Investment Analysis of Tobelo Powerplant 30 MW Project in Halmahera Island System

Review of Integrative Business & Economics Research

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ABSTRACT

PT PLN (Persero), a state-owned company in Indonesia responsible for developing electrification in North Maluku, faces major challenges, such as lack of power capacity, reserve margin and high generation cost. This research aims to compare all investment alternatives assessed by PLN to solve such issues and determine the best alternative for the new Tobelo power plant project using capital budgeting analysis and levelized cost of electricity. This research conducts risk analysis to determine the highly sensitive variables which influence the feasibility of the project. Of all three alternatives reviewed by PLN, the best is Alternative 1 – build Gas-Fired Engine Power Plant (30 MW). It results in NPV with value 660,41 billion IDR; MIRR of 12,07%; Profitability Index of 1,71; and Payback Period in 6,68 years. Its generation cost (LCOE) is 10% lower than the existing Tobelo power plant. Based on the analysis evaluation scenario, Alternative 1 is not financially feasible if the project runs in Scenario 1 (using HSD for 20 Years). Exchange rate and LNG cost are the most sensitive variables in the sensitivity analysis. The Monte Carlo analysis resulted in the probability of negative NPV is 0%, indicating that the Tobelo Project will be a successful investment project.

Keywords: Gas-Fired Engine Power Plant, Reserve Margin, Levelized Cost of Electricity, Investment Analysis

1. INTRODUCTION

1.1 Background

As time goes by, demand for electricity will continue to increase every year. Population growth and economic growth are the two main factors which affect electricity consumption. Furthermore, other factors that influence load electricity growth are technology and the capability of the supply.

PT PLN (Persero), as the state-owned company responsible for electrification in Indonesia, faces one major challenge in developing the electrical system in North Maluku. The region lacks power capacity and reserve margin, causing the system to be deficit and unreliable. Halmahera Island Interconnected System located in North Maluku, in December 2021, reached the net peak load of 36,4 MW with capability power of 34 MW, power deficit of 9,40 MW, and minus reserve margin of 6,59%.

On the other hand, the current *Biaya Pokok Penyediaan* (BPP) or generation cost from the existing Diesel-Fired Power Plant (High-Speed Diesel or HSD) Tobelo, which is part of Halmahera Island Interconnected System, has more than 12% higher generation cost than several power plants owned by PLN.

Moreover, in 2023, several power plants in Halmahera Island Interconnected System were planned to stop operating due to their life and lease contract being over, which caused a system deficit. In order to serve the growth of customer demand, increase the reliability, and produce a new Tobelo power plant which has the least generation cost, PLN has a new investment plan in a more capable and efficient power plant than the existing Tobelo power plant. This research aims to analyze the comparison between all alternatives that have been assessed by PLN and determine the best alternative for the new Tobelo power plant project in terms of investment analysis.

1.2 Research Objective

a. Determine the best investment alternative for PLN.
b. Determine the best alternative which requires the least generation cost.
c. Analyze the effects of project feasibility when the construction of supporting infrastructure is delayed.
d. Find out which variables are the most sensitive and affect the Investment Analysis.
e. Find out the distribution probability of NPV from changes in sensitive variables.

2. LITERATURE REVIEW

2.1 Reserve Margin

According to (European Commission, 2016) Reserve Margin is the difference between the available generation capacity and the load to be covered, disregarding transmission constraints. The reserve margin is therefore defined as the ratio of the installed or available capacity maximum commission annual load, minus one. In this case, reliability is calculated on the basis of the system's probability of being able, or not, to supply the maximum annual peak load. PLN believes that the available reserves or Reserve Margin are able to represent the reliability level of a system.

2.2 Discounted Cash Flow

One of the most common financial feasibility analysis is built on a general method named discounted cash flow. Using this method, the principle of time value of money is applied to the company's expected future cash flow to determine the present value of the total cash flow, usually known as Net Present Value (Heerkens, 2006). The time value of money assumes that money in the present is worth more than money in the future because money in the present can be invested and thereby earn more money.
The calculation formula is as follows:

$$PV = \frac{FVn}{(1+r)^n}$$

Where:
FV = Future Value;
PV = Present Value;
r = Rate of Return;
n = number of periods involved in the analysis

A different type of capital used in investment will also have a different rate of return, hence the rate of return (r) being used in investment analysis is subject to the capital structure implemented in the projects (Gitman & Zutter, 2015).

2.3 Weighted Average Cost of Capital (WACC)

In order to determine the expected average future cost of capital, we may use the Weighted Average Cost of Capital (WACC), which is the minimum value of return expected by a company when making long-run investments to get the weighted value of each type of capital cost, such as cost of stock and cost of debt. The formula for WACC is as follows:

$$wacc = (w_d \times r_d) + (w_e \times r_e)$$

Where:

w_d : Proportion of long-term debt in capital structure
r_d : Cost of long-term debt
w_e : Proportion of common stock in capital structure
r_e : Cost of common stock

2.4 Hurdle Rate

PLN shareholders have set a minimum rate of return which shall be achieved by their investment project to receive funding which will be different for each year, these rates are known as hurdle rates. (Dutta & Fan, 2009) found that optimal hurdle rates will be higher in companies whose investment opportunities are relatively good. In this analysis, the calculation and the analysis of hurdle rate are not conducted, instead, the hurdle rate will be used as a discount factor.

2.5 Net Present Value

NPV is the most common measure for financial strength. It calculates the present value of all future cash flows which the project will gain. NPV will determine how much money a project will make (Heerkens, 2006). Suppose that the NPV of a project or investment is positive, in such case, the discounted present value of all future cash flows which are related to that project or investment will also be positive. Therefore, the project is attractive and accepted. The formula for NPV is as follows:

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} - CF_0$$

Where:

n : the number of years in the lifetime of the machine to be purchased,
CF_t : the total cash flow
CF_0 : the initial cash flow
r : the discount rate

2.6 Internal Rate of Return

IRR is the discount rate that will make the investment have NPV equal to zero because the present value of cash inflows is equal to the initial investment. If the IRR of the project is greater than the cost of capital, then it can be accepted. The formula of IRR is as follows:

$$0 = NPV = \sum_{t=1}^{T} \frac{CF_t}{(1+IRR)^t} - CF_0$$

Where:

CF_t : Net cash inflow during the period t
CF_0 : Total initial investment costs

IRR : The internal rate of return
T : The number of time periods

2.7 Payback Period

PP will provide the time needed for the project to fully recover its cost of investment without calculating the time value of money (Heerkens, 2006). This type of analysis allows the company to compare alternative investment opportunities and decide on a project that returns its investment in the shortest time. PP is factored to make an accept-reject decision based on the following criteria (Faturohman & Rachman, 2021):

- If the PP is shorter than the maximum acceptable payback period, accept the project
- If the PP is longer than the maximum acceptable payback period, decline the project

Strengths:

- Easy to use and understand – can be used as a measure of liquidity

Weaknesses:

- Does not account for time value of money
- Does not consider cash flows beyond PP
- Cutoff period is subjective

2.8 Profitability Index

PI is calculated by dividing the present value of cash inflows by the initial cash outflows. If the PI of the project is greater than 1, then the project can be accepted (Gitman & Zutter, 2015).

2.9 Levelized Cost of Electricity (LCOE)

The levelized cost of electricity is a crucial metric in determining whether or not to move forward with the project. The LCOE will determine if a project will be a break-even or profitable. If not, then the firm will not go ahead with building the power-generating asset and will look for another alternative. Using the LCOE to assess a project is one of the first fundamental steps taken in analyzing projects of this nature (Corporate Finance Institute, 2021). PLN will choose the lowest LCOE from each alternative to run the project.

$$LCOE = \frac{\text{NPV of Total Costs Over Lifetime}}{\text{NPV of Electrical Energy Produced Over Lifetime}}$$

$$LCOE = \frac{\sum \frac{(I_t + M_t + F_t)}{(1+r)^t}}{\sum \frac{E_t}{(1+r)^t}}$$

Where:
I : The initial cost of investment expenditures
M : Maintenance and operations expenditures
F : Fuel expenditures
E : The sum of all electricity generated
r : The discount rate of the project
t : The life of the system

3. RESEARCH METHODOLOGY

After determining the business issue, then the next step is to develop a business situation. The business situation analysis focuses on internal and external factors that will affect the PLN investment plan. The external analysis is centered on threats and opportunities. By conducting an external analysis, an organization is able to mitigate threats and leverage opportunities in its competitive environment. This analysis also examines how competition in this environment is likely to evolve, and the impact to the threat and opportunities an organization is facing (Rothaermel, 2019). The research framework can be seen in figure 3.1 below.

The next step of this research will be developing the financial model of the PLN investment plan for each alternative. The financial model projection will be developed to find the Free Cash Flow to the Firm (FCFF) and Levelized Cost of Electricity (LCOE) as the basis of financial model evaluation. The investment will be evaluated based on three capital budgeting parameters as follows: Net Present Value (NPV); Internal Rate of Return (IRR); and Payback Period (PP) which are obtained by discounting the FCFF at the project Weighted Average Cost of Capital (WACC) (Gitman & Zutter, 2015). LCOE will be evaluated based on NPV of the total cost of building and operating the power generating asset (Corporate Finance Institute, 2021). The process of calculating LCOE is related to the concept of assessing a project's NPV, which is also calculated by the project WACC.

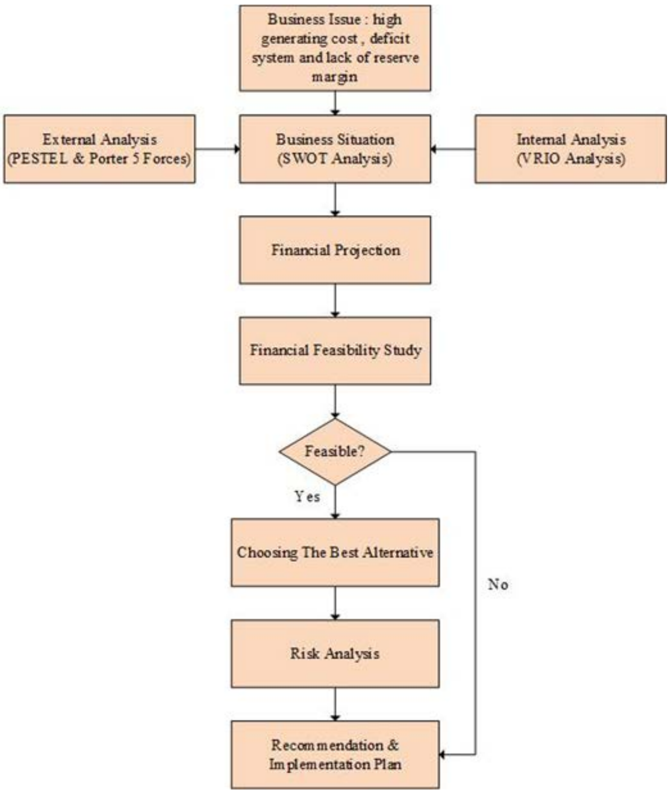

Figure 3.1 Research Framework

From the three alternatives that PLN considered for the Tobelo Project, the best alternative will be chosen, the one which generated the best investment criteria and the lowest LCOE—then to conduct financial risk analysis from the best alternative to determine the robustness of the project. Eventually, the recommendation and implementation plan will be presented to PLN after conducting all the above analyses.

4. BUSINESS SOLUTION

4.1 Business Solution Alternatives

The new Tobelo power plant project is the answer to serve demand growth and increase the reliability in the Halmahera Island Interconnected System. Furthermore, this project also aims to generate a power plant which costs the least. This section focuses on analyzing the best alternatives out of 3 possible courses of action which gives PLN the most feasible and produces the least generation cost. It is necessary to conduct an investment project analysis. The alternatives are:

1. Build Gas-Fired Engine Power Plant and Transmission Line
2. Build Diesel-Fired Power Plant and Transmission Line
3. Lease Diesel-Fired Power Plant and build Transmission Line

The analysis of the project investment uses several discounted cash flows (DCF) which are evaluated using investment decision analysis as provided in chapter 2.5 – 2.8. For the generation cost, Levelized Cost of Electricity (LCOE) method is used as provided in chapter 2.9.

After evaluating the investment on all criteria, an analysis of financial risk will be conducted to the best alternative analysis using three methods:

1. Scenario analysis with the worst and best situations
2. Sensitivity analysis with a simulation of +/- 20% swing to determine which parameters that is highly sensitive
3. Monte Carlo analysis to find the distribution of potential NPV of the project based on highly sensitive parameters.

4.2 Assumptions

This research only focuses on the generation business line to determine which alternative is best for this project. The comparison between every alternative is not based on the real revenue from distribution and retail line, assuming the generated energy will be the same for each alternative. Instead, it will be carried out on the overall cost over the economic life that must be incurred or required for each alternative, hence the market size will be based on the Net Capacity of the power plant (30 MW).

The Tobelo project is estimated to be completed within 12 months of construction, starting at the beginning of the year 2022 and Commercial on Date (COD) in the beginning year 2023. The project will be running as long as the economic years of the power plant which is 20 years and using the straight line method for depreciation. The project layout utilizes a private land of PLN (2,5 ha), thus the land acquisition cost is zero, and the pre-construction permits have been completed as well. The source of financing is from APLN (*Anggaran PLN*) which means 100% of its own equity. Hence, the WACC will be equal to the Cost of Equity. This research will be using PLN hurdle rate (9,1%) as the discount rate.

All assumptions in this project use the PLN contract references and internal database, which take into account the year adjustments, exchange rates and the location of the power plant. Secondary data will be collected mostly from reference books and articles from the library and the internet which have relations to the project, such as Exchange Rate from www.bi.go.id..

The description of each infrastructure is presented in Table 4.1, 4.2 and 4.3 below and the financial assumption is shown in Table 4.4.

Table 4.1 Gas-Fired Engine Power Plant Assumption

Gas Fired Engine Powerplant (30MW) Assumption

COST ASSUMPTION		
1. A Component (Investment cost)		
- EPC Cost	Million IDR	884.031,67
2. B component (Fixed O&M cost)		
- Annual Fixed O&M cost	Million IDR	33.151,19
- Fixed O&M growth	Percentage	3,00%
3. C component (Fuel cost)		
- Liquified Natural Gas (LNG)	USD/MMBtu	11,00
- High Speed Diesel (HSD)	IDR/Liter	7.749,3
4. D component (Variable O&M cost)		
- Annual Variable O&M cost	Million IDR	11.050
- Variable O&M growth	Percentage	2,00%

TECHNICAL ASSUMPTION		
1. Net Capacity	MW	30,00
2. CF (Capacity Factor)	Percentage	80%
3. Annual kWh Sales	MWh	210.240,00
4. Net Plant Heat Rate (NPHR)	Btu/kWh	8.066
	Liter/kwh	0,23
5. Economic life	Years	20

Table 4.2 Diesel-Fired Power Plant Assumption

Diesel Fired Powerplant (30 MW) assumption

COST ASSUMPTION		
1. A Component (Investment cost)		
- EPC Cost	Million IDR	160.461,62
2. B component (Fixed O&M cost)		
- Annual Fixed O&M cost	Million IDR	6.017,31
- Fixed O&M growth	Percentage	3,0%
3. C component (Fuel cost)		
- High Speed Diesel (HSD)	IDR / Liter	7.749,3
4. D component (Variable O&M cost)		
- Annual Variable O&M cost	Million IDR	2.005,77
- Variable O&M growth	Percentage	2,0%
5. Lease Cost		
- Diesel fired powerplant lease cost	IDR / kWh	285

TECHNICAL ASSUMPTION		
1. Net Capacity	MW	30,00
2. CF (Capacity Factor)	Percentage	80%
3. Annual kWh Sales	MWh	210.240,00
4. Diesel fired powerplant SFC (Buy)	Liter/ kWh	0,285
5. Diesel fired powerplant SFC (Lease)	Liter/ kWh	0,285
6. Economic life	Years	20

Table 4.3 Transmission Line Assumption

Transmission Line 150 kV ± 11 kmr assumption

COST ASSUMPTION		
1. A Component (Investment cost)		
- EPC Cost	Million IDR	43.946,00

TECHNICAL ASSUMPTION		
1. Transmission losses	Percentage	0,06%
2. Economic life	Years	40

Table 4.4 Financial Assumption

Financial Assumption		
1. Exchange Rate	USD to IDR	14.600
2. Discount Factor	Percentage	9,1%
3. Generating Cost Tobelo	IDR/kWh	Rupiah
4. Tax	Percentage	22%

4.3 Results and Comparison between Alternative 1, 2 and 3

Based on the analysis which has been conducted on all alternatives; it can be seen in Table 4.5 that the best alternative for the Tobelo Project is Alternative 1 because it has the highest Capital Budgeting Analysis criteria and the lowest LCOE compared to the current generation cost of Tobelo power plant (10% lower).

Table 4.5 Summary of Investment Criteria for all alternatives

Summary			
Parameter	**Alternative 1**	**Alternative 2**	**Alternative 3**
NPV (Billion IDR)	660,41	82,54	-217,71
MIRR (percentage)	12,07%	10,96%	-100,00%
Profitability Index	1,71	1,40	-3,95
Payback period (years)	6,68	7,13	21,84
LCOE (IDR/kWh)	-10%	4%	11%

This research also calculates the Minimum Lease Cost for NPV = 0 supposed PLN is still considering to go with Alternative 3. The result is 184,17 IDR / kWh. Therefore, for the next chapter and forward, the analysis will only focus on Alternative 1.

4.4 Financial Risk Assessment Analysis

4.4.1 Scenario Analysis

The advantage of choosing a gas-fired engine power plant is the capability to use dual fuel. Liquid Natural Gas (LNG) can be used as primary fuel and High-Speed Diesel (HSD) as secondary fuel. Thus, the infrastructure of the gas supply must be constructed in advance. Since PLN does not construct the infrastructure, there is a risk that the power plant cannot be operated with LNG due to construction delays where it is not aligned with the purpose of this project. Since the RUPTL project is designed for ten years (2021-2030) and the economic life of the power plant is planned twenty years (2023-2042), this research defines into three scenarios:

- Scenario 1: Fully using HSD for 20 years, assuming the construction of gas infrastructure will be late alongside the economic life of the power plant.
- Scenario 2: 8 years of using HSD, assuming that the construction of gas infrastructure is delayed as late as the end of the RUPTL plan and the rest of economic life of 12 years will be using LNG.
- Scenario 3: Fully using LNG for 20 years, assuming that the gas infrastructure is already constructed when the Tobelo Project is first operated in 2023.

From all scenarios which have been simulated, this project will generate a negative NPV if it runs at Scenario 1. The NPV range from Scenario 1 to Scenario 3 is 855,86 Billion IDR. The possible mitigation plan for PLN is to apply a Service Level Agreement (SLA) to the LNG Supplier to maintain the project's return within the expected NPV. The result of the scenario analysis can be seen in table 4.6.

Table 4.6 Scenario Analysis Result

SCENARIO ANALYSIS			
Variables	Worst Case (HSD 20 Years)	Bad Case (HSD 8 Years and LNG 12 Years)	Base Case (LNG 20 Years)
Fuel cost (Year)	1	2	3
2023	374,72	374,72	272,34
2024	374,72	374,72	272,34
2025	374,72	374,72	272,34
2026	374,72	374,72	272,34
2027	374,72	374,72	272,34
2028	374,72	374,72	272,34
2029	374,72	374,72	272,34
2030	374,72	374,72	272,34
2031	374,72	272,34	272,34
2032	374,72	272,34	272,34
2033	374,72	272,34	272,34
2034	374,72	272,34	272,34
2035	374,72	272,34	272,34
2036	374,72	272,34	272,34
2037	374,72	272,34	272,34
2038	374,72	272,34	272,34
2039	374,72	272,34	272,34
2040	374,72	272,34	272,34
2041	374,72	272,34	272,34
2042	374,72	272,34	272,34
NPV (Bil IDR)	(195,45)	230,94	660,41
	Range	855,86	

4.4.2 Sensitivity Analysis

Sensitivity analysis is conducted by testing the variables which have significant correlation. By performing these tests, the results will show which variables affect the project feasibility. This research uses a +/-20% swing to determine the change in NPV to the company. The variables used to perform sensitivity analysis are exchange rate, LNG Cost, Fix O&M Growth, Variable O&M Growth, and EPC Cost.

Table 4.7 below describes the sensitivity results of the investment project in tornado and spider charts as described in the following Figures 4.1 and 4.2. In this analysis, the results found two sensitive variables which resulted in NPV change above the input swing +/-20%, namely the LNG Cost and exchange rate. In order to maintain the project return and ensure the price of the Fix O&M Cost, Variable O&M Cost, and EPC Cost are increased reasonably, PLN must determine the fixed price in contract agreement with the vendor along with the life of the project.

Table 4.7 Sensitivity Analysis Result

SENSITIVITY ANALYSIS
In Billion IDR

Parameter	Normal	+20% Swing	-20% Swing	Current NPV	+20% Swing NPV	-20% Swing NPV
Exchange rate	14.600,00	17.520,00	11.680,00	660,41	197,47	1.123,34
LNG Cost	11,00	13,20	8,80	660,41	205,04	1.115,77
Fixed O&M growth	3,00%	3,60%	2,40%	660,41	638,35	680,79
A component (EPC Cost)	927,98	1.113,57	742,38	660,41	644,92	675,89
Variable O&M growth	2,00%	2,40%	1,60%	660,41	656,16	664,43

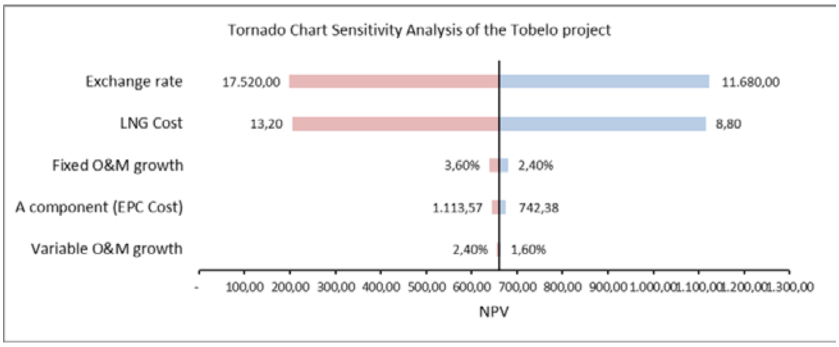

Figure 4.1 Tornado Chart Result

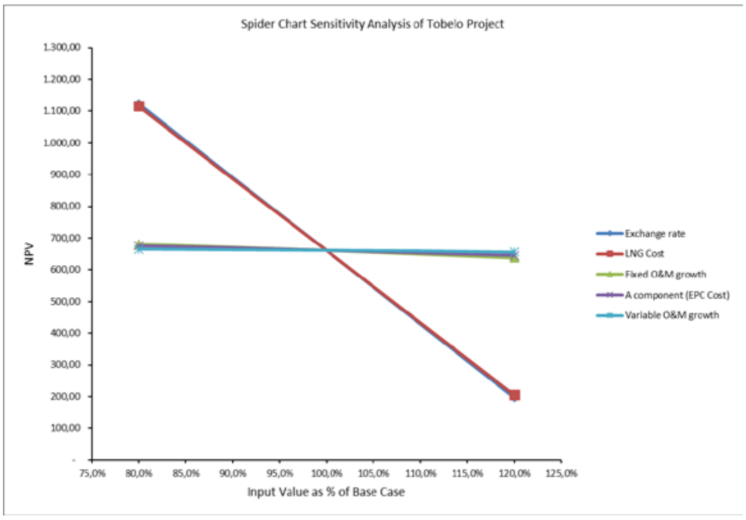

Figure 4.2 Spider Chart Result

4.4.3 Monte Carlo Simulation

Monte Carlo simulation is performed for the two highly sensitive parameters, which are the LNG cost and exchange rate. The results of Monte Carlo simulation provided in Table 4.8, Table 4.9 and Figure 4.3. This analysis is conducted for 10.000 times, and from the results, we can conclude that there is no probability that the project will provide negative NPV to PLN.

Table 4.8 Monte Carlo Simulation Result

MONTE CARLO SIMULATION				
Variables	**Normal**	**Low**	**Mostlikely**	**High**
LNG Cost	11,00	10,00	11,00	13,00
Exchange rate	14.600,00	14.310,33	14.600,00	14.648,00
NPV (Bil IDR)	660,41			

Table 4.9 Monte Carlo Simulation Statistics Result

Forecast: NPV (Bil IDR)	
Statistic	Forecast values
Trials	10.000
Base Case	660
Mean	591,41
Median	603,08
Mode	'---
Standard Deviation	131,74
Variance	17.355,39
Skewness	-0,3034
Kurtosis	2,51
Coeff. of Variation	0,2228
Minimum	197,61
Maximum	920,44
Mean Std. Error	1,32

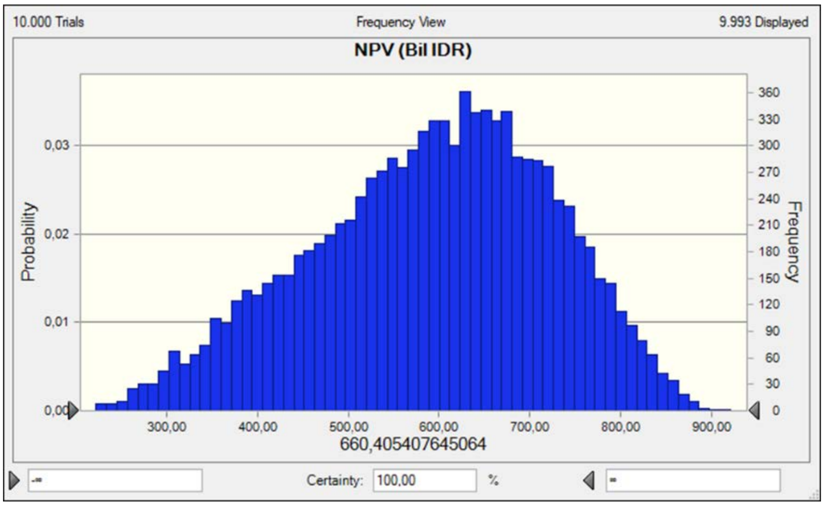

Figure 4.3 Monte Carlo Simulation NPV distribution

4.5 Discussions

In this section, all the analysis which has been conducted in this research will be highlighted.

a. Capital Budgeting Analysis and Levelized Cost of Electricity Analysis
   Alternative 1 is the best among all alternatives which PLN has assessed. From the analysis that has been performed, it shows that the value of NPV is 660,41 billion IDR; MIRR is 12,07%; Profitability Index is 1,71; and Payback Period in 6,68 years and LCOE is 10% lower than the present Tobelo power plant. If PLN continues to go with Alternative 3, the Minimum Lease Cost for NPV = 0 is 184,17 IDR / kWh.
b. Scenario Analysis
   Alternative 1 will not be financially feasible if the project runs in Scenario 3 (using HSD for 20 Years). It will generate a negative NPV with the value of 195,45 IDR. The NPV range from Scenario 1 to Scenario 3 is 855,86 Billion IDR.
c. Sensitivity Analysis
   From Alternative 1, the sensitivity analysis showed that exchange rate and LNG cost are the two most sensitive variables.
d. Monte Carlo Simulation
   From simulation on Alternative 1, the probability of negative NPV is 0%, the probability of NPV higher than 660,41 Billion IDR is 33,63%, and the probability NPV being lower than 660,41 Billion IDR is 66,37%

5. CONCLUSION

Based on the feasibility analysis of PLN's investment plan in a new power plant and transmission line in Tobelo to develop the Halmahera Island Interconnection System in North Maluku, the conclusions are as follows:

1. Out of all 3 alternatives which have been considered by PLN, Alternative 1 – build Gas-Fired Engine Power Plant (30 MW) is the best investment. Generation NPV with value of 660,41 billion IDR; MIRR of 12,07%; Profitability Index of 1,71; and Payback Period in 6,68 years.
2. Alternative 1 – build Gas-Fired Engine Power Plant (30 MW) also produces the least generation cost (LCOE). Its LCOE is 10% less than the current Tobelo power plant.
3. Based on the scenario analysis evaluation, Alternative 1 will not be financially feasible if the project runs in Scenario 1 (using HSD for 20 Years). It will generate a negative NPV with the value of 195,45 Billion IDR. The NPV range from Scenario 1 to Scenario 3 is 855,86 Billion IDR.
4. In the sensitivity analysis evaluation on Alternative 1, the result shows that two variables are the most sensitive, namely the exchange rate and LNG cost.
5. With the Monte Carlo analysis, the results obtained show that for Alternative 1, the probability of negative NPV is 0%, the probability NPV being higher than 660,41 Billion IDR is 33,63%, the probability NPV being lower than 660,41 Billion IDR is 66,37% which indicate that the Tobelo Project will be a successful investment project.

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