The Evaluation of CO_2 Removal Contract (A Case Study of Randegan Area)

Review of Integrative Business & Economics Research

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ABSTRACT

This research conducts a project valuation through Discounted Cash Flow (DCF) method, sensitivity analysis, and risk management in comparison between Scenario 1 vs Scenario 2 (with vs without CO2 removal plant). In terms of DCF analysis, with a discount rate of 10%, it produces a Net Present Value (NPV) of US$5,401,792 for Scenario 1 and an NPV of US$6,212,781 for Scenario 2. For risk management by conducting a sensitivity analysis of five parameters and conducting a Monte Carlo simulation of the selected scenario to provide optimal consideration to decision-makers from the results of the sensitivity analysis, the most dominant parameters are Oil Price and Oil Production where a 20% change in parameter will affect the Contractor's Net Present Value of 17% with a maximum amount of US$7,242,910. Based on the Monte Carlo simulation, using 1000 iterations, the NPV>Base is 52.31%, while the NPV<base is 47.69%, and the total NPV<0 is only 3.62% which is still below the maximum value (<10%). Therefore, it can be concluded that Scenario 2 is declared feasible or worthy.

Keywords: Discounted cash flow, Sensitivity, Net Present Value, CO_2 removal plant

1. INTRODUCTION

1.1. The important role of oil and gas energy in Indonesia

Until now, oil and gas are still the main fuel sources for power generation in Indonesia, with oil contributing 3.29%, gas contributing 17.36%, bringing the total to around 20.65% of the total fuel demand, as can be seen in Figure 1 below.

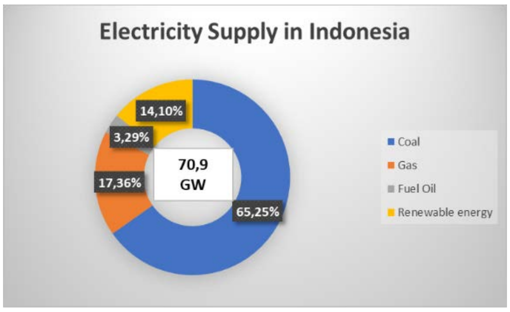

Figure 1. National Electricity Supply
(Source: Outlook Energi Indonesia 2021. Published by: Badan Pengkajian dan Penerapan Teknologi /BPPT)

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Likewise, with the need for energy consumption in Indonesia, the role of oil and gas is still very vital. From BPPT data[1], for 2019, the energy demand in Indonesia is 989.9 million barrels of oil equivalent (BOE) with the contribution of energy sourced from oil and gas is 52%. The projection made by BPPT until 2050, energy demand in Indonesia will reach 2,907.8 million BOE with the contribution of energy from oil and gas being 43% (see figure 2 below). Based on these data, it can be concluded that oil and gas will still dominate Indonesia's primary energy supply for the next several decades.

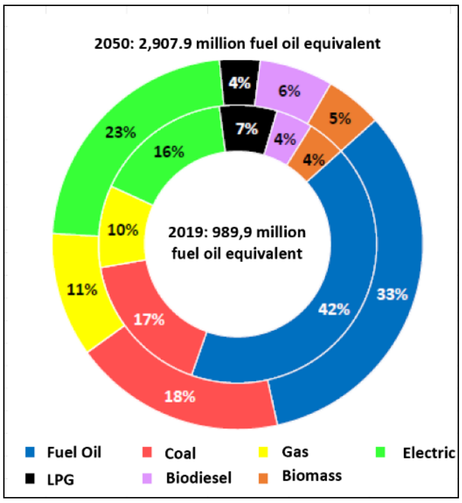

Figure 2. Share of Energy Needs per Type
(Source: Outlook Energi Indonesia 2021. Published by: Badan Pengkajian dan Penerapan Teknologi /BPPT)

Indonesia has a State-Owned Enterprise (SOE) which is tasked with meeting domestic energy needs, especially oil and gas to support the creation of national energy independence, namely PT Pertamina (Persero). The important role played by PT Pertamina (Persero) for more than six decades provides the energy that has driven the lifeblood of the Indonesian people. PT Pertamina (Persero) which is engaged in the upstream and downstream oil and gas industry is a national strategic project in addition to meeting national energy needs, it is also tasked with increasing state revenue through taxes, dividends, PNBP, and Signature Bonus.

1.2. Business Issue

Recently, PT Pertamina (Persero) has been faced with triple shocks, namely (i) the decline in fuel demand, (ii) the weakening of the rupiah exchange rate against the US dollar, and (iii) the drop in world oil prices. One of Pertamina's strategies in dealing with triple shocks is to perform operating expenses (OPEX) efficiency for all Pertamina Groups by 30%[2].
Efficiency efforts can be made by evaluating the components of operating costs in each area. As a pilot project, this research takes the Randegan area to evaluate the efficiency opportunities that can be carried out.

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[1] Outlook Energi Indonesia 2021 Perspektif Teknologi Energi Indonesia: Tenaga Surya untuk Penyediaan Energi Charging Station. Published by: Badan Pengkajian dan Penerapan Teknologi (BPPT). Page 18.

[2] 2019: “Gerak Cepat Pertamina Terjang tiga gegar”. Jakarta: Pertamina Energia Weekly. page:2

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

For 2020, Opex for the Randegan area was US$799.095, with the largest Opex cost for the "Handling & Storage" fee with a value of up to 45% of the total Opex cost (details of Opex can be seen in figure 3). The "Handling & Storage" cost component was the cost to pay for the CO2 Removal plant rental service.

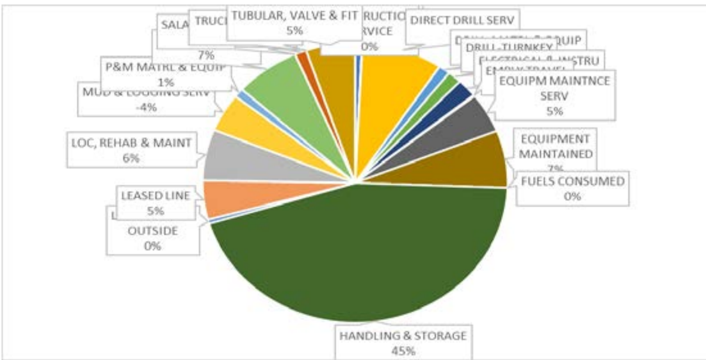

Figure 3. Opex breakdown by Group Line category
(Source: Author analysis)

With the following considerations: (i) the cost of renting the CO_2 removal plant is the highest cost component in the Randegan area, (ii) the contract expired in November 2021, and (iii) the consumer has submitted an official request to reduce the selling price of gas, the company needs to evaluate the existing contract.
Based on some of the issues above, the writer's research questions are:

- Can the addition of a CO_2 removal plant add value to the company? Is it still necessary to extend the CO_2 removal plant contract?
- What variables are sensitive to project value?
- Are the simulation results acceptable for the company?

2. LITERATURE REVIEW

2.1. Previous Study

Several authors have researched Project Evaluation. They are (i) Muhammad Rizki (Bandung Institute of Technology, 2021) and (ii) Ridwan Arief Kurniawan (Bandung Institute of Technology, 2019).

2.1.1. Muhammad Rizki's work

The first research has been conducted by Muhammad Rizki. He conducted research entitled "Project evaluation of constructing a new polypropylene plant in the annex area of town B Refinery" which discusses investment analysis on constructing a new polypropylene plant and project feasibility through sensitivity analysis.
At the end of the research, the writer concludes that using Discounted Cash Flow and sensitivity analysis can determine whether a project can be run or not.

2.1.2. Ridwan Arief Kurniawan's work

The second research has been conducted by Ridwan Arief Kurniawan entitled "Investment evaluation for new welding projects" which discusses investment analysis in the addition of welding units.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

At the end of the research, the writer concludes that using Discounted Cash Flow can determine whether a project can be run or not.

2.1.3. The Position of the current study

The author distinguishes this research from the previous research above. In this research, the author focuses on the comparison of the addition of value between with or without the addition of a CO_2 removal plant so that it can determine whether the CO_2 removal plant contract can be extended or completed. The author did sensitivity analysis to determine whether a project can be run or not and compare one scenario to another.

The author also did a Monte Carlo simulation to calculate all the possibilities that might occur. It would be useful for decision-makers to see the level of success of a project. To get better results, the Monte Carlo Simulation will use a hundred iterations for random variables.

2.2. Project Valuation

Capital budgeting is the process of evaluating and selecting long-term investments that are consistent with the firm's goal of maximizing owners' wealth (Gitman & Zutter, 2015, page 442). Evaluating a project is useful in conducting preliminary / portfolio analysis, funding, and business development. One of the commonly used methods is Discounted Cash Flow (DCF). In DCF valuation, we estimate the value of any asset by discounting the expected cash flows on that asset at a rate that reflects their riskiness. In a sense, we measure the intrinsic value of an asset (Damodaran, 2015:516). In this study, due to the comparison between with versus without continuing the CO_2 Removal Plant rental agreement, the parameter analysis used is Net Present Value (NPV). The project will be declared economical if the NPV value is positive. If the NPV value is negative, then the project is not economical. The greater the NPV value, the better a project will be.

2.2.1. Net Cash Flow (NCF)

The Net Cash Flow of a project is the cash remaining after all costs have been deducted in one period. To declare NCF each year related to oil and gas projects, cash receipts must be reduced by cash disbursements for a certain period.

$$\text{NCF} = \text{Revenue (cash inflows)} - \text{Cost (cash outflows)} \quad (1)$$

If a negative cash flow is found in the first year, it generally does not necessarily mean bad for the total investment. This may mean that in the first year the organization made a large investment that would generate a large income the following year. For example, in the first year, every oil and gas company will spend a large amount of money on exploration costs and development costs. At the beginning of the year, there was no income from oil and gas sales. However, after completion of the exploitation and development stage, the company will enter the production stage so that it will start to generate some returns to the organization/company.

2.2.2. Net Present Value (NPV)

The net present value (NPV) is found by subtracting a project's initial investment (CF_0) from the present value of its cash inflows (CFt) discounted at a rate equal to the firm's cost of capital (r) (Gitman and Zutter, 2015: 449). When NPV is used, both inflows and outflows are measured in terms of present dollars. For a project that has cash outflows beyond the initial investment, the net present value of a project would be found by subtracting the present value of outflows from the present value of inflows.

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$$\text{NPV} = \text{Present value of cash inflows} - \text{Initial investment}$$

$$\text{NPV} = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} - CF_0 \quad (2)$$

In terms of decision criteria, When NPV is used to make accept–reject decisions, the decision criteria are as follows:

- If the NPV > 0, accept the project.
- If the NPV < 0, reject the project.

If the NPV is greater than 0, the firm will earn a return that is greater than its cost of capital. The greater the value of the NPV calculation, the more profitable a project can be. The NPV calculation above only produces a single value because it only accommodates one scenario so that it cannot help provide optimal decisions, in other words, it cannot consider the certainty that may occur. NPV calculations with single value results are also called deterministic calculations.

The following is a comparison of the advantages and disadvantages of calculating NPV (Faturohman, Taufik., & Rachman, Mohammad Arief, 2021: page 259)

Strength:

- Cash flows assumed to be reinvested at the hurdle rate
- Account for the time value of money – Consider all cash flows.

Weaknesses:

- May not include managerial options embedded in the project

2.3. Risk Management

To provide a more optimal decision, it can be done by using sensitivity analysis and Monte Carlo simulation. This simulation describes the conditions of more than one scene so that it can produce multiple NPV values by modeling sensitive variables using a probability distribution.

2.3.1. Sensitivity analysis

In carrying out the sensitivity analysis, there are at least 3 variables that will be randomized in turn and carried out several times so that a value is obtained that considers various conditions. Referring to the “Pedoman Tata Kelola” /PTK Rencana Pengembangan Lapangan / Plan of Development (POD) no 72, tahun 2006 (page 26), the random variables consist of:

i. Price or production level,
ii. Capital Expenditures, and
iii. Operating Expenditures.

This sensitivity analysis needs to be shown in a spider diagram or tornado chart with a variance of ±20%

2.3.2. Monte Carlo Simulations

According to Mun (2006, page 74), Monte Carlo simulation in its simplest form is a random number generator that is useful for forecasting, estimation, and risk analysis. A simulation calculates numerous scenarios of a model by repeatedly picking values from a user-predefined probability distribution for the uncertain variables and using those values for the

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

model. As all those scenarios produce associated results in a model, each scenario can have a forecast. Forecasts are events (usually with formulas or functions) that you define as important outputs of the model.

When running the Monte Carlo Simulation, at least 3 variables will be randomized simultaneously and carried out several times so that a value is obtained that considers various conditions. In running the Monte Carlo Simulation, the author uses Microsoft Excel software by using references owned by the company, namely “Sistem Tata Kerja” No. C-001/R00100/2011-S0-Penyusunan Kajian Risiko Tahapan Usulan Investasi, with the steps in running the Monte Carlo Simulation are as follows:

i. Determine the sensitive variable to be randomized and the magnitude of its fluctuation. In Monte Carlo Simulation, these variables are randomized simultaneously and carried out several times so that a value is obtained that considers various conditions
    - If sufficient data is available (at least 30 data) then the normal distribution is used, with the following formula: = NORMIV(RAND(), average price, deviation price)
    - If the data is limited and there are only two maximum and minimum data, the formula: = minimum price + (maximum price-minimum price) x RAND()
    - If the data is limited and there are only 3 (three) data, namely maximum, minimum, and average, the formula: =minimum price+(maximum price-minimum price) x (RAND() + RAND())/2

i. Creating a Monte Carlo Simulation on an Economic Calculation Model

ii. Perform a Monte Carlo Simulation using Confidence Level 95% to generate an NPV. The following are economic indicators that apply to the company:

economic indicators	Probability	Criteria
NPV <0	<10%	Feasible / Worthy
NPV <0	>10%	Non-Feasible/ Non-Worthy

3. RESEARCH METHODOLOGY

This study aims to solve the problems that have been presented in the business issue section above. This study will analyze the value obtained by the company in terms of with versus without a CO2 Removal Plant (Scenario 1 vs Scenario 2) to determine whether the existing CO2 Removal Plant contract needs to be extended or completed.

The first step is to break down operating costs to determine the largest possible cost for budget efficiency. The selection of the largest cost is expected to have greater efficiency opportunities, which means that it is in line with the policies set by the company. After getting the efficiency target, the next step is to evaluate the best option that can be chosen by the company to get added value. For economic analysis, using Discounted cash flow in comparing the calculation of Net present value Cash flow, and daily profit between with CO_2 Removal plant versus without CO_2 Removal plant.

Then, after determining the best option, risk management is carried out on the selected option by performing sensitivity analysis, determining the minimum gas price & rate analysis, and Monte Carlo simulation. The results of risk management, if the project is declared feasible, the project will be selected and conclusions, recommendations, and implementation plans are made.

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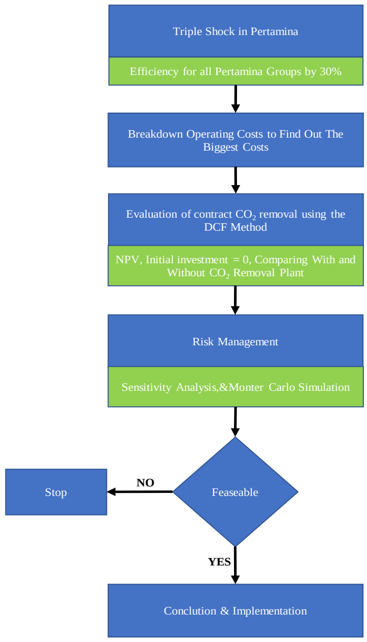

Figure 4. Conceptual Framework
(Source: Author Analysis)

4. RESULT

4.1. DCF Result

4.1.1. Cash flow Projection 2022-2029

In calculating each scenario using fiscal terms based on cost recovery production sharing contract. The results of the calculation of the Contractor's cash flow in both scenarios can be seen in Tables 1 & 2 below, while the detailed calculation of cash flow & NPV can be seen in Tables 3 & 4 for each scenario.

Table 1. Cash Flow for Scenario 1
(Source: Author Analysis)

Year	Cash Flow
2022	USD 233,833
2023	USD 1,355,032
2024	USD 2,210,705
2025	USD 1,842,451
2026	USD 1,696,121
2027	USD 815,335
2028	USD 260,292
2029	USD 92,638
Total	USD 8,506,407

Table 2. Cash Flow for Scenario 2
(Source: Author Analysis)

Year	Cash Flow
2022	USD 400,941
2023	USD 1,522,140
2024	USD 2,378,271
2025	USD 2,009,558
2026	USD 1,863,229
2027	USD 982,443
2028	USD 427,858
2029	USD 259,746
Total	USD 9,844,187

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Referring to Figures 1&2 above, it can be concluded that the cumulative net cash flow for Scenario 2 provides better-added value because the result is US$9,844,187 higher than Scenario 1 which is only US$8,506,407. For the calculation of cash flow in each scenario without considering the time value of money.

4.1.2. NPV Projection 2022-2029 Result

In calculating each scenario using fiscal terms based on cost recovery production sharing contract. Table 3 shows the results of the NPV calculation for scenario 1, while Table 4 shows the results of the NPV calculation for scenario 2. The difference in Table 7 with the addition of the rental cost of CO_2 removal plant.

Referring to Tables 3&4 above, it can be concluded that the Contractor's NPV for Scenario 2 is US$ 6,212,781 higher than Scenario 1 which is only US$ 5,401,792.
Based on the results of the calculations above, it can be concluded that Scenario 2 provides more value-added for the company. Therefore, the next step in this research will discuss risk management, which focuses on scenario 2 only.

4.2. Risk Management

4.2.1. Sensitivity Result for Contractor's Net Cash Flow

Table 5 shows the NPV changes based on the different five parameters input. The results show that oil production, gas production, oil price, and gas price have a directly proportional relationship with the Contractor's NPV, where if the four parameters increase, the Contractor's NPV will increase. On the other hand, Operating Expenditures have an inverse relationship with the Contractor's net present value, where if Operating Expenditures increase, the Contractor's NPV will decrease.

Figures 5 and 6 describe the effect of each parameter on the Contractor's NPV. In the spider plot, a curve with a high slope, both positive and negative, indicates that the variable has a significant effect on the estimated value, while a line with a low angle slope means the opposite. On the tornado chart, the graph with the widest graph shows that the variable has a significant effect on the estimated value, while the graph with the smallest width means the opposite.
The spider plot and tornado chart for net present value can be summarized as follows:

a. Oil price and oil production are the variables that have the most significant effect. A change of 20% will affect the Contractor's NPV by 17% with a maximum amount of US$7,242,910.
b. The second most significant effect on the Contractor's NPV is Opex. A change of 20% will influence the Contractor's NPV of 9% with a value of US$ 6,771,031.
c. The least sensitive factor is Gas Price and Gas Sales/Production. A change of 20% will affect the Contractor's NPV of 3% with a value of US$6,425,208.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Table 3. NPV Calculation for Do Nothing Scenario
(Source: Author analysis)

			ECONOMIC ANALYSIS SCENARIO 1 (WITH CO2 REMOVAL)								
			2022	2023	2024	2025	2026	2027	2028	2029	
		0	1	2	3	4	5	6	7	8	Total
1	**LIFTINGS**										
2	Oil / Condensate (bbls)		659,722	4,722,038	7,821,788	6,488,046	5,957,869	2,766,613	755,075	148,146	29,319,298
3	Gas (MMbtu)		1,023,825	1,023,825	1,026,630	1,023,825	1,023,825	1,023,825	1,026,630	1,023,825	8,196,210
4	**GROSS REVENUE**		1,683,547	5,745,863	8,848,418	7,511,871	6,981,694	3,790,438	1,781,705	1,171,971	37,515,508
5	**FIRST TRANCHE PETROLEUM**		84,177	287,293	442,421	375,594	349,085	189,522	89,085	58,599	1,875,775
6	**GROSS REVENUE after FTP**		1,599,370	5,458,570	8,405,997	7,136,278	6,632,609	3,600,916	1,692,620	1,113,373	35,639,733
7	**INVESTMENT CREDIT**										
8	**COST RECOVERY**										
9	Unrecovered Other Costs										
7	Current Year Operating Costs		1,098,965	2,358,282	3,321,656	2,905,745	2,741,390	1,752,101	1,130,975	940,376	16,249,490
8	Depreciation - Prior Year Assets										
9	Depreciation - Current Year Assets										
10	Lease Cost (With CO_2 Removal Plant)		577,065	577,065	578,646	577,065	577,065	577,065	578,646	577,065	4,619,682
11	OPEX (include Manpower)		521,900	1,781,217	2,743,010	2,328,680	2,164,325	1,175,036	552,329	363,311	11,629,808
12	INTANGIBLE		-	-	-	-	-	-	-	-	-
13	**TOTAL COST RECOVERY**		1,098,965	2,358,282	3,321,656	2,905,745	2,741,390	1,752,101	1,130,975	940,376	16,249,490
14	**TOTAL RECOVERABLES**		1,098,965	2,358,282	3,321,656	2,905,745	2,741,390	1,752,101	1,130,975	940,376	16,249,490
15	Carry forward										
16	**EQUITY TO BE SPLIT**		500,405	3,100,287	5,084,342	4,230,533	3,891,219	1,848,816	561,645	172,997	19,390,243
17	**INDONESIA SHARE**										
18	BPMIGAS FTP Share	**0.328**	27,588	94,155	144,995	123,094	114,406	62,112	29,196	19,205	614,750
19	BPMIGAS Equity Share		163,998	1,016,061	1,666,297	1,386,477	1,275,273	605,914	184,069	56,696	6,354,786
20	Domestic Requirement										
21	Government Tax Entitlement		159,164	922,333	1,504,766	1,254,105	1,154,503	554,976	177,174	63,056	5,790,076
22	**TOTAL INDONESIA SHARE**		350,750	2,032,548	3,316,057	2,763,676	2,544,182	1,223,002	390,438	138,957	**12,759,611**
23	**CONTRACTOR SHARE**	**0.672**									
24	Contractor FTP Share		56,590	193,138	297,426	252,500	234,679	127,410	59,889	39,394	1,261,025
25	Contractor Equity Share		336,407	2,084,227	3,418,045	2,844,056	2,615,946	1,242,901	377,577	116,300	13,035,458
26	Less : Gross Domestic Requirement										
27	Add : Domestic Requirement Adjustment										
28	Taxable Share		392,997	2,277,365	3,715,471	3,096,555	2,850,624	1,370,311	437,466	155,694	14,296,483
29	Government Tax Entitlement	**0.405**	159,164	922,333	1,504,766	1,254,105	1,154,503	554,976	177,174	63,056	5,790,076
30	**NET CONTRACTOR SHARE**		233,833	1,355,032	2,210,705	1,842,451	1,696,121	815,335	260,292	92,638	**8,506,407**
	Contractor Cash flow	-	233,833	1,355,032	2,210,705	1,842,451	1,696,121	815,335	260,292	92,638	8,506,407
	Government income		350,750	2,032,548	3,316,057	2,763,676	2,544,182	1,223,002	390,438	138,957	12,759,611
	NPV	**5,401,792**									

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Table 4.NPV Calculation for Doing Something Scenario
(Source: Author analysis)

			ECONOMIC ANALYSIS SCENARIO 2 (WITHOUT CO2 REMOVAL)								
			2022	2023	2024	2025	2026	2027	2028	2029	
		0	1	2	3	4	5	6	7	8	Total
1	**LIFTINGS**										
2	Oil / Condensate (bbls)		659,722	4,722,038	7,821,788	6,488,046	5,957,869	2,766,613	755,075	148,146	29,319,298
3	Gas (MMbtu)		792,963	792,963	795,135	792,963	792,963	792,963	795,135	792,963	6,348,045
4	**GROSS REVENUE**		1,452,685	5,515,000	8,616,923	7,281,009	6,750,831	3,559,576	1,550,210	941,109	35,667,343
5	**FIRST TRANCHE PETROLEUM**		72,634	275,750	430,846	364,050	337,542	177,979	77,511	47,055	1,783,367
6	**GROSS REVENUE after FTP**		1,380,051	5,239,250	8,186,077	6,916,958	6,413,290	3,381,597	1,472,700	894,053	33,883,976
7	**INVESTMENT CREDIT**										-
8	**COST RECOVERY**										
9	Unrecovered Other Costs										
7	Current Year Operating Costs		450,332	1,709,650	2,671,246	2,257,113	2,092,758	1,103,469	480,565	291,744	11,056,876
8	Depreciation - Prior Year Assets										
9	Depreciation - Current Year Assets										
10	Lease Cost										
11	OPEX (include Manpower)		450,332	1,709,650	2,671,246	2,257,113	2,092,758	1,103,469	480,565	291,744	11,056,876
12	INTANGIBLE		-	-	-	-	-	-	-	-	-
13	**TOTAL COST RECOVERY**		450,332	1,709,650	2,671,246	2,257,113	2,092,758	1,103,469	480,565	291,744	11,056,876
14	**TOTAL RECOVERABLES**		450,332	1,709,650	2,671,246	2,257,113	2,092,758	1,103,469	480,565	291,744	11,056,876
15	Carry forward										
16	**EQUITY TO BE SPLIT**		929,718	3,529,600	5,514,831	4,659,846	4,320,532	2,278,129	992,134	602,310	22,827,100
17	**INDONESIA SHARE**										
18	BPMIGAS FTP Share	**0.328**	23,804	90,372	141,202	119,311	110,623	58,329	25,403	15,422	584,465
19	BPMIGAS Equity Share		304,698	1,156,760	1,807,382	1,527,176	1,415,973	746,614	325,153	197,396	7,481,150
20	Domestic Requirement										
21	Government Tax Entitlement		272,909	1,036,079	1,618,823	1,367,851	1,268,249	668,722	291,231	176,802	6,700,665
22	**TOTAL INDONESIA SHARE**		601,412	2,283,210	3,567,406	3,014,338	2,794,844	1,473,664	641,787	389,619	**14,766,280**
23	**CONTRACTOR SHARE**	**0.672**									
24	Contractor FTP Share		48,830	185,378	289,644	244,740	226,919	119,650	52,108	31,634	1,198,902
25	Contractor Equity Share		625,021	2,372,840	3,707,449	3,132,669	2,904,559	1,531,515	666,981	404,914	15,345,949
26	Less : Gross Domestic Requirement										
27	Add : Domestic Requirement Adjustment										
28	Taxable Share		673,850	2,558,219	3,997,094	3,377,409	3,131,478	1,651,165	719,089	436,548	16,544,852
29	Government Tax Entitlement	**0.405**	272,909	1,036,079	1,618,823	1,367,851	1,268,249	668,722	291,231	176,802	6,700,665
30	**NET CONTRACTOR SHARE**		400,941	1,522,140	2,378,271	2,009,558	1,863,229	982,443	427,858	259,746	**9,844,187**
	Contractor Cash flow	-	400,941	1,522,140	2,378,271	2,009,558	1,863,229	982,443	427,858	259,746	9,844,187
	Government income		601,412	2,283,210	3,567,406	3,014,338	2,794,844	1,473,664	641,787	389,619	14,766,280
	NPV	**6,212,781**									

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Table 5. Sensitivity Analysis – Net Present Value Contractor 2022-2029
(Source: Author analysis, 2021)

Parameters	Changes				
	-20%	-10%	0%	10%	20%
Oil Productions	USD 5,182,651	USD 5,697,716	USD 6,212,781	USD 6,727,845	USD 7,242,910
Gas Productions	USD 6,000,354	USD 6,106,567	USD 6,212,781	USD 6,318,994	USD 6,425,208
Oil Price	USD 5,182,651	USD 5,697,716	USD 6,212,781	USD 6,727,845	USD 7,242,910
Gas Price	USD 6,000,354	USD 6,106,567	USD 6,212,781	USD 6,318,994	USD 6,425,208
Opex	USD 6,771,031	USD 6,491,906	USD 6,212,781	USD 5,933,656	USD 5,654,531
Parameters	**Changes**				
	-20%	**-10%**	**0%**	**10%**	**20%**
Oil Productions	-17%	-8%	0%	8%	17%
Gas Productions	-3%	-2%	0%	2%	3%
Oil Price	-17%	-8%	0%	8%	17%
Gas Price	-3%	-2%	0%	2%	3%
Opex	9%	4%	0%	-4%	-9%

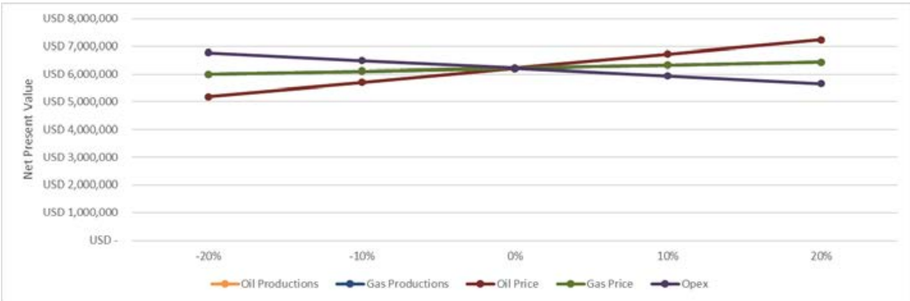

Figure 5. Spider Plot Sensitivity Analysis – Contractor's Net Present Value 2022-2029
(Source: Author analysis, 2021)

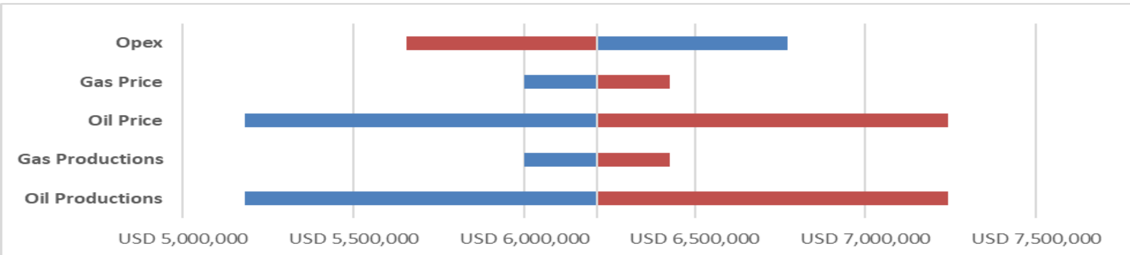

Figure 6. Tornado Chart Sensitivity Analysis – Contractor's Net Present Value 2022-2029
(Source: Author analysis)

4.2.2. Monte Carlo Simulation Result

The author performs a simulation using 1000 iterations, and five parameters as detailed in the following Table 6. For more detailed data sources for the gas price, oil price, gas quantity, and oil production parameters.

Table 6. Parameter Boundaries for Monte Carlo Simulation
(Source: Author Analysis)

No.	Parameter		Mean	Stand Dev
1	**Price**			
	gas price (US$/ MMBtu)		3.37	1.92
	oil price (US$/barrel)		67.65	24.29
2	**Sales Volume**			

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	Gas Quantity (mmscf)		0.49	0.19
	Oil Production (barrel/day)		191.78	152.61
No.	**Parameter**	**Base**	**Minimum**	**Maximum**
3	**Opex (US$/annual)**	100%	15%	257%

The results of the Monte Carlo simulation are shown in Table 7 and Figure 7 below. Based on the simulation, for the project period 2022-2029, the Mean NPV value is US$ 5,915,137, the Minimum NPV is US$ (8,797,048) and the Maximum NPV is US$ 17,267,811. As mentioned in sub-chapter 2.3.2 above, referring to "Sistem Tata Kerja" No. C-001/R00100/2011-S0-Penyusunan Kajian Risiko Tahapan Usulan Investasi, From the results of the Monte Carlo simulation, the NPV>Base is 52.31%, while the NPV<base is 47.69%, and the total NPV<0 is only 3.62% which is still below the requirement (<10%). Therefore, it can be concluded that Scenario 2 is declared feasible or Worthy.

Table 7. Monte Carlo simulation for NPV
(Source: Author Analysis)

Column1	
Mean	5,915,137
Standard Error	109,326
Median	5,990,210
Mode	#N/A
Standard Deviation	3,457,180
Sample Variance	11,952,093,043,507
Kurtosis	0.32
Skewness	(0.03)
Range	26,064,859
Minimum	(8,797,048)
Maximum	17,267,811
Sum	5,915,137,187
Count	1000
Confidence Level (95.0%)	214,534

Bin	*Frequency*	*Cumulative %*
(8,797,048)	1	0.10%
(7,956,247)	0	0.10%
(7,115,445)	0	0.10%
(6,274,643)	0	0.10%
(5,433,841)	1	0.20%
(4,593,039)	1	0.30%
(3,752,237)	0	0.30%
(2,911,435)	0	0.30%
(2,070,633)	4	0.70%
(1,229,831)	12	1.90%
(389,029)	18	3.70%
451,773	21	5.80%
1,292,574	32	9.00%
2,133,376	52	14.20%
2,974,178	53	19.50%
3,814,980	65	26.00%
4,655,782	84	34.40%
5,496,584	99	44.30%
6,337,386	94	53.70%
7,178,188	102	63.90%
8,018,990	100	73.90%
8,859,792	87	82.60%
9,700,593	47	87.30%
10,541,395	44	91.70%
11,382,197	26	94.30%
12,222,999	18	96.10%
13,063,801	20	98.10%
13,904,603	11	99.20%
14,745,405	1	99.30%
15,586,207	2	99.50%
16,427,009	1	99.60%
More	4	100.00%

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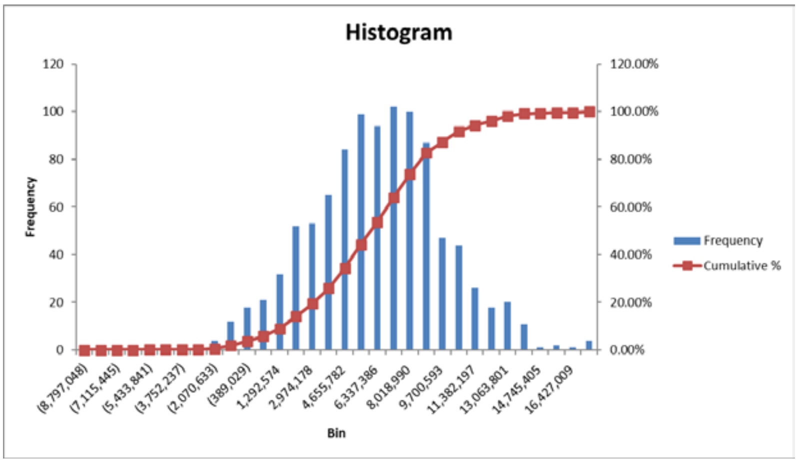

Figure 7. Histogram for Monte Carlo NPV result
(Source: Author Analysis)

5. CONCLUSION

Based on the project valuation, the best scenario is Scenario 2 because it produces an NPV of US$6,212,781 compared to Scenario 1 which only provides an NPV of US$5,401,792.

Based on sensitivity analysis, after calculating with five parameters, it can be concluded that sensitivity to price changes has more impact than Opex changes. Oil price and oil production are the variables that have the most significant effect. A change of 20% will affect the Contractor's NPV by 17% with a maximum amount of US$7,242,910.
Based on the Monte Carlo simulation, using 1000 iterations, the NPV>Base is 52.31%, while the NPV<base is 47.69%, and the total NPV<0 is only 3.62% which is still below the maximum value (<10%). Therefore, it can be concluded that Scenario 2 is declared feasible or worthy.

ACKNOWLEDGEMENTS

Hopefully, this paper would give value-added insight for the oil and gas community and company, especially for Pertamina EP. It is also expected that through this paper, the author could sharpen the analytical thinking, decision-making skill, and strategic thinking in the real-world practices as required from a graduate BLEMBA Program of SBM ITB. Special thanks and gratitude would author given to my parents and my families for all their support and prayers.

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ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)