PT ABC is an LNG producer that has been producing a reliable LNG for its customers since 2013. Initial GSA with upstream parties is set to be expired in 2026, however, recent development indicates that upstream parties have secured PSC extension for another 20 years. Considering this development, PT ABC is considering an opportunity to secure a long-term gas supply that enables production capacity expansion which will create additional revenue and improve plant reliability. A technical feasibility study has been performed and 2 options with estimated construction time of 30 months are considered feasible. This final project aims to provide a financial feasibility assessment of the production capacity expansion project with capital budgeting and risk assessment technique. Capital budgeting analysis using base case scenario indicates that both options will provide additional value to DSLNG with an estimated NPV 52.1 MUSD, IRR 20.57%, DPBP 9.4 years, and PI 1.52 for Option 1, and estimated NPV 117.8 MUSD, IRR 28.77%, DPBP 8.62 years, and PI 2.68 for Option 2. However, this study also found that some variables are affecting the project financial feasibility significantly, such as LNG and feed gas price, plant availability, Capex realization and long-term debt interest rate. Monte Carlo simulation shows that the project has a probability of success (NPV > 0) of 54.24% for Option 1 and 65.80% for Option 2.

Keywords: Capacity Expansion, Capital Budgeting, Risk Assessment, Financial Feasibility

I. INTRODUCTION

Liquefied Natural Gas (LNG) is a natural gas, mainly consists of methane (CH4), that has been cooled down to approximately -160°C changing its phase from gaseous to liquid. In its liquid phase, natural gas volume is around 600 times smaller making it economical to be transported by ship. LNG is widely considered as the cleanest among fossil fuel. LNG produces around 53 kg of CO2 per million British thermal units (MMBtu) compared to 91 kg of CO2 produced by coal and 73 kg of CO2 produced by distillate fuel oil. In other words, LNG is ~40% cleaner than coal and ~27% cleaner than oil for the same amount of energy produced (Ashkanani & Kerbache, 2023). Many countries are transitioning into more clean fuel in their energy mix. However, this transition is not expected to be completed soon. Therefore, many consider that LNG will play a significant role in the transition period as a transitional fuel.

BP (2022) projected that LNG trade will peak at around 2030s in 2 out of their 3 projected scenarios and will continue to increase beyond 2050 in their New Momentum scenario which is based on how the actual global energy system is currently progressing. In any scenario, LNG demand will still be there to be fulfilled lead by demands from emerging markets, especially in Asia despite the world leaders is pledging to achieve net zero emission by 2050, during COP 21 in Paris, through phasing out fossil fuel consumption.

PT ABC is a Foreign Investment company that was established in 2005. Shareholders of PT ABC are comprised of 4 oil and gas companies. PT ABC is operating a single train liquefaction plant with capacity of 1 million tonnes per annum (MTPA) and has been producing LNG since 2013 and the initial gas sales agreement (GSA) will expire in 2026 due to upstream companies’ license expiration. However, recent developments indicate that the upstream companies have been able to secure contract extension with the government for another 20 years.

The additional gas reserve from exploration and extension of PSC creates an opportunity for DSLNG to secure an additional gas allocation for long-term that could enable possible capacity expansion. On top of that, if the expansion plan is sanctioned, this will not only create additional production for DSLNG, but it will also increase the reliability of DSLNG since there will be additional train, albeit in smaller capacity. This additional train will allow the maintenance plan of existing train more flexible since DSLNG will not lose all production if there is a maintenance in one train.

From global LNG market point of view, investing for a capacity expansion project now is a preferable move for any LNG producer around the world, considering the issue of net-zero emission by 2050. If countries stick to their commitment, as BP (2022) states, the LNG demand will be lower than today’s demand starting as early as the end of 2030s. Lower
demand could drive the price of LNG down, thus it would be better for LNG and natural gas producers to produce and monetize their assets as soon as possible before the LNG demand starting to go down.

Following the initial plan to have a capacity expansion, a technical feasibility study (FS) on PT ABC capacity expansion plan has been performed by PT XYZ (Engineering Company). In the FS study, there are several capacity expansion options explored: 1) Two steps (small-scale LNG (30 MMscfd) + small-scale LNG (70 MMscfd)), 2) One Step (small-scale LNG 100 MMscfd), 3) Two Steps (BOG re-liquefaction Unit (30 MMscfd) + small-scale LNG (70 MMscfd)). In the FS, main consideration in determining the feasibility of an option is the complexity of modification (i.e. modification on existing facility and new equipment). Based on the evaluation, Option 3 is not considered feasible because several modifications on existing facility are foreseen (i.e. scrub column and heat exchanger modification), thus it is not reviewed further. Meanwhile Option 1 and Option 2 are technically feasible. Even though two options are technically feasible, the shareholders must be convinced that this project would bring additional value to PT ABC. Therefore, financial assessment shall be performed to justify the investment.

Based on the information mentioned previously, there are 4 research questions that will be answered in this research:

1. How is the feasibility of the project based on capital budgeting analysis?
2. What major factors that may sway the finance of the project from risk analysis?
3. How likely is this project will generate additional value to PT ABC?
4. Is there any initiative that could positively impact the project financial feasibility?

II. LITERATURE REVIEW

Capital budgeting is an instrument which is used by the decision maker in order to make the right investment decision by measuring the project feasibility as well as identifying all risks associated with the project. In doing so, the decision maker can correctly allocate the company’s financial resources to maximise or increase the shareholders’ wealth. Failure to perform a proper capital budgeting could impact the competitiveness of the company in a negative way and threaten the survival of it. (Sureka et al., 2022)

In general, techniques which are being used in capital budgeting is classified into Non-Discounted Cash Flows (NDCF) and Discounted Cash Flows (DCF) technique (Puska et al., 2018). The following techniques are classified as NDCF:

A. Payback Period (PBP)

PBP is the expected amount of time required to recover the original investment of project indicated by zero cumulative cash flow.

B. Cumulative Cash Flow (CCF)

CCF is the sum of all cash flows which are generated during a project’s life.

Meanwhile, the following techniques are classified as DCF:

C. Net Present Value (NPV)

NPV is the sum of discounted annual cashflows generated/lost by a project including the initial outflow of the project, calculated using (1). A positive NPV indicates that the project will bring additional value to the company.

$$NPV = \sum_{t=0}^{N} \frac{CF_t}{(1+r)^t}$$  \hspace{1cm} (1)

where,

NPV: Net Present Value,

CFt: Expected net cash flow at period t,

r: Project’s cost of capital or discount rate,

N: Project lifetime.

D. Internal Rate of Return (IRR)

IRR is described as the discount rate that will return a zero NPV, which is calculated using (2). In general, project that has a higher IRR than its cost of capital will generate value for the company.

$$NPV = \sum_{t=0}^{N} \frac{CF_t}{(1+IRR)^t} = 0$$  \hspace{1cm} (2)

where,

IRR: Internal Rate of Return,

CFt: Expected net cash flow at period t.

Graham and Harvey (2001) found that more than 70% CFOs almost always IRR and NPV technique to evaluate their investment.

E. Discounted Payback Period (DPBP)

DPBP is similar with PBP which is to find the required time to recover the original investment. However, in DPBP, the expected cash flows are discounted by project’s cost of capital.

F. Profitability Index (PI)

PI indicates the present value per dollar of initial cost of a project, calculated using (3). When a project’s PI is higher than 1, it indicates that the project will provide additional value to the company.

$$PI = \frac{PV \ of \ future \ cash \ flows}{Initial \ cost} = \frac{\sum_{t=0}^{N} \frac{CF_t}{(1+r)^t}}{CF_0}$$  \hspace{1cm} (3)

where,

PI: Profitability Index,

CF0: Initial outflow of the project,

G. Weighted Average Cost of Capital

Even though it is not prohibited to finance an entire company or project using equity, most companies employ several types of capital. Two most common types of capital used by companies are equity (common stock) and debt. In the evaluation of a project or investment, (4) is used to calculate Weighted Average Cost of Capital (WACC). WACC is the weighted average of capital components cost.

$$WACC = (r_d x (1 - T) x w_d) + (r_e x w_e)$$  \hspace{1cm} (4)

where,

WACC: Weighted Average Cost of Capital
rd: Cost of debt
dt: Tax rate
We: Proportion of equity
We: Proportion of equity

H. Capital Asset Pricing Model (CAPM)

CAPM is widely used to determine the cost of equity. It indicates that the cost of common stock equity is the return required by investors as compensation for the firm’s non-diversifiable risk, measured by beta (Gitman & Zutter, 2010).

\[ r_e = R_f + b \times (r_m - R_f) \]  

(5)

where,

- RF: Risk free rate of return,
- rm: Market return,
- b: beta.

I. Risk Analysis

Every project is expected to return a positive value to the company. However, since capital budgeting technique involves forecasting to some extent, there will always be a risk attached to a project. In general, there are three types of risk:

- Stand-alone risk
- Corporate risk
- Market risk

Brigham and Houston (2012) suggest that all three types of risk mentioned above are highly related. Since it is usually easier to assess project’s stand-alone risk than its corporate and market risk, most projects’ stand-alone risk could act as a good indicator for all three measures. Project’s stand-alone risk could be assessed using some techniques that will be discussed further in next section.

Fig. 1. Research Methodology.
J. Sensitivity Analysis

This technique is used to evaluate the impact of a single input variable change to the project’s NPV while keeping the other variables constant. The result of a sensitivity analysis is often plotted in a spider chart or a tornado chart. These charts will show which variable(s) has the most significant impact to a project’s value.

K. Scenario Analysis

Scenario analysis offers a more comprehensive analysis of the changes in key variables in which the probability distributions of input variables are considered. In addition, unlike sensitivity analysis which analyze individual variable impact to the project’s NPV, scenario analysis assesses the impact of several variables change to project’s NPV at once. Three scenarios are usually assessed in scenario analysis. It usually starts from the base-case scenario and followed by worst-case and best-case scenario.

L. Monte Carlo Simulation

A more complex analysis that combines the sensitivities and probability distributions to generate all possible outcomes is called the Monte Carlo simulation. In this simulation, random values are generated for each key variables which has been identified during sensitivity analysis. The random values are limited to the boundaries set for best-case and worst-case scenarios during the scenario analysis. Then, the project’s NPV is calculated using these random values. These steps are repeated time after time until large enough data is generated (i.e. 1,000 data). The average value of these data would give the expected project’s NPV. While the standard deviation will be used to measure the project’s risk.

III. METHODOLOGY

PT ABC expansion project was used as case study in this study. Quantitative approach was used in this study to analyze the project’s financial feasibility. The research methodology which was used in this study is shown in Fig. 1.

All data which were used in this study were taken from PT ABC internal documents and reports. Other supporting data (e.g., economic data, LNG outlook, etc.) were derived from free online sources. It shall be noted that all data and information used in this study were accurate up to 31st December 2022. Other data or information that was available after 31st December 2022 was not considered or used in this study.

IV. RESULTS AND DISCUSSION

A. Market Data

1) Inflation Rate

Indonesian inflation rate for the last 5 years is taken from Bank Indonesia record (Bank Indonesia, 2023). Prior to 2020, the inflation rate was relatively stable at around 3%. However, Covid-19 pandemic drove the inflation down to around 1.5% before economic recovery took place and driving the inflation up. Using regression and moving average will not accurately project the inflation rate since the recent uptick in inflation will affect the trend. Thus, in this study, average value of 5 years was used.

2) WACC

a) Cost of Debt

PT ABC existing shareholders loan has an interest rate of London Interbank Offered Rate (LIBOR) + 3.75% per annum. It is assumed in this research that the long-term bank loan required twice the shareholder loan margin, which is 7.5% margin.

b) Cost of Equity

To calculate the cost of equity of PT ABC, beta value from PT Medco Energi Internasional, Tbk (MEDC) is used as it is similar company with PT ABC.

TABLE I: COST OF DEBT

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIBOR (Average from 2010)</td>
<td>1.25%</td>
</tr>
<tr>
<td>Margin</td>
<td>7.50%</td>
</tr>
<tr>
<td>Tax Rate</td>
<td>22.00%</td>
</tr>
<tr>
<td>After Tax Cost of Debt</td>
<td>6.83%</td>
</tr>
</tbody>
</table>

TABLE II: COST OF EQUITY

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levered Beta</td>
<td>2.45</td>
</tr>
<tr>
<td>Project Debt to Equity Ratio</td>
<td>1.40</td>
</tr>
<tr>
<td>Unlevered Beta</td>
<td>1.17</td>
</tr>
<tr>
<td>Risk Free Rate (10 years Indonesian Government Bond)</td>
<td>6.93%</td>
</tr>
<tr>
<td>Market Return</td>
<td>1.72%</td>
</tr>
<tr>
<td>Risk Premium</td>
<td>9.23%</td>
</tr>
<tr>
<td>Cost of Equity</td>
<td>29.58%</td>
</tr>
</tbody>
</table>

Fig. 2. Indonesian Inflation Rate 2018-2022.

Fig. 3. MEDC vs Market Return.

Source: Yahoo Finance
In this study, it is assumed that the project is financed through a combination of debt and equity. The ratio of debt to equity used in this study is the average of the last five years, which is 1.40. In addition, in the end of 2021, the debt-to-equity ratio of PT ABC is down to 0.63 which means the company is in a good shape in terms of loan repayment. Thus, it is logical to finance the project through a mix of debt and equity. This ratio translates to 58.33% debt financing and 41.67% equity financing. The calculated WACC of the project is 16.31% for base case as shown in Table III. This value was used as discount rate to calculate the NPV of the project later on.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Weight</th>
<th>Cost</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debt</td>
<td>58.33%</td>
<td>6.83%</td>
<td>3.98%</td>
</tr>
<tr>
<td>Equity</td>
<td>41.67%</td>
<td>29.58%</td>
<td>12.33%</td>
</tr>
<tr>
<td>WACC</td>
<td></td>
<td></td>
<td>16.31%</td>
</tr>
</tbody>
</table>

3) Terminal growth rate

The terminal growth rate is used in the financial model to determine the cash flow of the project in perpetuity. The terminal growth rate in this study is derived from LNG trade volume CAGR from BP Outlook (2022). There are three cases in the outlook, Accelerated, Net Zero, and New Momentum. In this study, the CAGR from Accelerated case (0.33%) was used since it is considered the most realistic case based on current development.

4) Additional LNG and condensate production

The planned project is intended to increase the LNG production capacity of PT ABC by 0.63 MTPA from 1 MTPA to 1.63 MTPA. In addition, additional condensate will also be produced because of the configuration of the LNG production process. From historical data of PT ABC, the average condensate yield (in barrel) is around 0.69% from the produced LNG in calorific value (MMbtu). The additional production is summarized in Table IV.

<table>
<thead>
<tr>
<th>Product</th>
<th>Option 1 Phase 1</th>
<th>Option 1 Phase 2</th>
<th>Option 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNG (MMbtu)</td>
<td>10,342,950</td>
<td>24,271,456</td>
<td>34,614,406</td>
</tr>
<tr>
<td>Condensate (barrel)</td>
<td>71,366</td>
<td>167,473</td>
<td>238,839</td>
</tr>
</tbody>
</table>

In actual plant operation, it is expected that the plant will not be producing all the time. There will be downtime, either planned or unplanned, that will lower the yearly output of a plant. The percentage of actual production time over a certain period (i.e. a year) is called plant availability. In the past, PT ABC actual plant availability has been always above 90% with average value of 97.15%.

5) Commodity price

It has been widely acknowledged that the price of energy commodity like LNG and crude oil has always been volatile. An unforeseen event like Covid-19 pandemic at the start of 2019 could drive the price of crude oil to around 20 USD per bbl. As for LNG, prior to the economy recovery in mid 2021, the price was relatively stable. However, spike in demand and Russia invasion to Ukraine at the start of 2022, pushed the price to an all-time high in August 2022. PT ABC, as most of other LNG producers, has a contract with long term buyers to protect all parties from such volatilities. It is expected that for the expansion project, PT ABC will first seek to secure a contract with long term buyer/buyers. Thus, average contract price for LNG and condensate from the last 5 years was used in the financial model.

The same can be said for the price of feed gas. PT ABC has a contract with upstream parties in feed gas procurement that determines the price of feed gas based on certain formula and not following the market price. The 5-year average of contractual feed gas price was also used as input for the model.

In this study, it is assumed that 100% of the Capex is subjected to depreciation. The method and period for depreciation is assumed to be the same with what PT ABC currently uses. The depreciation will follow the straight-line method. As the expansion project will only construct and install new machinery, tools, and plant equipment, the estimated useful lives for depreciation calculation is 13 years, which is the longest useful lives for machinery, tools, and plant equipment.

3) Revenue

The sales of additional LNG and condensate will give additional revenue to PT ABC. Based on construction schedule, additional capacity will be able to be utilized at the 31st month (third year) after start of construction. Additional revenue from LNG and condensate is calculated by multiplying the annual additional LNG and condensate production with plant availability and price.

<table>
<thead>
<tr>
<th>Option</th>
<th>Estimated Additional Revenue (MUSD)</th>
<th>Year 3</th>
<th>Year 4+</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LNG</td>
<td>Condensate</td>
<td>LNG</td>
</tr>
<tr>
<td>1</td>
<td>173.8</td>
<td>6.5</td>
<td>347.7</td>
</tr>
<tr>
<td>2</td>
<td>173.8</td>
<td>6.5</td>
<td>347.7</td>
</tr>
</tbody>
</table>
4) Projected free cash flow

The additional revenue of the project does not immediately provide investors with clear picture of the project profitability. The Free Cash Flow (FCF) is the cash flow that matters. There are two types of FCF, FCF to the firm and FCF to the equity. Fig. 3 and Fig. 4 provide the estimated FCF of the project for Option 1 and Option 2.

C. Capital Budgeting Analysis

Based on the projected free cash flow, capital budgeting analysis was performed. In the analysis, 5 parameters were calculated to provide the profitability of the project. Those 5 parameters are NPV, PBP, DPBP, PI, and IRR. Table VIII. summarizes the capital budgeting analysis result for all technically feasible options of the project.

D. Risk Assessment

1) Sensitivity analysis

Sensitivity analysis was performed to identify variables and measure its impact to the capital budgeting analysis of a project. In the analysis, evaluation of NPV were performed by changing the value of selected variables to -20% and +20% of their base case value. Based on the analysis, the project’s NPV is very sensitive to change in LNG price, direct material price, plant availability, and Capex realization.

TABLE VIII: CAPITAL BUDGETING ANALYSIS RESULT

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Option 1</th>
<th>Option 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBP (years)</td>
<td>5.83</td>
<td>4.50</td>
</tr>
<tr>
<td>DPBP (years)</td>
<td>9.40</td>
<td>8.62</td>
</tr>
<tr>
<td>NPV (MUSD)</td>
<td>52.1</td>
<td>118.4</td>
</tr>
<tr>
<td>IRR (%)</td>
<td>1.52</td>
<td>2.68</td>
</tr>
<tr>
<td>Capex Realization</td>
<td>20.57%</td>
<td>28.78%</td>
</tr>
</tbody>
</table>

Other variables that affect the NPV to a lesser degree are long-term debt interest rate and condensate price unit. Fig. 5 and 6 present the sensitivity analysis result for option 1 and 2 in the shape of tornado chart.

2) Scenario analysis

Scenario analysis is an analysis to evaluate the NPV if several variables are set at their worst- and best-case scenario values. In performing scenario analysis, 6 (six) variables which have been identified through sensitivity analysis. From the analysis, the project is not financially feasible if all variables are set at worst-case scenario. Table IX. summarizes the scenario analysis.

TABLE IX: SCENARIO ANALYSIS RESULT

<table>
<thead>
<tr>
<th>Variables</th>
<th>Worst Case</th>
<th>Base Case</th>
<th>Best Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNG Price</td>
<td>35.59%</td>
<td>100.00%</td>
<td>173.21%</td>
</tr>
<tr>
<td>Feed Gas Price (USD/MMbtu)</td>
<td>11.32</td>
<td>5.48</td>
<td>1.35</td>
</tr>
<tr>
<td>Plant Availability</td>
<td>91.23%</td>
<td>97.15%</td>
<td>99.40%</td>
</tr>
<tr>
<td>Capex Realization</td>
<td>150.00%</td>
<td>100.00%</td>
<td>70.00%</td>
</tr>
<tr>
<td>Interest Rate (Long Term Debt)</td>
<td>11.75%</td>
<td>8.75%</td>
<td>7.75%</td>
</tr>
<tr>
<td>Condensate Price</td>
<td>32.89%</td>
<td>100.00%</td>
<td>325.47%</td>
</tr>
<tr>
<td>NPV Option 1 (MUSD)</td>
<td>-1,400</td>
<td>52.7</td>
<td>1,654</td>
</tr>
<tr>
<td>Feasibility Option 1</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>NPV Option 2 (MUSD)</td>
<td>-1,407</td>
<td>118.4</td>
<td>1,669</td>
</tr>
<tr>
<td>Feasibility Option 2</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

3) Monte carlo simulation

Table IX shows that during worst-case scenario, the NPV of the project will be as low as -1,407 MUSD, while during best-case scenario, the NPV of the project could reach 1,669 MUSD. However, there is a probability factor in each variable that makes the scenario analysis only provides part of the picture. To incorporate the probability of each variable, Monte Carlo simulation was performed to provide the most probable outcome based on random occurrence of each variable. 1,000 simulations were performed in this study with each simulation utilize random value between worst-case and best-case value for each variable.
Table X provides the summary of Monte Carlo simulation for Option 1 and Option 2.

Based on the Monte Carlo simulation, Option 1 and Option 2 probability of returning negative NPV is 46.37% and 35.33% respectively which means both options have higher probability to return positive NPV than negative NPV. Therefore, the project is deemed to be financially feasible. However, since the standard deviation of both options are high, it shall be noted that the risk of the project is high.

d. Capex realization

e. Long-term debt interest rate

f. Condensate price

C. How likely is this project will generate additional value to PT ABC?

Option 1 has 54.24% probability of returning positive NPV, while Option 2 has 65.80% probability of returning positive NPV. Both options were assessed using Monte Carlo simulation.

D. Is there any initiative that could positively impact the project financial feasibility?

Based on the risk assessment, two most significant variables are LNG price and feed gas price. Effort to lower the risk associated with these variables should be taken to affect the project value positively. One initiative that can be explored is to secure a long-term contract and price formula with buyers and upstream parties.

**CONFLICT OF INTEREST**

Authors declare that they do not have any conflict of interest.

**REFERENCES**


