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## **ECONOMIC EVALUATION OF BRAVO GEOTHERMAL PROSPECT IN PARTICIPATING GREEN ENERGY EFFORT**

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### **Abstract**

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*Indonesia utilizes only 2.356 MW, around 8% of its geothermal resources. The government aims to increase geothermal power generation to 5.799 MW by 2030. Numerous geothermal projects, including Bravo, face challenges in achieving promising condition due to unfavorable economic returns. This study aims to find approach to make the Bravo geothermal project financially viable. It analyzes expenditures, financing strategies, revenue projections, depreciation, and taxes. The capital budgeting framework, employing discounted cash flow analysis, calculates economic indicators such as Net Present Value (NPV), Internal Rate of Return (IRR), and Debt Service Coverage Ratio (DSCR). Sensitivity analysis identifies the most influential project parameter. The findings provide recommendations for achieving the required economic return. After implementing cost reductions and tax incentives, Bravo's current state reveals unviable equity situation with an NPV of -15.80 million USD and an IRR of 5.91% below the project's discount rate. While meeting lenders' requirements with DSCR of 1.3 and 14-year repayment period, additional efforts are needed. Approaches such as a 115% increase in the stage 1 tariff, 15% reduction in CAPEX, 2-year construction period acceleration, or 20-year license extension helps achieve the desired return. Negotiations with off-taker regulators and industry partnerships are crucial for executing these approaches.*

**Keywords:** *Geothermal; Project; Equity; Lender; Investment*

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### **INTRODUCTION**

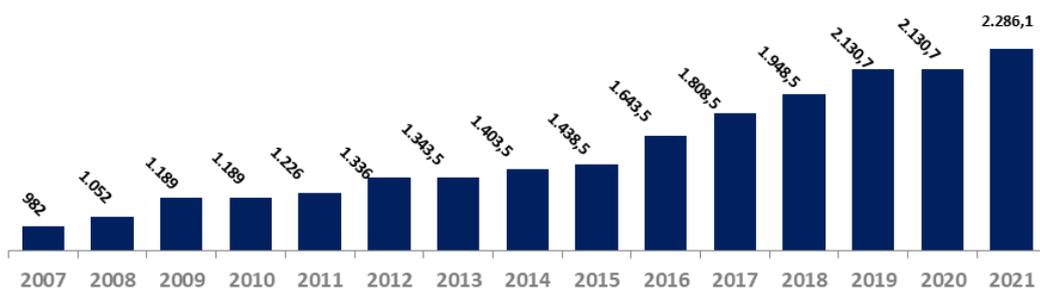
Indonesia possesses significant untapped potential in various renewable energy sources, such as geothermal, wind, hydro, bio, and solar power. The utilization of renewable

energy not only offers a reliable and localized energy supply but also contributes to the growing demand for sustainable energy in the future.

In line with this, Indonesia has formulated comprehensive plan to accelerate the adoption of renewable energy as the primary energy source. This strategic move aim to support the country's energy growth while simultaneously working towards achieving its net zero carbon emissions target (IRENA, 2022).

Indonesia is the country with the largest geothermal potential (approx. 23 GWe). It is one of the top two geothermal producers in the world (approx 2,286.05 MW), after the United States and ahead of the Philippines (Darma, Imani, Shidqi, Riyanto, & Daud, 2021; ADB, 2018). Unfortunately, the potential is still underutilized, as just 8 percent of the overall potential is now being utilized (Fadhillah, et al., 2022). Indonesia aims to increase geothermal use to 5,799 MW by 2030, a 259% increase over the existing capacity (PLN, 2021). Presently, 16 power stations are run by state-owned companies (SOE) and independent power producers (IPP) in Indonesia's geothermal industry (IPP). As seen in Figure 1, the installed capacity exhibits a rising trend throughout the course of the year. Existing usage was insufficient and additional work was required to reach the objective.

Utilizing geothermal as source of renewable energy is crucial to Indonesia's ambitions to reach 23 percent renewable energy by 2025 and an additional 21 percent of renewable power generation by 2030. (DEN, 2022a). Geothermal has market potential that present reserves are primarily located in Sumatra and Java, where energy-electricity demand is high. In addition, these regions are served by coal-fired power plants subject to early phase-out scheme. Based on Bisset et al. (2021), Institute of Essential Service Reform-IESR (2021), Ministry of Energy and Mineral Resources-MEMR (2022), International Renewable Energy Agency-IRENA (2022), and IESR, the Government of Indonesia's (GoI) plan to phase out coal would create market for geothermal electricity generation as fossil power plant substitute (2022).



**Figure 1 The installed capacity of geothermal power plants in Indonesia (ESDM, 2022).**

Project Bravo, undertaken by PT. Foxtrot, is an active geothermal project located in the western region of Indonesia. The primary objective of the Bravo geothermal project is to deliver clean and sustainable energy to the communities in Java, thereby supporting Indonesia's national energy security objectives. The project aims to generate a capacity of 1X55 MW, with a targeted Commercial on Date scheduled for 2031. Under the take-or-pay scheme, all the electricity produced by the Bravo geothermal plant will be fully absorbed by PLN (Perusahaan Listrik Negara), the state-owned electricity company of Indonesia. This arrangement ensures that PLN is obligated to purchase the generated electricity, regardless of the actual demand.

## **Challenges to Develop Geothermal Project**

The geothermal sector in Indonesia holds considerable promise, yet it currently lacks appeal to investors due to the combination of high risk and low returns. The implementation of geothermal projects frequently encounters obstacles in reaching production stages, primarily due to unfavorable economic conditions, challenging resource circumstances, and social concerns. Additionally, the sector is significantly influenced by various factors, including political, economic, social, and technical aspects (Komendantova, Patt, Barras, & Battaglini, 2012; IRENA, 2022).

The geothermal sector necessitates substantial initial investment, which carries inherent risks stemming from uncertainties surrounding resources, social-environmental factors, finances, and technology (IRENA, 2022). The Bravo geothermal project encounters difficulties in achieving favorable project economics primarily due to the presence of high upfront costs and resource-related risks. The considerable upfront expenses encompass activities aimed at confirming and extracting the resources, requiring costly technologies such as drilling and power plant construction. The condition of the resources significantly influences the technology required, directly impacting the overall investment amount. (IGA, 2014; ESMAP, 2012; ESMAP, 2021)

A comprehensive evaluation of cost reduction measures for geothermal projects is crucial to minimize upfront capital requirements and enhance overall attractiveness. Additionally, from an economic perspective, the Indonesian government has introduced various incentives for the geothermal sector, including tax holidays, tax allowances, import tax exemptions, and land tax exemptions. These initiatives aim to bolster the attractiveness of the geothermal industry and support the transition towards renewable energy. However, it is unfortunate that the existing government tax incentives have not yielded significant improvements in project economics. (IRENA, 2022; IESR, 2022; EBTKE, 2021).

The Bravo geothermal project encounters a regulatory risk associated with the evolving tariff scheme, influenced by the recently implemented renewable tariff regulation in Indonesia. This regulatory change has direct implications for the project's economic viability. President Regulation 112/2022 has introduced substantial modifications to the financial framework governing new and renewable power generation initiatives. Unlike the previous tariff structure characterized by a flat rate with escalation, the new scheme involves a ceiling tariff with staging mechanisms. Notably, the base tariff is reduced after ten years of geothermal power plant operation. Consequently, this shift directly affects revenue projections for the projects and may introduce substantial alterations to their overall feasibility.

## **Business Issue and Research Objective**

The primary business issue addressed in this research is the unattractive condition of the Bravo geothermal project, which fails to provide satisfactory economic returns. The objective of the study is to identify approaches that can help achieve the desired economic returns for the Bravo geothermal greenfield prospect through both internal and external improvements. The economic parameter is assessed from two perspectives: that of the investor and the lender.

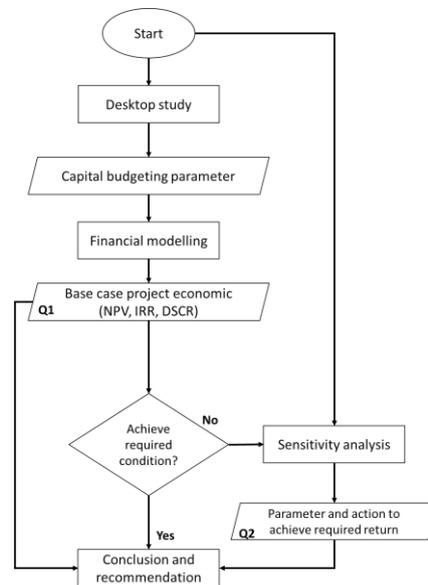
The attractiveness for equity is measured by evaluating whether the project offers a fair reward to the investor. On the other hand, the lender's perspective focuses on the project's ability to repay debt. Throughout the research, several key questions are addressed, including Is it economically feasible to develop a geothermal power plant under the new tariff scheme,

taking into account existing cost efficiency and fiscal incentives. What specific internal and external efforts are necessary to enhance the project's attractiveness for both equity investors and lenders.

## RESEARCH METHOD

### Data Collection and Analysis

Figure shows the research workflow. The Bravo geothermal project, a proxy to a geothermal project in Java, is selected because the project is one of the primary top-priority of PLN to be executed immediately to fulfill the electricity supply for the region. The research was sourced from the desktop study from internal Bravo geothermal project document and external open-source data. It consisted of project capital, technical-financial assumption, operating expenses, depreciation-tax rate, and cost reduction-tax incentives implementation scenario. It was analyzed using the financial model to determine the economic feasibility of the base case project. The sensitivity analysis also carried out to determine most influencing internal and external aspect that need to be improved to achieved required economic return.



**Figure 2 Research workflow**

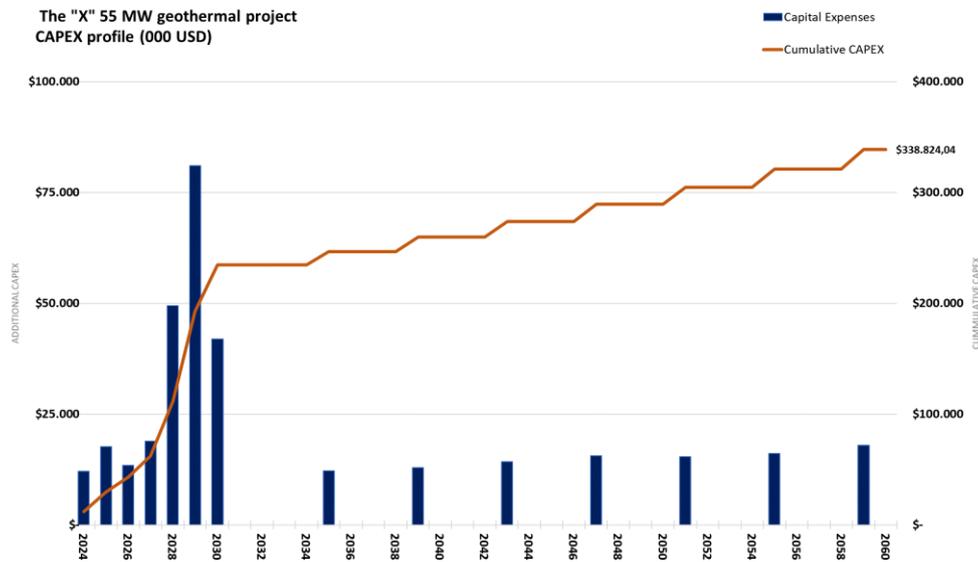
### Project Assumption

#### 1. Capital Expenditure

The capital expenditure (CAPEX) for a geothermal project encompasses various expenses associated with different stages of the project, including surveys, infrastructure preparation, drilling, construction of the steam above ground system (SAGS) and power plant, as well as reinvestment activities. Among these components, the power plant costs typically constitute the largest portion of the capital expenditure, followed by drilling. Drilling activity, particularly exploration drilling, presents unique challenges as it involves high levels of uncertainty. (Purwanto, 2019).

The Bravo project's base case assumes a pre-commercial operation date (pre-COD) capital expenditure (CAPEX) of 234.42 million USD, which includes costs associated with exploration, appraisal, and development activities. Additionally, the project includes

makeup well drilling as a reinvestment activity, which is planned to be conducted every 5 years. The projected cost for makeup well drilling is estimated to be 104.39 million USD. Considering the entire duration of the project, from its inception to the end of the production period, the total CAPEX amounts to 338.82 million USD. The CAPEX profile profile as in Figure .



**Figure 3 The CAPEX profile of the geothermal Bravo project.**

## 2. Financing Goal

The financing strategy of a business involves determining approach to obtain the necessary capital for its operations and expansion. This can be achieved through various approaches such as utilizing shareholder capital, issuing stocks, or obtaining short-term and long-term debt financing (Damodaran, 2011). During the pre-operation period, geothermal projects typically employ a mixed financing approach, combining shareholder equity with external financing options such as loans or grants (Yescombe, 2014) (ACE, 2022). Independent Power Producer (IPP) schemes for geothermal power plants have limited options for debt financing. IPPs typically have access to loans from commercial banks or financial institutions. In terms of soft loans, banks and other institutions tend to prioritize them for projects with significant social and environmental impacts rather than focusing solely on financial returns. Soft loans are often provided to state-owned enterprises in the context of geothermal projects based on Climate Policy Initiative (2019).

The Bravo project employs a mixed financing strategy, utilizing both equity financing and commercial loans. During the exploration period, 30% of the pre-commercial operation date (pre-COD) capital expenses are covered by equity financing. The expected return on equity is 12%.

The remaining 70% of the capital requirement is financed through debt. The debt is drawn down after 65% of steam is confirmed under the wellhead, which is expected to occur in the fifth year of exploration. The Weighted Average Cost of Capital (WACC) for the Bravo geothermal project is 7.42%. The WACC serves as the discount factor in assessing the project's financial feasibility and evaluating the present value of future cash

flows. It represents the average cost of financing the project, considering the cost of equity and the cost of debt.

### 3. Revenue Projection

The revenue is primarily affected by the sales volume and unit prices. Indonesia's geothermal business primarily sources revenue from electricity generation and/or steam sales. Furthermore, the geothermal business has several possible revenue streams, such as direct use, carbon trading, and other derivatives product.

The Bravo project aims to generate revenue through the sale of electricity to PLN (Perusahaan Listrik Negara), the national electric utility company. The project's revenue stream is based on a single-source model, focusing solely on electricity sales. . The power plant uses technical assumptions as shown in

Table . erved as the basis for the revenue calculations. The tariff structure follows the ceiling-staging scheme as per President Regulation 112/2022. During phase 1, the base price for electricity is set at 86.4 USD/MWh, while in phase 2, it decreases to 73.5 USD/MWh. The tariff escalation applied for 37,5% of the base tariff that uses the US PPI index based on ADB (2014). The production and tariff profile is shown in Figure .

Table 1 The power plant technical assumptions

Parameter	Bravo geothermal project
Power plant capacity	55 Mw
Available time/annual	8.760 hours
Capacity factor	90%
Off-take absorption	100%
Net saleable electricity	912.912 MWh
Stage 1 tariff	
Base tariff	86.4 USD/MWh
Location factor	1
End price	86.4 USD/MWh
Stage 2 tariff	
Base tariff	73.5 USD/MWh
Stage 1-2 alpha	0.375

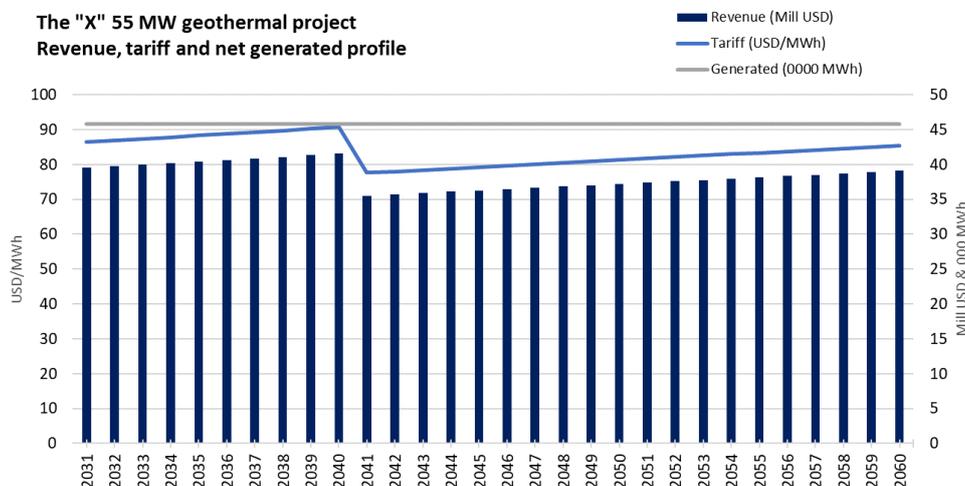


Figure 4 The profile of revenue and applied tariff.

#### 4. Expenses Projection

The cost of electricity, also referred to as variable cost, encompasses various expenses associated with the operation and maintenance of the geothermal power plant. These costs typically include maintenance expenses, inspection costs, field office expenses, field transportation costs, and camp-related expenses (Radityo, 2009; Nur, Burton, Aida, & Ikhwali, 2023).

The Bravo geothermal project base case determined that the cost of electricity is 18 USD/MWh that already includes the field and head office expenses. The major plant overhaul is planned to be performed periodically for 5-year with 2 million USD. The expense is escalated using the US PPI index. The project also has obligation to pay royalty (2.5% of revenue), production bonus (0.5% of revenue), and exploitation fixed fee (4 USD/Ha/Yr) to the government as non-tax government take.

#### 5. Depreciation and Tax

Depreciation is an accounting technique used to allocate the cost of a long-term asset over the estimated useful life of the asset. Corporate income tax for the geothermal sector that holds the license after Law. 21/2014 (known as WKP 'IPB') is referred to Law No 36/2008. The income tax would be 22% of positive taxable income.

The project uses straight-line depreciation method for 8 year with zero-salvage value as applied by Nur et al. (2023), and industrial practices (2005). Furthermore, the corporate income tax is 22%. Bravo geothermal project base plan uses the existing tax holiday where Bravo project is eligible for 7 years tax holiday.

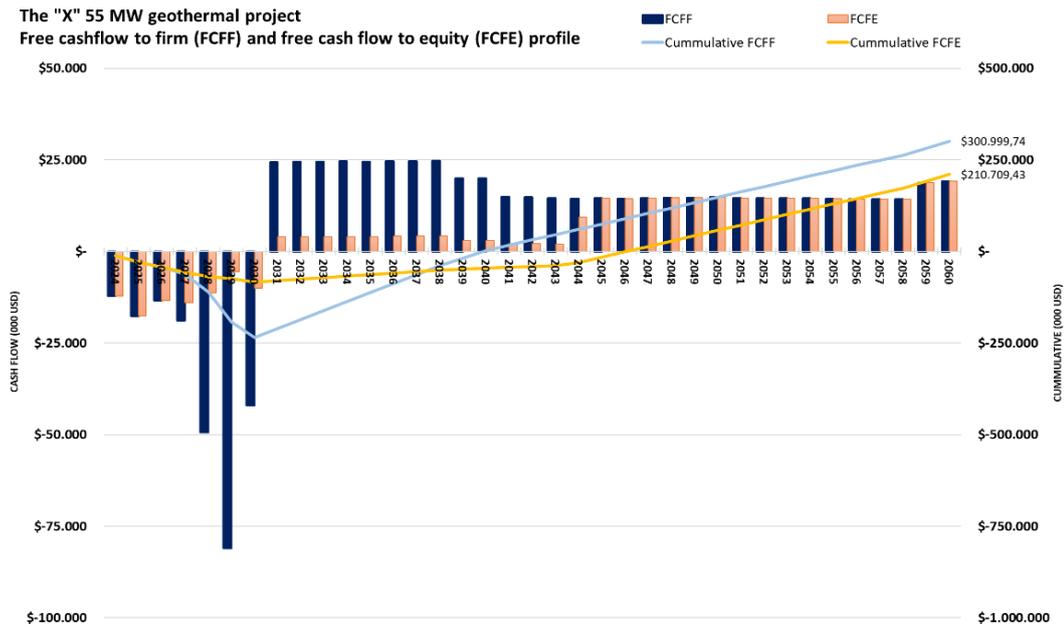
## RESULTS AND DISCUSSION

### Project Economic Analysis

Figure 4 presents the base case cash flow for the Bravo project, showcasing the cash inflows and outflows over the project period. The cash outflow is notably significant between 2028-2030, corresponding to the expected start of the project's development phase. This period likely involves substantial capital expenditures and investment in infrastructure.

The cash inflow profile demonstrates two significant drops during the project's timeline. The first drop occurs in 2038, coinciding with an increase in corporate income tax. This increase is attributed to the end of the depreciation period for the exploration asset, resulting in a higher taxable income. The second drop in cash inflow occurs in 2041, associated with the implementation of the second stage of the tariff scheme. This stage introduces a lower tariff, leading to a reduction in the project's free cash flow, which is reflected in the cash inflow.

The cumulative cash flow for the project is reported as 277.41 million USD, indicating the net sum of cash inflows and outflows over the project's duration. The break-even point, where cumulative cash flow equals zero, is estimated to occur in the 10th year of operation. For equity investors, the cumulative cash flow is reported as 192.81 million USD, suggesting the net cash flow specifically attributable to equity holders. The break-even point for equity is projected to be reached in the 15th year of operation.

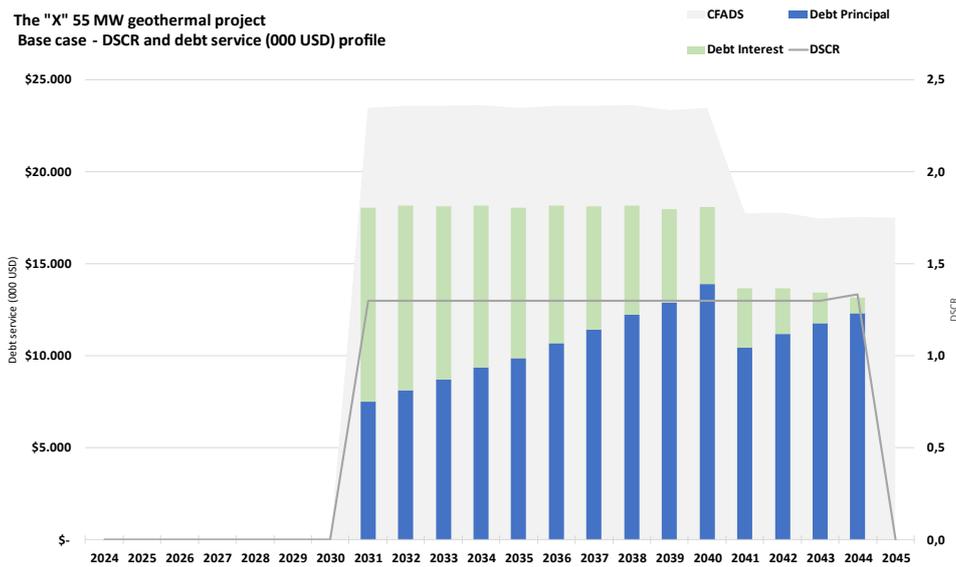


**Figure 5 FCFF and FCFE profile base case of the Bravo geothermal project.**

Figure 5 illustrates the CFADS (Cash Flow Available for Debt Service) and DSCR (Debt Service Coverage Ratio) profile of the Bravo geothermal project base case. The DSCR values range from a maximum of 1.33 to a minimum of 1.3, indicating a relatively stable pattern throughout the project's duration. The DSCR represents the project's ability to generate sufficient cash flow to cover its debt service obligations. The minimum value of 1.3 suggests that the project's cash flow is 1.3 times higher than the required debt service payments.

The CFADS profile demonstrates two main conditions: a high period between 2031 and 2038 and a low period from 2041 to 2044. The high period corresponds to a time when cash inflows exceed cash outflows, resulting in a positive CFADS. Conversely, the low period is characterized by a drop in revenue due to the transition from stage 1 to stage 2 tariff, which leads to lower cash inflows. However, the expenses do not decrease proportionally, resulting in a decline in CFADS.

The DSCR consistently maintains values above 1.2 throughout the project, indicating the project's ability to meet its debt service obligations. The repayment period is estimated to be 14 years, which is shorter than the overall project period. This indicates that the project has the capacity to fulfill the requirements of the lender and generate sufficient cash flow for debt repayment.



**Figure 2 CFADS and DSCR profile of base case scenario of the Bravo geothermal project.**

According to Table 2, the base case feasibility analysis of the Bravo geothermal project indicates an infeasible condition for equity but satisfies the lender requirements. The NPV (Net Present Value) at a discount rate of 7.42% shows a negative value of -16.33 million USD. A negative NPV indicates that the project's cash inflows are not sufficient to cover the initial investment and generate a positive return, making it unfeasible for equity investors.

The IRR (Internal Rate of Return) of the Bravo project is calculated to be 5.96%, which is lower than the project's WACC (Weighted Average Cost of Capital) of 7.42%. The IRR represents the expected rate of return from the project, and a value lower than the WACC suggests that the project is not expected to generate a return higher than the cost of capital, indicating its unfeasibility.

The minimum DSCR of 1.3 with a 14-year repayment period satisfies the lender's requirement. The DSCR represents the project's ability to generate sufficient cash flow to cover its debt service obligations, and a minimum value of 1.3 indicates that the project can meet these requirements.

**Table 2 The summary of base case project economic calculations.**

Parameter	Requirement	Result	Remarks
<b>Equity and regulator</b>			
NPV	>0 USD	-16,33 Million USD	Unfeasible
IRR	>WACC	5,96%	Unfeasible
<b>Lender</b>			
Minimum DSCR	$\geq 1,2$	1,3	Feasible
Repayment period	Repayment period < project period	14 Y	Feasible

### Sensitivity Analysis

The enhancement of project economic related to the equity return is need to carried out. The sensitivity analysis for geothermal project is not regulated yet, While specific guidelines for geothermal projects still not be available, the author has adopted the practices

followed in the oil/gas industry based on technical guideline 37/208 regarding the plan of development (PTK 37 POD). This allows for a comprehensive evaluation of the project's sensitivity to key parameters.

Sensitivity analysis for NPV and IRR parameter shown in Figure and Figure . The analysis considers parameters such as CAPEX, OPEX, tariff, tax incentives, construction period, and operation period. By assessing the impact of these parameters on the project's return, both internal and external factors that require improvement to achieve the required return can be identified.

The sensitivity analysis highlights that the applied tariff is the most influential parameter affecting the NPV and IRR of the Bravo geothermal project. Increasing the tariff by 50% has a significant impact, resulting in a change of 119.78 million USD for NPV and a 8.4% change for IRR. Given the importance of the tariff in determining the project's economic viability, it may be necessary to prioritize and carefully consider adjustments to the tariff structure. Ensuring a fair and reasonable tariff that adequately rewards the investor for their investment and risk is crucial for project attractiveness and financial sustainability.

The sensitivity analysis reveals that the CAPEX (Capital Expenditure) is the second most influential parameter for both NPV and IRR of the Bravo geothermal project. Reducing the CAPEX by 50% would result in a significant impact, with a change of 80.27 million USD for NPV and a 9.9% change for IRR. However, it is important to note that the CAPEX parameter in the project is already in its most efficient condition, meaning that the base case assumption already reflects the most optimized and cost-effective scenario. While the CAPEX parameter may not provide further room for improvement in the current analysis, it is still important to periodically reassess and optimize the project's cost structure to identify potential cost-saving opportunities. This can be done by exploring alternative technologies, procurement strategies, or construction methods that could potentially reduce the overall project costs without compromising quality and performance.

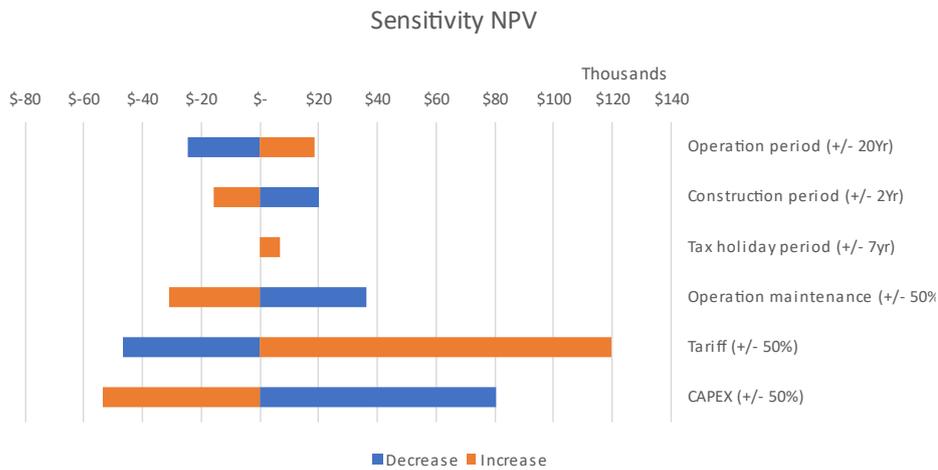
The operation and maintenance cost is the third influencing parameter for both outputs. The 50% reduction of the operation and maintenance cost would affect to 36.28 million USD change for NPV. The IRR also has 3.1% changes from existing condition. Unfortunately, the operation and maintenance cost as internal factor already in most efficient condition. This means any reduction scenario already implemented in the base case assumption and could not provide any reduction at this step.

The construction period is fourth most influencing parameter. The acceleration of construction period up to 2 years from existing plan would increase the NPV by 19,97 million USD from existing. The IRR also has positive effect from project acceleration that increase 1.9% from current IRR. By shortening the construction period, the project can begin generating revenue earlier and potentially reduce costs associated with construction delays, inflation, and market uncertainties. Accelerating the construction phase can improve the project's financial performance, enhance cash flow, and expedite the realization of returns on investment.

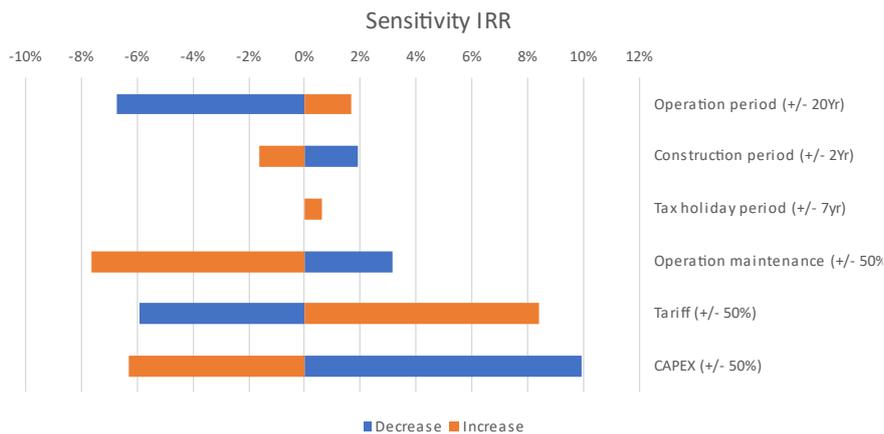
The operating period is identified as the fifth parameter that influences the NPV and IRR of the Bravo geothermal project. The additional 20 year of operating period would result in an additional 18.35 million USD in NPV compared to the existing plan. Additionally, the IRR would increase by 1.8% from the current IRR. Extending the operating period allows for a longer duration of revenue generation and cash flow from the project. This can result in increased profitability and improved financial returns over the extended timeframe.

However, it is important to consider various factors when assessing the feasibility of extending the operating period, such as resource availability, maintenance requirements, technological advancements, market demand, and regulatory considerations.

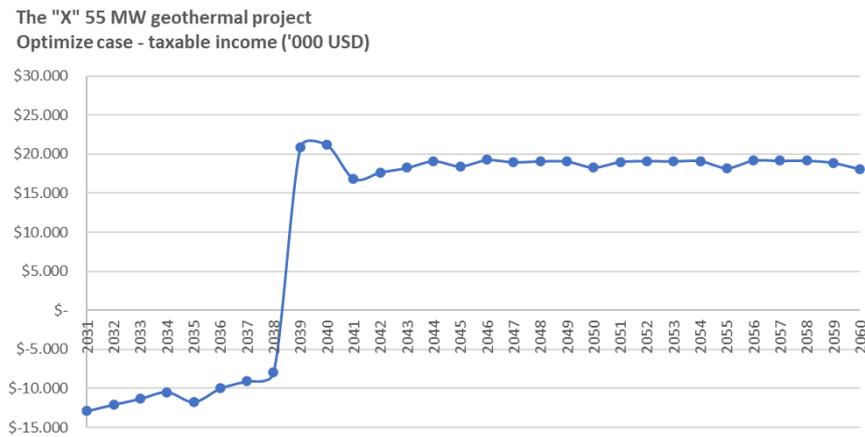
Tax incentives have the least impact on the project return in terms of NPV and IRR for the Bravo geothermal project. The additional 7-year period of tax incentives only provides a relatively small increase in NPV, amounting to 6.53 million USD, and a slight improvement in IRR by 0.6%. The limited impact of tax incentives on project returns can be attributed to the project's already negative taxable income during the 7-year tax holiday period. Since the project is not generating taxable income, the tax incentives do not have a significant effect on improving the project's financial performance (Figure ).



**Figure 7 The sensitivity analysis for NPV**



**Figure 8 The sensitivity analysis for IRR**



**Figure 9 The taxable income profile.**

## DISCUSSION

The existing condition of Bravo project could not provide the fair reward to the investor. Several internal and external approaches that could be implemented to achieve the targeted reward, such as:

1. The tariff increasing to 110% from existing conditions could provide the NPV and IRR in desired condition as per WACC. The expected return from equity at 12% could be achieved by increasing the tariff to 135% from existing condition. The tariff increasing could be focused on the first stage of tariff (Y1-Y10). This approach needs the negotiation with off taker. The tariff negotiation above the regulation tariff is allowed by Perpres 112/222 article 5. Although the targeted tariff falls above the regulated tariff, the project still could open the negotiation process since the project is one of planned electricity source for Java area that prioritize by offtaker. Furthermore, the project also has potential of carbon credit that may be claimed by off taker as additional product besides the electricity. The 115-135% tariff increasing may be achieved by providing the location factor equals to 1.15-1.35 or increasing the stage 1 tariff to 99.1 – 116.7 USD/MWh.
2. The CAPEX reduction around 15% from existing conditions that could provide IRR 7.42%. This parameter is internal controllable parameter since the CAPEX and OPEX would be determined by exploration-operation strategy. Although this parameter is controllable internal parameter, the CAPEX and OPEX reduction alternatives seems challenging to achieve since current project CAPEX and OPEX already in internal most efficient approach with current conditions. The CAPEX and OPEX also already on most low fair industrial cost basis.
3. Project acceleration to 2 year faster than existing schedule. The acceleration could provide higher NPV-IRR since the project would gain revenue faster. The accelerate project also reduce the escalation of the CAPEX. The project acceleration could be performed through strengthening the internal project management team. This condition could be achieved by enhancing the team ability to execute geothermal project through collaboration and partnership with third parties that already had rigid experience in performing geothermal project.
4. Operation period extension up to 20 years. The extension could result higher NPV-IRR in desired conditions since it provide higher net cashflow. The extension of operation period also allowed by geothermal law 21/2014 up to 20 years from existing condition.

The operation extension could be acquired by negotiation with off taker during Power Purchase Agreement (PPA) negotiation and confirmation from regulator.

## **CONCLUSION**

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