FEASIBILITY ANALYSIS OF A GAS ENGINE POWER PLANT (GEPP) PROJECT USING CAPITAL BUDGETING TECHNIQUE (Case Study: GEPP XX-2 50 MW Project)

Dimas Primasatya, Asep Risman

Abstract— This research aims to analyze the feasibility project of the Gas Engine Power Plant (GEPP) XX-2 50 MW using a capital budgeting technique and sensitivity analysis with changes variables. Indicators used to analyze feasibility project of the Gas Engine Power Plant (GEPP) XX-2 50 MW are: payback period (PP), net present value (NPV), internal rate of return (IRR), sensitivity analysis of EPC cost deviation variables , deviations in fuel prices, fluctuations in exchange rates and changes in capacity factors. This research analyzes the feasibility of project investment from the financial aspect by considering the basic electricity tariff (TDL) and break event point (BEP) assumptions. The calculation of the value of investment made amounted to 2,108.38 IDR/kWh, net present value (NPV) of minus 420,385.574,000,- IDR for the assumption of TDL and minus 37,687,189,000,- IDR for the BEP assumption, the internal rate of return (IRR) is 2.85% for the TDL assumption and 8.63% for the BEP assumption where this project is not feasible by financially aspect, the results of this study has also been calculated the payback period (PP) for 16.02 years for the TDL assumption and 11.39 years for the BEP assumption where this project is feasible because it is shorter than the project age (20 years). The results of the sensitivity analysis to the deviation of the EPC variable costs have a significant effect on the cost of electricity generation (LEGC) and the project is not feasible, then both the sensitivity analysis to the deviation of fuel prices and to fluctuations exchange rate have a less significant effect on the cost of electricity generation (LEGC) and projects is not feasible, and sensitivity analysis to changes in capacity factors has a very significant effect on the cost of electricity generation (LEGC) and the project is feasible

Index Terms— Capital Budgeting, Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period (PP), Sensitivity Analysis

1 INTRODUCTION

Electricity has an important role for economic activities, especially to support and grow developing regions in Indonesia. In the growth of regional development, the need for energy electricity will be continue to increase. In the future, the growth of economic activity will cause the demand for energy supply to increase. The largest electricity system in West Papua province is the Sorong region which has a peak load of 44.25 MW (average) and the largest peak load of 49.54 MW in 2020. It is supplied from a diesel power plant which is connected directly to a medium voltage 20 kV and a gas engine power plant (GEPP) which is connected to a 150 kV transmission [1].

The high cost of fuel oil and limited subsidies from the government forced PT X to immediately look for a cheaper alternative energy. One of the energy diversification efforts carried out is the use of gas, either liquefied natural gas (LNG) or compressed natural gas (CNG) as fuel to obtain electricity. Investment in thermal power plants (gas engine power plant), just like investments in other energy sectors, is basically a capital intensive investment. The existence of energy sources which are generally found in hard-to-reach locations require high technology and adequate expertise [2].

The interest of investors to invest their funds in electricity development projects is still low. This is due to the low expected rate of return from these activities, which is caused, among other things, by the uncompetitive basic electricity tariff (TDL) and less competitive business costs compared to other domestic businesses [3].

Because the potential for developing natural gas power plants requires a fairly large initial investment, and has a fairly high level of risk, valuation as one of the bases in the development of this sector has a very important role, so a feasibility analysis of project investment is needed. Acceptable to investors and management for the benefit of the implementation of the business, especially those related to the price side and business costs, and their effect on the rate of return on investment.

- *Dimas Primasatya is Student magister management in Mercu Buana University, Jl. Meruya Selatan no 1, West Jakarta, Indonesia, phone : +62 21 5840816, E-mail: primasatya06.dimas@gmail.com*
- *Dr. Asep Risman, SE, MM is Lecturer Managemenet in Mercu Buana University, Jl. Meruya Selatan no 1, West Jakarta, Indonesia, phone : +62 21 5840816. E-mail: asep.risman@mercubuana.ac.id*

2 LITERATURE REVIEW

2.1 Project and Electric Power Cost Components

A project is a temporary activity that takes place within a limited period of time with the allocation of certain resources and is intended to produce a product or deliverable whose quality criteria have been clearly outlined [4].

The selling price of electric power consists of five cost components, namely: components A, B, C, D and E. The cost of component A is calculated based on the amount of investment cost for the plant. The cost of component B is the fixed cost of operation and maintenance or operation and maintenance of the plant. The cost of component C is the cost of fuel which is calculated based on the amount of fuel consumption, duration of power generation, type of fuel and several other things. The cost of component D is the operational and maintenance variable cost of the generator. The cost of component E is the cost of transmission construction, if the project is included in a non-PLN project that does not have access to transmission [5].

2.2 Capital Budgeting Concept

According to Ekawati (2015:5.18), what is meant by capital budgeting is the process of analyzing investments in potential fixed assets. The hardest part of capital budgeting is estimating the cash flows and risks inherent in a project. Capital budgeting means a decision to invest a large initial fund accompanied by cash inflow in the next period. [6]

There are several methods in evaluating investment feasibility, namely payback period (PP), net present value (NPV), internal rate of return (IRR) and sensitivity analysis.

a. Payback Period (PP)

The payback period is the number of years required for a firm to recover its initial investment required by a project from the cash flows it generates" (Ross 902: 2005). Calculation of the payback period of a project can be calculated using the following formula:

$$Payback\ Period = \frac{Initial\ Investment}{Cash\ Inflow} \quad (1)$$

The payback period reflects the level of liquidity (the speed at which the capital is invested), and thus provides an overview of the risk of being able to immediately recoup the investment with the cash flow generated by the investment.

b. Net Present Value (NPV)

Net Present Value (NPV) is a method of calculating the net value (net) at the present time. The present assumption is to explain that the initial time of the calculation coincides with the time the evaluation is carried out or in the zero year period (0) in the calculation of the investment cash flow [7].

This method is based on the premise that the value of an asset is the present value of the estimated cash flows that will be generated by the asset in the future. NPV can be expressed as follows:

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+k)^t} \pm CF_0 \quad (2)$$

Where,

CF_t = (*Cash Flow*) annual cash flow after tax in period t (value can be positive or negative)

k = Appropriate discount rate, i.e. required rate of return or cost of capital

CF_0 = Initial cash disbursement for project investment

n = Expected age of the project

c. Internal Rate of Return (IRR)

Internal Rate of Return is defined as the discount rate or interest rate that equates the present value of the project's expected cash flows with the initial outlay of the project (NPV = 0). Mathematically the internal rate of return is defined in the following equation:

$$\$0 = \sum_{t=1}^{n} \frac{CF_1}{(1+IRR)^t} - CF_0 \quad (3)$$

The decision criteria using the Internal Rate of Return (IRR) can be stated as follows: IRR the required rate of return: Accept, IRR< the required rate of return: Reject.

2.3 Capital Asset Pricing Model in Determining Cost of Capital

The calculation of the rate of return on shareholder capital (cost of equity) is carried out using the Capital Asset Pricing Model (CAPM). Furthermore, to calculate the project's rate of return, the cost of equity that has been calculated using the CAPM is then used to calculate the weighted average cost of capital, which is the cost level of the overall funds used in the company's capital structure sourced from own capital and debt, using the formula: (Ekawati 2015:5.18) [6]

$$WACC = W_d . k_d (1-t) + W_s . k_s \quad (4)$$

$$W_d = \frac{D}{(D+S)} \qquad W_s = \frac{S}{(D+S)} \quad (5) \& (6)$$

Where,

D = debt

k_d = cost of debt

t = tax

W_d = weight of debt value to total funding

S = equity

W_s = weight of equity value to total funding

k_s = cost of equity

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Sensitivity analysis is used to see the effect of changes in various business variables on investment feasibility indicators. There are two factors that greatly affect the rate of return and profitability of the company (which in this case is calculated using the NPV), namely revenues and costs. The investment parameters of sensitivity analysis are:

a. benefit
b. investation
c. cost
d. interest

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3 METHODOLOGY

The research method used in this study is to perform calculations using available data, both primary data from the field and secondary data from existing references by using descriptive research with a quantitative descriptive approach, because this study will describe or describe the variables of the object under study. . The data collection stage is the stage to obtain information and data from existing problems and conditions. The following is the flow of investment feasibility research.

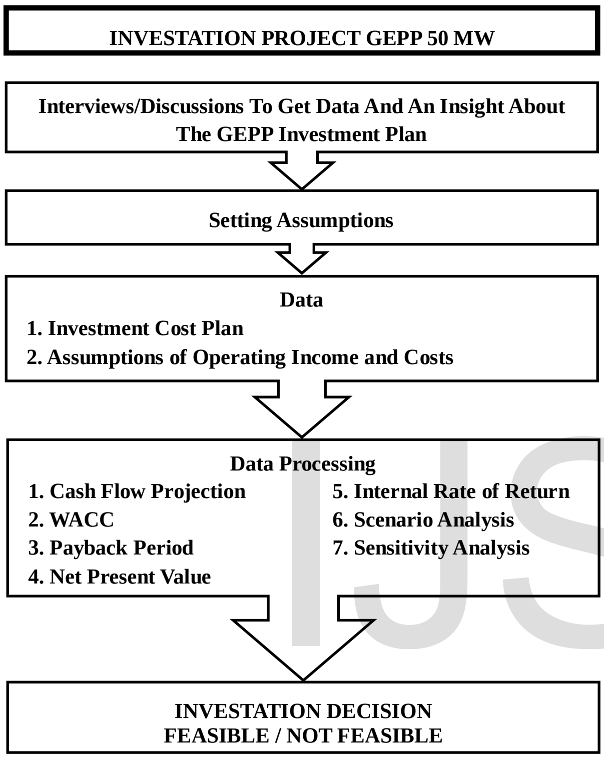

Figure 1. Research flow chart

4 RESULT AND DISCUSSION

Gas Engine Power Plant XX-2, hereinafter referred to as GEPP XX-2, is located on Durian Street, Arar Village, Mayamuk District, Sorong Regency, West Papua Province. From the data obtained, it is known that the project scope is as follows: (Source: Report Feasibility Study GEPP Sorong-2 50 MW) [8]

- Plant Type : GEPP (Gas Engine Power Plant)
- Power Capacity : 50 MW + 10% (Min 50 MW & Max 55 MW)
- Area : 2.41 Ha and 0.19 – 1.894 m² for switchyard / substation
- Engine Scheme : 3 Unit Gas Engine 17 MW
- Substation Voltage : 150 kV
- Type of Fuel : Natural Gas (Main Fuel) and High Speed Diesel (Pilot Fuel)

4.1 Assumptions Used

a. Economic Factor Assumption

The GEPP XX-2 construction project will be financed with PT X own funds. Fees apply based on data with the applied exchange rate of 14,445.87 IDR/US Dollar. The inflation assumptions used are Indonesian inflation, Euro inflation, Japanese inflation and American inflation. The company tax that will be imposed on the calculation of the feasibility of this investment is assumed to be 20%.

b. Investment Assumption

The EPC cost plan from the construction of this project can be seen in the following table:

Table 1 EPC Cost GEPP Class 17 MW

No	Description	EPC Cost IDR Equivalent	Percentage
1	Civil Works	140.483.085.000	17,87%
2	Mechanical Works	498.746.005.000	63,44%
3	Electrical and I&C Works	135.723.456.000	17,26%
4	Others	11.193.744.000	1,42%
	TOTAL	**786.146.290.000**	**100,00%**

The Non-EPC cost plan from the construction of this project can be seen in the following table:

Table 2 Non-EPC Cost GEPP Class 17 MW

No	Description	Non-EPC Cost IDR Equivalent
1	**EPC Cost (without VAT)**	**786.146.290.000**
2	**Non-EPC Cost**	**193.664.557.048**
a	Owner Cost	78.614.629.000
b	Value Added Tax (VAT)	36.435.299.048
c	Contingency	78.614.629.000
	Total Project Capital Cost	**979.810.847.048**

c. Other Assumption

In this research, the financial appraisal process will be carried out using the standard discounted cash flow technique. The basic assumptions in the financial feasibility research carried out are as follows:

Table 3 Basic Assumption

BASIC ASSUMPTION	
Base Year for Cost Estimates	2021
Construction Start	2022
Power Plant Operation Start	2023
Service Life (Year) *	20
Base Year for NPV Calculation	2021
Financial Assumptions	
Foreign Exchange Rate, USD – IDR **	14,445.87
Electricity tariff, IDR / kWh	1444.7
Funding Structure	
Debt-to-EPC Cost Ratio	0%
Equity-to-EPC Cost Ratio	100%
Discount rate (WACC)	9.06%
Price Escalation	
Electricity Tariff, per annum	1.16%
Fuel Price, per annum	0%
Fixed O&M Cost Power Plant, per annum	2.49%
Variable O&M Cost Power Plant, per annum	2.83%
Corporate Income Tax	20%

The technical assumptions in the financial feasibility research carried out are as follows:

Table 4 Technical Assumption

TECHNICAL ASSUMPTION		
Capacity Factor *	40%	
Auxiliary Power	2.30%	
Gross Power Output	52.65	MW
Net Power Output	51.44	MW
Gross Plant Heat Rate (Gas)	1,806.72	kCal/kWh
Gross Plant Heat Rate (Oil)	1,848.90	kCal/kWh
Net Plant Heat Rate (Gas)	1,849.25	kCal/kWh
Fuel Oil Price (B30)	13.11	US$/MMBTU
Gas Price (FOB + Transport)	6.00	US$/MMBTU
Gas Supply Projection		MMBTU/year
Ratio Gas to Oil Used	99.00	(90% Gas & 10% Oil, dikarenakan menggunakan dual fuel Engine)

(source: Technical Data Report Feasibility Study Sorong-2 50 MW)

4.2 Capital Budgeting Analysis

a. Weight Average Cost of Capital (WACC)

Cash flow on the project is discounted with WACC which is determined by assuming the value of equity or capital owned by PT X is 100% of the total project cost. The cost of equity is determined beforehand by using the Capital Asset Pricing Model (CAPM) method. The calculations are shown in the following table.

Table 5 WACC Calculation

Component	Value	Source
Risk Free Rate (r_f)	6.0377%	YTM 10-year Indonesian government bonds in USD
Market Risk Premium (r_m-r_f)	3.47%	Indonesia's market risk premium based on historical data
Beta (β)	0.87	Assumed sensitivity of return on equity investment to market returns
cost of equity (k_s)	9.06%	Calculation Result $r_f + \beta \times (r_m - r_f)$
Tax	20%	Corporate Tax in 2021
WACC	9.06%	The calculation results

b. Levelized Electricity Generating Cost

The tariff structure analysis aims to obtain a tariff structure on the generating side which consists of component A, component B, component C and component D. The following are the results of the calculation of levelized electricity generating cost (LEGC):

Table 6 Levelized Electricity Generating Cost

Description	Amount (IDR x 1000)	IDR/kWh
Present Value Cost Recovery (Component A)	827,356,753	978.22
Present Value Fixed O&M Cost (Component B)	291,690,604	344.88
Present Value Fuel Cost (Component C)	544,245,973	643.49
Present Value Variable O& M Cost (Component D)	119,926,325	141.79
Total	**1,783,219,655**	**2,108.38**

(source: Author's processed results)

c. The Result of the Calculation of payback period (PP), net present value (NPV) and internal rate of return (IRR)

Assuming an electricity tariff of 1,444.70 IDR/kWh or 10.26 cents US$/kWh as project income and assuming an increase in electricity prices of 1.16% per year. Then the results of the calculation of financial analysis through two scenarios, namely the assumption of basic electricity rates and the assumption of a break event point, then the following table below is the result of the calculation:

Table 7 Analysis Capital Budgeting 17 MW Class

Capital Budgeting Analysis	Assumption (TDL) Tarif Dasar Listrik	Assumption (BEP) Break Event Point
Tariff	1.444,70	1.920,04
Internal Rate of Return (%)	2,85%	8,63%
Net Present Value (IDRx1000)	(420.385.574)	(37.687.189)
Benefit Cost ratio	0,77	0,98
Payback Period	16 years 2 months	11 years 5 months

(source: Author's processed results)

Based on the calculation results that have been obtained, the financial feasibility analysis of the project is as follows:

- The TDL assumption and the BEP assumption result in a negative NPV value which means that this project is not financially feasible.
- The TDL assumption and the BEP assumption result in an IRR value that is smaller than the WACC (9.06%) indicating that the construction of this project does not meet expectations and is not financially feasible.
- The TDL assumption and the BEP assumption result in a smaller return on investment compared to the economic value of the company's assets (generating age), which means that this project is financially feasible.

d. Sensitivity Analysis

The value of the financial feasibility indicator is tested and analyzed to see its sensitivity in terms of the following:

- EPC Cost Deviation

The results of the calculation of the sensitivity analysis on the influence of the EPC cost deviation parameters can be seen in the table below:

Table 8 Sensitivity Analysis of EPC Variable Cost Deviations

	Base	+15%	-15%
EPC Cost Power Plant (US$/kW)	1.034	1.189	879
LEGC (IDR/kwh)	2.108,38	2.255,11	1.961,65
NPV (IDR x 1000)	(420.385.574)	(538.579.303)	(302.694.036)

(source: Author's processed results)

- Fuel Price Deviation

The results of the calculation of sensitivity analysis to the influence of the parameter deviations in fuel prices can be seen in the table below:

Table 9 Sensitivity Analysis to Fuel Price Deviations

	Base	+5%	+10%
Fuel Price (US$/MMBTU)	6,00	6,30	6,60
LEGC (IDR/kwh)	2.108,38	2.139,84	2.171,31
NPV (IDR x 1000)	(420.385.574)	(443.051.094)	(465.716.613)
	Base	**-5%**	**-10%**
Fuel Price (US$/MMBTU)	6,00	5,70	5,40
LEGC (IDR/kwh)	2.108,38	2.076,91	2.045,45
NPV (IDR x 1000)	(420.385.574)	(397.720.055)	(375.429.395)

(source: Author's processed results)

- Exchange Rate Fluctuations

The results of the calculation of sensitivity analysis on the influence of the parameters of exchange rate fluctuations can be seen in the table below:

Table 10 Sensitivity Analysis to Exchange Rate Fluctuations

	Base	+10%	-10%
Exchange Rate (IDR)	14.445,87	15.890,46	13.001,28
LEGC (IDR/kwh)	2.108,38	2.171,31	2.045,45
NPV (IDR x 1000)	(420.385.574)	(465.716.613)	(375.429.395)

(source: Author's processed results)

- Changes in Power Plant Capacity Factor

The results of the calculation of sensitivity analysis to the influence of changes in the power plant capacity factor parameters can be seen in the table below:

Table 11 Analysis of Sensitivity to Changes in Power Plant Capacity Factors

	Base	Follower	Base Load	Peaker
Capacity Factor (%)	Following Demand	60,00%	80,00%	20,00%
LEGC (IDR/kwh)	2.108,38	1.355,27	1.210,87	2.510,43
NPV (IDR x 1000)	(420.385.574)	320.578.550	756.310.158	(574.382.846)

(source: Author's processed results)

5 CONCLUSIONS

5.1 Conclusions

Based on the analysis that has been done, it can be concluded:

✓ The results of the project feasibility analysis from the financial aspect that the GEPP XX-2 50 MW development project using a 17 MW class engine is not feasible to run with the following considerations:

- NPV is negative for the assumption of TDL (420,385.574,000,-) IDR and for the assumption of BEP (37,687,189,000,-) IDR.
- IRR assuming TDL is 2.85% and assuming BEP is 8.63%, which is smaller than the WACC applied at 9.06%.
- PP assuming TDL for 16 years 2 months (16.02 years) and assuming BEP for 11 years 5 months (11.39 years). The length of this payback period when compared with the economic value of the company's assets outside the land is 20 years, so this project is financially feasible.

✓ The results of the project's economic sensitivity analysis are as follows:

- Sensitivity analysis to the deviation of EPC costs variable has a significant effect on the cost of electricity generation (LEGC) and the project is not feasible to run because the NPV is negative.
- Sensitivity analysis to fuel price deviations and sensitivity to exchange rate fluctuations has a less significant effect on electricity generation costs (LEGC) and the project is not feasible to run because the NPV is negative.
- Sensitivity analysis to changes in the factor of power plant capacity has a very significant effect on the cost of electricity generation (LEGC) and the project is feasible to run because the NPV is positive.

5.2 Suggestions

Suggestions that can be given to various parties are as follows:

➢ The Project GEPP XX-2 50 MW is not financially feasible to run but it is also necessary to pay attention to the feasibility from the technical side, the environment and the potential for cost savings when compared to the rental costs of existing Diesel Power Plant.

- Project risk assessment using sensitivity analysis is feasible, because this method uses statistical sampling technique with simultaneous calculation processing so that it can produce a fairly precise analysis in projecting the project's economy.

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