

**Table 3.7 Trial and Error IRR**

<i>Interest Rate</i>	$\Sigma$ <i>PV Outlay</i>	$\Sigma$ <i>PV Income</i>	<i>NPV</i>
12,50%	(6.233.333.333)	1.582.304.346	(4.651.028.987,45)
10,00%	(6.300.000.000)	1.934.003.996	(4.365.996.003,85)
7,50%	(6.369.767.442)	2.409.973.204	(3.959.794.237,82)
5,00%	(6.442.857.143)	3.067.368.086	(3.375.489.056,61)
2,50%	(6.519.512.195)	3.994.706.369	(2.524.805.826,47)
1,00%	(6.567.326.733)	4.735.751.389	(1.831.575.343,83)
0,50%	(6.583.582.090)	5.022.256.406	(1.561.325.683,23)
-1,79%	(6.660.146.347)	6.660.146.347	-

### Benefit Cost Ratio (BCR)

The evaluation criterion in the Benefit Cost Ratio of the project determines a project feasible if the BCR value is bigger than 1 (BCR >1), and not feasible if the BCR is less than 1 (BCR <1). The BCR value of PLTMH Moanamani project is calculated as follows:

$$\begin{aligned}
 BCR &= \Sigma PV \text{ Income} / \Sigma PV \text{ Outlay} \\
 &= \text{IDR } 1.987.056.834 / \text{IDR } 6.300.000.000 \\
 &= 0,32 \text{ (not feasible)}
 \end{aligned}$$

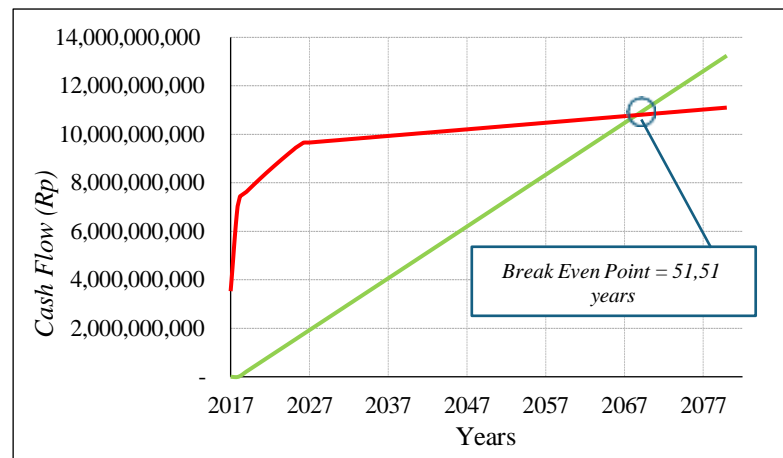
### Pay Back Period

The evaluation criterion of the Pay Back period establishes that when PBP is faster than the required time (the age of economic assets), the investment is feasible. However, if PBP is longer than the age of the economic assets, the investment is not feasible. PBP value of the PLTMH Moanamani is determined as follows:

$$\begin{aligned}
 PBP &= \text{Total Investment} / \text{Average Revenue} \\
 &= \text{IDR } 6,600.000.000 / \text{IDR } 327.963.713 \\
 &= 20,12 \text{ years (not feasible)}
 \end{aligned}$$

### Break-Even Point (BEP)

The Break Even Point analysis is run for a period of 51 years. The BEP result of PLTMH Moanamani is presented in **Figure 3.4**. This study shows that the BEP in PLTMH Moanamani project is longer than the planned economic age of PLTMH Moanamani, accordingly the construction project is not feasible. The estimated profit shows that the Cost of Goods Sold significantly affect the analysis results. The funding scheme of the construction project of PLTMH Moanamani used the 30% equity and 70% loan. Different schemes and results are presented in **Table 3.8**.



**Figure 3.4** Break Even Point Chart (Calculation Result)

This study shows that the BEP in PLTMH Moanamani project is longer than the planned economic age of PLTMH Moanamani, accordingly the construction project is not feasible. The estimated profit shows that the Cost of Goods Sold significantly affect the analysis results. The funding scheme of the construction project of PLTMH Moanamani used the 30% equity and 70% loan. Different schemes and results are presented in **Table 3.8**.

**Table 3.8** Effects of Changes in Funding Scheme on Analysis Results

No	Funding Scheme	-	Financial Analysis Result				
			NPV	IRR	BCR	PBP	BEP
1	Equity 30% - Loan 70%	-Rp	431,294,166	-1.79%	0.32	20.12	51.51
2	Equity 40% - Loan 60%	-Rp	431,294,166	-1.79%	0.32	20.12	49.22
3	Equity 50% - Loan 50%	-Rp	431,294,166	-1.79%	0.32	20.12	46.97
4	Equity 60% - Loan 40%	-Rp	431,294,166	-1.79%	0.32	20.12	44.77
5	Equity 70% - Loan 30%	-Rp	431,294,166	-1.79%	0.32	20.12	42.61
6	Equity 80% - Loan 20%	-Rp	431,294,166	-1.79%	0.32	20.12	40.50
7	Equity 90% - Loan 10%	-Rp	431,294,166	-1.79%	0.32	20.12	38.43
8	Equity 100% - Loan 0%	-Rp	431,294,166	-1.79%	0.32	20.12	36.40

#### 4. CONCLUSION

This study has demonstrated that the construction project of PLTMH Moanamani with combined funding scheme (30:70 of equity and loan) is not financially viable. The evaluation of investment parameters showed the results are under the minimum feasibility value (NPV = IDR 4,312,943,166), IRR lower than the interest rate (-1,79), BCR < 1(0,32), PBP longer than the age of economic assets (20.12 year), and BEP longer than the age of economic assets ( $\pm$  50 years). However, PT PLN (Ltd.) should look beyond financial/economic aspect to determine project feasibility because the power plants is vital for community activities. Further research is recommended to evaluate other aspects, such as social

and environmental aspects, to promote social welfare for the Indonesian community in Moanamani.

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