



Valuation Real Option for Investment Project Addition Source Supply Power in Coal Processing Plant ABC Mine Operation PT XYZ

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ABSTRACT:

Real options appraisal in investment projects provides a robust framework for decision-making under uncertainty, especially in the context of large-scale industrial operations. This research focuses on real options appraisal for an investment project in a coal processing plant at PT XYZ's ABC mine operation. The need for this research arises due to the inherent uncertainty of fossil energy sources, regulatory changes, and technological developments that significantly impact the viability and profitability of mining projects. The main objectives of this study are to evaluate the feasibility of different investment strategies for the ABC mine operation using real options appraisal and to determine the impact of various uncertainties on project profitability. The methodology used was a combination of qualitative and quantitative analysis, including scenario planning, sensitivity analysis, and the use of Monte Carlo simulation to model the potential outcomes and risks associated with different investment options. The expected outcomes of this research include a comprehensive valuation model that incorporates uncertainties specific to the coal industry and provides actionable insights for PT XYZ's investment decisions. The model aims to decide on expansion projects with reference to constraints optimising the timing and scale of investments in ABC mine operations, thereby improving the company's ability to navigate investment project feasibility and regulatory changes.

Keywords: Real Options, Investment Strategy, Coal Industry, Uncertainty, Managerial Flexibility, CAPM, Monte Carlo Simulation.

INTRODUCTION

Coal remains the world's second largest primary energy source today, after oil, and the largest source of electricity. Coal's future will depend heavily on the small but significant group of countries – China, India, Indonesia, Pakistan, Bangladesh, the Philippines and Vietnam – that account for 70% of global coal consumption and most of the world's new coal power projects. (Alvarez & Arnold, 2020)

President Joko Widodo's government aims to phase out coal mining activities by 2030, gradually closing all coal-fired power plants by 2050 and transitioning to renewable energy

sources. This transition will likely lead to a considerable decline in coal demand, resulting in reduced mining operations and subsequent job losses within the coal industry. (Askar, 2023).

The Indonesian government should take economic factors into account when moving away from coal, especially with regard to jobs and regional economies. Additionally, it must carefully manage this transformation while taking the environment and economy into account. Two conventional energy businesses could work together to find better solutions based on environmental factors. This could entail constructing hybrid power plants, which incorporate energy from fossil sources but are centralized, or co-investing in projects.

From a regulatory perspective, Indonesia already has UU No.11/2020 about Job Creation Law, to create an conducive business ecosystem without ignoring` standards safety and security values, and environmental sustainability. In addition, the Indonesia Investment Authority (INA) has also been established which will provide alternative investment facilities for the development of a green economy. (Limanseto, 2022)

"The Indonesian government will also implement a carbon pricing policy in the form of a carbon cap and trade, as well as a carbon tax scheme in 2023. This policy will set an upper limit on carbon emissions in certain sectors and introduce a trade and carbon tax scheme. We hope this policy can provide benefits for the industry converting its energy into renewable sources," Coordinating Minister Airlangga explained. (Limanseto, 2022)

Electricity generation remains a key issue for Indonesian policy-makers. Millions of households are still without access to electricity, and large investments are needed to supply reliable power for households and industries across the country. (Attwood, et al., 2017).

Indonesia, one of the largest developing countries in the world, is facing challenges in the electricity sector. The state-owned electricity company Perusahaan Listrik Negara (PLN), which is responsible for electricity supply, is suffering from oversupply. Several complex factors have contributed to the situation, including the 35 gigawatt coal-fired megaproject announced in 2015. This was revealed by the Executive Director of the Institute for Essential Services Reform (IESR), Fabby Tumiwa in the Business Compass programme on the topic 'PLN Excess Electricity, the State Should Not Lose' on Wednesday (11/10/2023). (Hasjanah, 2023).

With over 270 million in popuDEFon and as one of the global leaders in manufacturing, Indonesia is facing a substantial electricity demand. The industrial and transportation sectors have emerged with the highest electricity consumption in the country, driven by the need for power for production and mobility. Over the years, Indonesia's per capita electricity consumption has also steadily increased. As an emerging economy, Indonesia's electricity demand is expected to rise significantly, particularly in the industrial and household sectors. (Siahaan, 2023).

PLN's power capacity in the Tanjung Redep system in East Borneo Regency, East Kalimantan, is 33,700 kW with a peak load of 24,888 kW, which is still a surplus of 8,812 kW. PLN's plan to merge the system with the Tanjung Selor system in Bulungan district, East Kalimantan, has the potential to improve household and industrial customer services without the worry of a deficit with a reserve of 21,309 KW.

Indonesia is one of the largest thermal coal exporter countries in the world. According to the data from 2022, Indonesia is the second largest coal producer globally and the largest thermal coal exporter (Workman, 2023). In 2021, China, India, Japan, and South Korea were the top buyers of Indonesian coal, accounting for 73% of its exports (Nangoy & Christina, 2022).

Indonesia's economy lives and breathes coal. In 2022, the Southeast Asian country exported 450 million tonnes of coal, which is more than 100 times the annual consumption in Denmark, placing the country at the top of the list of coal exporters worldwide. At the same time, Indonesia, a country renowned for its white sandy beaches, volcanos, partying backpackers and spiritual yoga, used more than 100 million tonnes of coal to create enough electricity for the national grid (Susatyo, 2023).

PT XYZ, the main entity of the company's subsidiary, diversified its market in 2022 as a strategy to optimize opportunities to increase sales and reduce dependence on the main market, especially China. PT XYZ successfully gained new market share in Poland through this strategy and will continue to diversify its markets to ensure the sustainability of its marketing efforts. The handling and processing of coal obtained by PT XYZ at the ABC Mine Operational site uses diesel power generation from 4 units of 500 kVA generating engines using 35% vegetable liquid fuel, and this is the only power plant for operations. The single power generation system has been used since the beginning of the mine operation, when the single system of coal processing operational power sources is very sensitive to the continuity of coal processing operations.

The power supply performance difficulties at PT XYZ's ABC Mine Operations pose substantial hurdles that affect operational efficiency and financial sustainability. The existing reliance on a single power supply system is causing inadequate availability, which in turn leads to operational downtime and higher expenses. In order to guarantee uninterrupted operation of PLN, it is crucial to investigate options that can enhance the reliability of power supply. It is necessary to conduct a comprehensive analysis of proposed scenarios, such as the introduction of a dual power supply system, to determine their practicality. An extensive feasibility analysis, which includes the use of capital asset pricing models and risk assessment, will generate the essential data required to make well-informed investment decisions for upper management. This analysis will guarantee the long-term sustainability and profitability of PT XYZ's activities beyond 2027.

RESEARCH METHODS

This research methodology offers a systematic way to tackling the power supply issues faced by PT XYZ's ABC Mine Operation. The objective is to combine decision analysis, financial valuation, and risk assessment to provide practical insights that assist in making well-informed investment decisions. This will ultimately improve operational efficiency and sustainability in response to increasing coal demand.

The ABC Mine Operation of PT XYZ is encountering operational difficulties as a result of an inconsistent power supply system. The study will utilize a mixed-approaches approach, combining qualitative and quantitative research methods to gain a comprehensive understanding of the problem and its consequences.

RESULTS AND DISCUSSION

Business plan strategy

Regarding the economic performance aspect, the Company has diversified its new market to Bangladesh, India, and Malaysia. In the midst of favourable market conditions, the Company has succeeded in penetrating the Polish market by taking advantage of the coal sales growth momentum when some countries in the European region are now actively importing coal from various producing countries, including from Indonesia, as an effect of the disruption of energy, coal, and gas supplies from Russia to Europe. (Wanengpati, PT Berau Coal Energy Tbk Annual Report, 2022).

When coal prices rise in 2022, the company's management will see the chance to boost output. The plan is based on life of mine (LOM) production data, as displayed in the table below.

Table 1. Data production Life of Mine (LOM) revision 30 PT XYZ

Revision 30	2023	2024	2025	2026	2027
DEF	8.443.000	11.700.000	13.300.000	2.750.000	660.000
PQR	13.976.000	17.000.000	19.000.000	19.500.000	19.500.000
ABC	3.291.000	4.000.000	4.000.000	3.000.000	2.340.000
RST	4.300.000	6.050.000	5.900.000	7.500.000	7.500.000
Total	30.000.000	38.750.000	42.200.000	32.750.000	30.000.000

Facing the situation of coal market diversification with its successful entry into Poland in 2022, where AMO sites still rely on a single system using diesel power plants with biofuel blends that are prone to operational disruptions. The company is considering ways to improve reliability by upgrading the single-system diesel power plant or exploring a hybrid system that combines with a subscription electricity supply to PLN, which could be a potential solution. Including exploring options to purchase PT PLN's excess coal-generated electricity is included in the power grid management solution.

In industries with continuous operation, no outages are allowed for the electricity supply, but this depends on the circumstances, so it can be summarized in the key performance indicator that availability should be 100% or performance availability (PA) 100%, whether with a single electrical supply system or redundant electrical supply systems.

Table 2. Musts and Wants Decision-making parameters

No	Business Requirement Plan	Musts and Wants Scenario	Weight
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1	Performance Availability (PA) 100% Power Supply full load	Musts	Go/Not
2	24 Hours electricity operation (No Shutdown)	Musts	Go/Not
3	Operational expenditure (Opex) <= Existing	Wants	6
4	Small capital expenditure (Capex)	Wants	5
5	Duration finish project	Wants	4
6	PESTEL positive impact	Wants	3
7	Easy operation and maintenance	Wants	2
8	Durability investment	Wants	1

Data parameters and assumptions

This subchapter should outline the research design, data collection and input limitations to answer the research questions and problems identified in the problem analysis subchapter. This is to ascertain the parameters used to reach the implications of the findings, highlight the strengths and limitations of the research, and suggest avenues for future result.

Data power capacity existing

Existing generation capacity compared to the existing load to see the real situation of the ABC Mine Operation site power supply. This is a consideration for business strategies to maintain sustainable production operations, one of the input parameter considerations.

Table 3. Power Demand & Installed by grouping load distribution

No	Group Distribution Load	Power Demand (kW)	Power Installed (kW)	Load Factor
1	Crusher 1 (CR-08)	196,17	342,55	57,7%
2	Crusher 2 (CR-10)	179,18	459,25	39,0%
3	BLC	184,18	196,55	93,7%
4	Utility	34,74	244,97	14,2%
	Total	594,27	1243,32	47,8%

in a practical context, Load Power Demand is how much power is needed at any one time, while Load Power Installed is how much power the system or instalDEFon can provide. Keep in mind that installed power is not always the same as the power used or needed. (Electrical-InstalDEFon Wiki, 2022)

$$Power\ Demand\ (kW) = \frac{Energy\ (kWh)}{Time\ (Hours)}$$

$$Power\ Installed\ (kW) = \sum Power\ unit\ installed$$

$$Power\ factor = \frac{Real\ Power\ (Watt)}{Apparent\ Power\ (Volt\ Ampere)}$$

Table 4. Power demand and installed based on power factor (pf)

No	Group	Distribution	Load	Power Demand (kW)	Power Installed (kW)	Load Factor
1	Total	Power factor (0,85)		699,14	1462,73	47,8%
2	Total	Power factor (0,6)		990,45	2072,20	47,8%

Table 5. Characteristics of generator sets

Qty	Generator Set	Installed	Power Rating (kW)	COP (%)	Possible Power (kW)
4	Komatsu EGS630		1200	70	840

A single power supply system falls under the category of continuous operation power (COP) rating for industries in continuous production. Prime and continuous power ratings are very similar. However, continuous power ratings do not allow for varying loads or overload capability. A generator rated for continuous power can be run for an unlimited number of hours per year, but not as close to max capability as a prime power generator. They should be run at about 70% of the maximum rating on average, and never overloaded. (CK Power, 2024)

Fuel diesel

The mandatory biodiesel programme was implemented in 2008 with a biodiesel blend level of 2.5%. The biodiesel content gradually increased to 7.5% in 2010. In the period from 2011 to 2015, the percentage of biodiesel was increased from 10% to 15%. Then on 1 January 2016, the biodiesel content was increased to 20% (B20). The mandatory B20 programme is well underway with incentives from BPDPKS for the PSO sector. And from 1 September 2018, the incentives were extended to the non-PSO sector. (Kementrian Energi dan Sumber Daya Mineral, 2019)

The Government of Indonesia The Ministry of Energy and Mineral Resources promotes the Mandatory Biofuel Program through Minister of Energy and Mineral Resources ReguDEFon No. 32 of 2008 concerning the Provision, Utilisation, and Administration of Biofuel as Other Fuel as last amended by Minister of Energy and Mineral Resources ReguDEFon No. 12 of 2015. (Kementrian Energi dan Sumber Daya Mineral, 2019).

Performance Availability (PA) required

Performance availability (PA) in the Indonesian mining industry refers to the efficiency and effectiveness of mining operations in terms of production output and resource utilisation. It measures the industry's ability to maintain consistent mining activities and meet production targets.

Performance Availability (PA) is benchmarked against market sales and mining company performance indicators by regulators such as the Ministry of Energy and Mineral Resources to monitor industry compliance with reguDEFons and ensure sustainable and responsible mining practices. And the company set an availability performance of 93%.

In the meeting with PLN regarding the electricity subscription plan, the availability of existing performance could not be agreed upon. However, we conveyed in the meeting that we hope PLN can fulfil the expected performance availability (PA) of 90%. Nevertheless, all these things still need to be studied for their benefits, especially for the production of coal crushers.

Production capacity coal crushing

The performance availability standard at PT XYZ for the production unit, especially the Coal Processing Plant (CPP), is 93% in terms of time per month or per year. The year is 365 days, the month is 30 days, and the operating time is 24 hours. So, the performance availability value is as follows:

$$\text{Performance Availability (PA) Monthly} = \frac{X}{30 \text{ days} \times 24 \text{ Hours}}$$

$$X = 669,6 \text{ Hours}$$

$$X = 27,9 \text{ Days in a month}$$

$$X = 334,8 \text{ Days in a year}$$

There are two crushers, each with a capacity of 650 Tonnes per hour (Tph) and 800 Tonnes per hour (Tph) and a Barging Loading Conveyor of 1500 Tonnes per hour (Tph). Maximum production per year:

$$\text{Efficiency } (\eta) = 90\%$$

$$\text{Max. Crusher 1 (650)} = 90\% \times 669,6 \times 650 \text{ Ton} = 391.716 \text{ Ton/Month}$$

$$\text{Max. Crusher 1 (650)} = 12 \times 391.716 = 4.700.592 \text{ Ton/Year}$$

$$\text{Max. Crusher 2 (800)} = 90\% \times 669,6 \times 800 \text{ Ton} = 482.112 \text{ Ton/Month}$$

$$\text{Max. Crusher 2 (800)} = 12 \times 391.716 = 5.785.344 \text{ Ton/Year}$$

$$\text{Max. BLC (1500)} = 90\% \times 669,6 \times 1500 \text{ Ton} = 903.960 \text{ Ton/Month}$$

$$\text{Max. BLC (1500)} = 12 \times 903.960 = 10.847.520 \text{ Ton/Year}$$

From the above calculations, it is found that with a business strategy plan, production of up to 4 million per year is still within the maximum production limit.

WACC PT XYZ

WACC is necessary for companies because it provides a comprehensive view of the cost of capital, which is essential for evaluating financial performance, making investment decisions, and determining the value of a company. It is a critical metric for both financial analysts and company management in making strategic financial decisions.

Table 6. References WACC calculations

Parameters	References	Range	Value
Risk-free rate Indonesia	Indonesia Government Bond PHEI	4 years	6,8754
Equity risk premium	Damodaran	Data 2022	7,38%
Default spread	Damodaran	Data 2022	2,07%
Beta	Unlevered PTBA Pefindo	2022	0,991

$$\text{Cost of equity} = \text{Risk-free rate} + \beta \times \text{Equity risk premium}$$

$$\text{Cost of equity} = 12,14$$

$$\text{WACC} = [\text{Cost of equity} \times \% \text{Equity}] + [\text{Cost of debt} \times \% \text{Debt} \times (1 - \text{tax rate})]$$

$WACC = Cost\ of\ Equity = 12,14\%$

However, the company's internal policy is set at 12%.

Capital Expenditure (Capex)

Investment is more about system planning to achieve 100% performance availability, if the system uses existing then it needs to add 1 unit of generator ready when one of the existing generators is carried out maintenance. If the system planning uses 2 electricity supply systems by subscribing to PLN, so that the existing generator as a backup system when PLN does maintenance.

Table 7. Generator set Capital expenditur.

No	Item description	Price (IDR)
1	Generator set Prime 500 kVA / Stand By 550 kVA	Rp. 1.050.000.000,00
2	Tax (PPh) 11%	Rp. 115.000.000,00
3	Oil Genuine set @2 Drum	Rp. 16.174.092,00
Total in IDR		Rp. 1.181.174.092,00
Total in USD		\$ 78.745

Table 8. PLN subscription system Capital expenditur

No	Item description	Price (IDR)
1	Project system support for tapping PLN	Rp. 3.071.767.446,00
2	Tax (PPh) 11%	Rp. 115.000.000,00
3	Uang jaminan Langganan	Rp. 249.750.000,00
4	Self-investment Distribution Network 1,2 Km	Rp. 904.151.421,00
Total in IDR		Rp. 4.225.669.446,00
Total in USD		\$ 281.711,30

Development analysis using Kepner-Tregoe

Table 9. Kepner-Tregoe "Musts and Wants" Decision-making

Musts (No)	Single system (Existing 4 Genset)	Addition 1 Unit Genset	Addition subscription PLN
1	Not Go	Go	Go
2	Go	Go	Go

Table 10. Kepner Tregoe "Wants" Analysis

Wants (No)	Single system (Existing 4 Genset)		Addition 1 Unit Genset		Addition subscription PLN	
	Rating	Score	Rating	Score	Rating	Score
3	-	-	4	24	5	30
4	-	-	4	20	2	10
5	-	-	4	16	2	8
6	-	-	1	3	5	15
7	-	-	2	6	4	8
8	-	-	3	3	4	4
			Total	72	Total	75

Financial Analysis

Considering that the selection of a backup or redundant power supply system provides several advantages over a single power supply system, if an unexpected event of equipment failure or network failure may disrupt a single power source, Redundant systems provide an additional layer of protection that can reduce downtime, which can lead to lost productivity. The financial analysis parameters that will be discussed will determine the true cost difference between various alternative investment opportunities.

Making assumptions for project investment analysis involves considering various factors that can impact the outcome of the project. By presuming as much factual information as feasible and variables that are thought to have a direct influence, researchers take parameters into consideration. Project planning, risk management, and decision-making are all based on these presumptions. While some factual assumptions are disclosed, others are kept under wraps because the corporation owns the entire set of data.

Data parameters and limitations

The parameters used for project investment analysis can be used as a limit for project implementation. The specific parameters used will vary depending on the level of detail required for the analysis. The debt-to-capitalization ratio is 0% or none, while the equity-to-capitalization ratio is 100%. This is because PT XYZ does not do debt in actual capital expenditure, but the cost of debt is calculated based on government bond coupons.

The risk-free rate is a basic concept in financial analysis, which is often used in investment analysis or valuation. It represents an investor's expected return on an investment that contains no risk. The yield used in this calculation is government bonds used as a proxy for the risk-free rate. The equity risk premium is the compensation expected by investors for the additional risk they take when investing in the stock market, and the data used in calculating the company's weighted average cost of capital (WACC) uses Damodaran data.

The incremental calculation here is used to help understand how changes in operating expenditure can affect the finances of capital expenditure. It is also used to determine how changes in costs or benefits can affect investment decisions.

Operational existing

PT XYZ's internal policy limit regarding performance availability is 93%, where 100% of total hours of operation in a month period is reduced by 7% of downtime for maintenance scheduled; this means that the overall internal acceptable scheduled downtime unit is 7% and an estimated time of about 50 hours out of 720 hours per month. While the limit of PT XYZ's internal policy related to performance reliability is 97%, where 100% of working hours in a month period are reduced by 3% of stop time while operating, this means that from the entire stop time unit that can be accepted internally is 3%. The estimated maximum time is around 20 hours from 670 hours per month.

Table 11. Expected parameters subscript PLN to supply power

Subscription payment PLN	
0. Investment Capex	\$316.017,65

1. Productivity	90%	
PA	100%	
PR	100%	
UA	7.884	Hour
HM/Year	657	Hour
HM/Month	1.110	kW
Power supplied	90%	
2. Maintenance Cost PLN		
Schedule maintenance	0	USD
Unschedule maintenance	17.593,94	USD
Assumption Maintenance per Year	8.797	USD
Subscription payment I3-TM		
Tarif Waktu Beban Puncak (WBP)	Rp1.608,67	IDR/kWh
Tarif Luar Waktu Beban Puncak (LWBP)	Rp1.090,78	IDR/kWh
Tarif kVar	Rp1.114,74	IDR/kWh
Price/kWh (IDR)	Rp1.477,36	IDR
Price/kWh (USD)	\$0,100	USD
Minimum kWh per Month requirement (IDR)	Rp180.385.503,38	IDR

The productivity expected from the company is 90%, and this was conveyed during the agreement meeting with PLN. However, PLN has its own clause because it is a state-owned enterprise, so the value is an expectation from management that is not binding on the agreement.

Incremental cost

Table 62. Total cost compared to achieving 100% Performance Availability (PA)

Description	Unit	2024	2025	2026	2027	Total
Coal Production	Mio.ton	4.000.000	4.000.000	3.000.000	2.340.000	13.340.000
Existing 4 Genset	\$/year	624.833	668.879	558.808	486.161	2.338.681
PLN	\$/year	262.570	262.570	199.127	157.254	881.522
Add 1 Unit	\$/year	704.567	668.879	558.808	486.161	2.418.415

Incremental cash flow Identification is based on incremental cash flows, which means there is a difference in cash flows with and without the project. This includes estimating all incremental costs associated with the project, including capital expenditure, operating costs,

and financing costs, and estimating the value of the project at the end of the operational period.

It focuses on the project's specific impact on the company's overall cash flow, providing a more accurate picture of its profitability. Develop an Incremental Cash Flow Timeline that shows the incremental cash flows for each year of the project's life. For evaluation and decision-making, calculate the net present value (NPV) to indicate what the project is expected to create.

Summary Capital budget analysis

The table below contains financial data regarding the capital budget analysis of the investment model. The data contains specific financial data, projections, or parameters related to the investment model. The initial investment or capital expenditure (CAPEX) set indicates the capital required at the start of business development. The operational or financial evaluation period is set at 42 months, which is approximately 3.5 years. The residual value of 65% referring to the internal policy indicates that the project has potential end-of-life value, which affects the overall financial return. The key financial parameters WACC and the corporate tax rate are critical for evaluating the net present value (NPV), internal rate of return (IRR), and other project financial metrics.

The Cash Flow Analysis uses the concept of incremental cash flow within the FCFF (Free Cash Flow to the Firm) framework to assess the impact of the project on the company's overall free cash flow. Analyse the impact of the project by calculating the changes in each component due to the project and adding them up. By summing up these changes, you can estimate the project's overall impact on the firm's FCFF. If the incremental sum is positive, it indicates that the project is expected to increase the company's overall free cash flow.

Table 13. Result in capital budget analysis Non-GRK

NPV (\$)	1.171.481
IRR	6,80%
Payback	16,31 Month
PI	4,71
Discounted Payback	16,43 Month

The NPV of \$1,254.82 indicates that the project is expected to create value for the company over its lifetime. The IRR is 7.04%, which is acceptable. If the IRR is higher than the required rate of return, the project is considered acceptable. The payback period is 16.10 months. The payback period is the time it takes for the project's cumulative cash flows to equal the initial investment. A shorter payback period is generally considered favourable. This suggests the project is financially attractive.

Risk Analysis

Sensitivity analysis variables can help in assessing how these changes in NPV may affect the expected level of an investment. By changing each variable by 20% and observing how

the change affects the model results and gives a rough idea of the risks and factors that might affect the investment results.

Table 14. Sensitivity analysis variable Swing 20%.

No	Sensitivity Analysis	-20% Swing	Current Assumption	+20% Swing
1	Fuel Price (\$)	14,40%	12,00%	9,60%
2	PA (Performance Availability)	80%	90%	100%
3	Coal Production	2.668.000	3.335.000	4.002.000
4	Capex (\$)	379.221,18	316.017,65	252.814,12
5	WACC	14,40%	12,00%	9,60%

Table 15. NPV sensitivity analysis – Non-GRK (Greenhouse Gases)

No	Sensitivity Analysis	NPV -20% Swing	NPV Current Assumption	NPV +20% Swing
1	Fuel Price (\$)	908.213,76	1.188.650,52	1.469.087,27
2	PA (Performance Availability)	1.031.182,58	1.188.650,52	1.346.118,46
3	Coal Production	1.070.626,68	1.188.650,52	1.306.674,35
4	Capex (\$)	1.159.615,69	1.188.650,52	1.217.685,34
5	WACC	1.181.003,60	1.188.650,52	1.196.508,79

Table 16. NPV sensitivity analysis - GRK (Gas Rumah Kaca)

No	Sensitivity Analysis	NPV -20% Swing	NPV Current Assumption	NPV +20% Swing
1	Fuel Price (\$)	991.553,36	1.271.990,11	1.552.426,86
2	PA (Performance Availability)	1.114.522,17	1.271.990,11	1.429.458,05
3	Coal Production	1.153.966,28	1.271.990,11	1.390.013,94
4	Capex (\$)	1.242.955,29	1.271.990,11	1.301.024,93
5	WACC	1.263.903,63	1.271.990,11	1.280.300,06

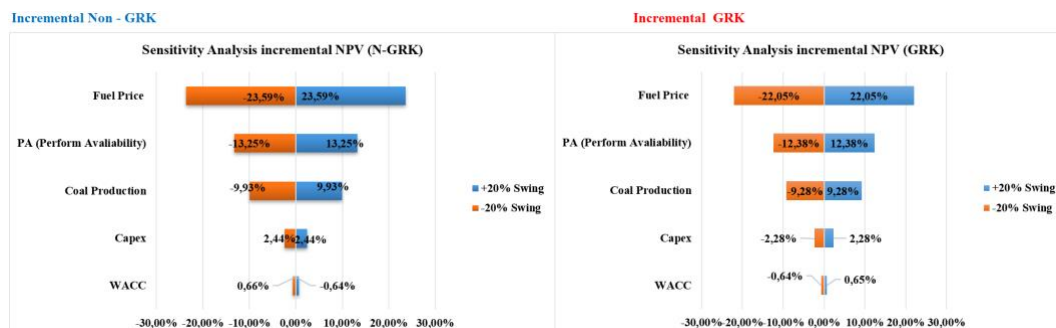


Figure 1. Tornado chart sensitivity analysis GRK & N-GRK

Interpretation of Risk Analysis WACC and Capex show reDEFvly small changes in NPV, indicating that the project is not very sensitive to fluctuations in these variables. Coal production and PA have a moderate impact on NPV. Changes in production volumes and performance availability significantly affect project profitability, but not as drastically as changes in fuel prices, which pose the most significant risk to the project's financial stability. The risk management recommendation from the analysis is that fuel prices have a high sensitivity, so business strategies related to performance availability from PLN electricity supply can be used to reduce the use of diesel fuel. Optimizing Performance and Production focuses on schemes to maximize coal production efficiency to maintain potential negative impacts. When reviewing capital and financing costs, although WACC and Capex are not very sensitive, optimizing these costs can still provide financial benefits and improve overall project resilience.

Monte Carlo

We typically use Monte Carlo simuDEFon to obtain a more thorough and accurate view of the risk and uncertainty in the investment model after completing sensitivity analysis. Sequential application of these two complementing strategies can lead to a greater understanding of risk and uncertainty in financial models, despite their differing goals and methods.

To represent and comprehend risk in a more realistic scenario where some or all variables vary simultaneously, enter the Monte Carlo simuDEFon by assigning random values to selected variables and see the variation of the simuDEFon's output.

Researchers have limited data due to internal corporate restrictions or data collection limitations. Therefore, they have chosen to employ the triangular distribution, which can illustrate uncertainty since it displays a relatively steady and understandable distribution.

Table 17. Scenario Analysis

Variables	Min	Most Likely	Max
PA (Performance Availability)	80%	90%	100%
Capex (\$)	347.619	316.018	284.416
Coal Production	3.001.500	3.335.000	3.668.500
WACC	13%	12%	11%
Fuel Price (\$)	0,23	0,56	1,03

The histogram, by including the carbon tax variable (GHG), shows that the result of the probability of $NPV < 0 = 0.0\%$. This indicates that the simulated NPV value is greater than zero. A high probability of NPV greater than zero indicates a positive return on investment. While the histogram does not include the carbon tax variable, the probability of $NPV < 0$ has a value of 0.1%. This means there is a small risk (0.1%) that the Net Present Value (NPV) of the project or investment will be negative. While there is a possibility that the investment or project may result in a negative NPV, the probability is very low. However, consideration of the investor's

or project management's risk tolerance and other factors such as strategic objectives, environmental impact, and so on are useful for risk assessment in financial forecasting or investment analysis.

The distribution's symmetry and tails can be inferred from the values of skewness and kurtosis. The kurtosis value from the two histograms above is low, below 0, indicating that there are fewer extreme findings (outliers) in the data. On the other hand, the skewness value indicates how much the NPV distribution is skewed or biased to one side. The right tail of the distribution has a higher weight when the skewness value is larger than zero. Stated differently, there's a higher chance of a really favourable result.

Business Solution

The assessment of real options for the investment project to re-arrangement the power supply source at the coal processing plant at PT XYZ's ABC Mine Operation involved a strategic plan from analysis to implementation. The real options to expand were selected initially with the goal of 100% power supply performance availability, not ruling out other options if once analysed they were financially unprofitable.

The option will be abandoned if there is no benefit from the power supply's availability performance (PA), which cannot possibly be achieved 100%. The option to wait if the analysis of the option to expand has the benefit of 100% power supply performance availability (PA), but the financial analysis is not good because there are factors that affect it. These two options were chosen after going through the stages of criteria analysis and financial risk analysis.

1. Diesel Power Plant (4 existing Gensets) + 1 additional ready unit:
 - a. Description: Utilize the existing 4 diesel gensets to supply electricity to the coal processing plant but additionally invest in 1 genset unit to replace the existing unit under maintenance.
 - b. Pros: Small capital expenditure, Flexibility in operation due to in-house control function, quick installation and construction, and self-power supply.
 - c. Disadvantages: High operating costs due to fuel and maintenance costs and subject to carbon tax when enforced by the government in October 2024 or early 2025.
2. PLN (State Electricity Company) Subscription:
 - a. Description: Subscription to PLN for electricity supply so that the existing diesel genset is a backup power supply.
 - b. Pros: Potentially lower operational expenditure and stable electricity supply and not subject to the carbon tax that will take effect in October 2024.
 - c. Disadvantages: Large capital expenditure to build the infrastructure from the ground up to the electrical system. Savings due to the difference in dependence on external resources.

Implementation Plan & Justification

PT XYZ immediately implements the plan to achieve 100% Performance Availability (PA) in supplying operational electricity to AMO (ABC Mine Operation), specifically at the coal processing plant, by investing in additional power sources and subscribing to PLN (Perusahaan Listrik Negara).

Implementation of development scenarios for business plan strategies by looking at available data such as existing electricity systems, supply capacity, fuel prices and coal production plans. Tools such as Kepner-Tregoe are used to analyse the criteria required for development and ensure they are met.

Ensuring 100% PA will guarantee a sustainable and reliable power supply, which is critical for AMO's operations. This investment prevents potential downtime and operational losses due to blackouts.

Combining the two electricity supply systems also helps reduce the environmental impact of using diesel fuel in generators used for operations. Compliance with government regulations on carbon tax gives the company an advantage to choose to subscribe to PLN as it reduces carbon emissions from operations.

It can, therefore, be concluded that implementing a plan to achieve 100% PA in supplying electricity to AMO by investing in additional supply resources and subscribing to PLN is critical for the company's operational reliability, cost-effectiveness, environmental sustainability and regulatory compliance. This implementation plan should be implemented as soon as possible to ensure a continuous and reliable electricity supply to AMO.

This implementation plan provides an overview of the implementation strategy based on a sequence of steps from idea to handover to ensure the success of the investment. Following timelines and establishing clear communication among stakeholders helps achieve the goals and outcomes of the investment project. Completion of the investment project on time and according to plan, effectively mitigates the risks of achieving the investment project's objectives and outcomes with return on investment (ROI).

CONCLUSION

The conclusion of this study indicates that PT XYZ faces challenges in coal processing operations affecting sales and marketing sustainability, particularly due to market diversification into Poland as a new market share. The current single diesel-powered system cannot achieve 100% availability performance (PA), resulting in downtime during maintenance and high operational costs driven by price fluctuations. Therefore, restructuring the power supply system is identified as the primary solution. Through a real options approach, PT XYZ considers two main options to achieve 100% PA: expanding the diesel power plant by adding an additional generator unit or subscribing to PLN (the State Electricity Company). The analysis shows that subscribing to PLN with the existing diesel generator as backup is more advantageous, offering lower operational costs, stable electricity supply, and compliance with upcoming carbon tax regulations. Risk analysis and Monte Carlo simulations demonstrate a high probability of financial viability for the project. The implementation plan

for this investment is carried out in phases, focusing on investment objectives, feasibility assessments, and risk management, with reliable power supply being critical for operational efficiency and long-term cost savings.

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