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Analysis of Investment Feasibility and Risk for the Batanghari Micro-Hydro Power Plant Project at PT Brantas Total Energi

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Abstract:- The increasing demand for electricity and the Indonesian government's commitment to reducing carbon emissions necessitate the development of renewable energy, including Mini Hydro Power Plants (PLTM). PT. Brantas Total Energi, a subsidiary of PT. Brantas Energi, plans to develop the Batanghari PLTM project in West Sumatra. This study aims to evaluate the investment feasibility of this project from financial and risk perspectives and to provide recommendations for its continuation. The research methodology employed financial analysis using four key indicators: Internal Rate of Return (IRR), Net Present Value (NPV), Discounted Payback Period (DPP), and Profitability Index (PI). In addition, a sensitivity analysis was conducted to assess investment risk in response to changes in key variables, such as electricity sale tariffs, investment costs, and electricity production rates. The results indicate that the Batanghari PLTM project achieves an IRR of 12.25%, a positive NPV of IDR 31.257 billion, a DPP of 15 years, and a PI of 1.18, signifying that the project is financially feasible. However, the sensitivity analysis results show that the project is somewhat sensitive to fluctuations in tariffs and investment costs. In a worst-case scenario, such as a decrease in electricity tariffs and an increase in investment costs, the project could become financially unfeasible. Consequently, it is recommended that PT. Brantas Energi and PT. Brantas Total Energi conduct regular risk monitoring and consider mitigation strategies, such as tariff renegotiations or investment cost controls, to maintain the project's sustainability and profitability.

Keywords:- *Mini Hydro Power Plant, IRR, NPV, Discounted Payback Period, Profitability Index, Sensitivity Analysis.*

I. INTRODUCTION

As a developing country, Indonesia continually strives to expand its electricity supply capacity to meet growing demand across all sectors. PT Brantas Energi, a subsidiary of PT Brantas Abipraya (Persero), was established to support government efforts in transitioning toward clean energy through the development of renewable power plants, such as hydroelectric power plants (PLTA), mini-hydropower plants (PLTM), and solar power plants (PLTS). In this endeavor, PT Brantas Energi collaborates with various strategic partners, both state-owned enterprises and private entities, to develop reliable and sustainable energy infrastructure. As part of its long-term development strategy, PT Brantas Total Energi was created to manage the Batanghari PLTM project in West Sumatra, with a targeted electricity capacity of 5.1 MW. This initiative aims to reduce reliance on fossil fuels and increase the electrification ratio in the surrounding area.

Energy demand continues to rise alongside population growth and the shift towards electrification in the era of Industry 4.0. According to a study by Chakrabarty et al. (2024), global energy consumption has increased significantly by 69.22% over the past three decades, with Asian countries being the primary contributors. From 2020 to 2021, global energy consumption rebounded by 5% due to economic recovery. According to projections by the International Energy Agency (IEA), global energy demand is expected to increase by 45% by 2030, with an average growth rate of 1.6% per year. The power generation sector is the largest contributor to global energy demand, accounting for 70%, especially in developing countries (IEA, 2023). In 2022, total energy consumption in Indonesia reached 1.18 billion barrels of oil equivalent, a 28.31% increase from the previous year’s 924.2 million BOE, with projections indicating it may reach 2.91 billion BOE by 2050, as illustrated in Figure 1 below.

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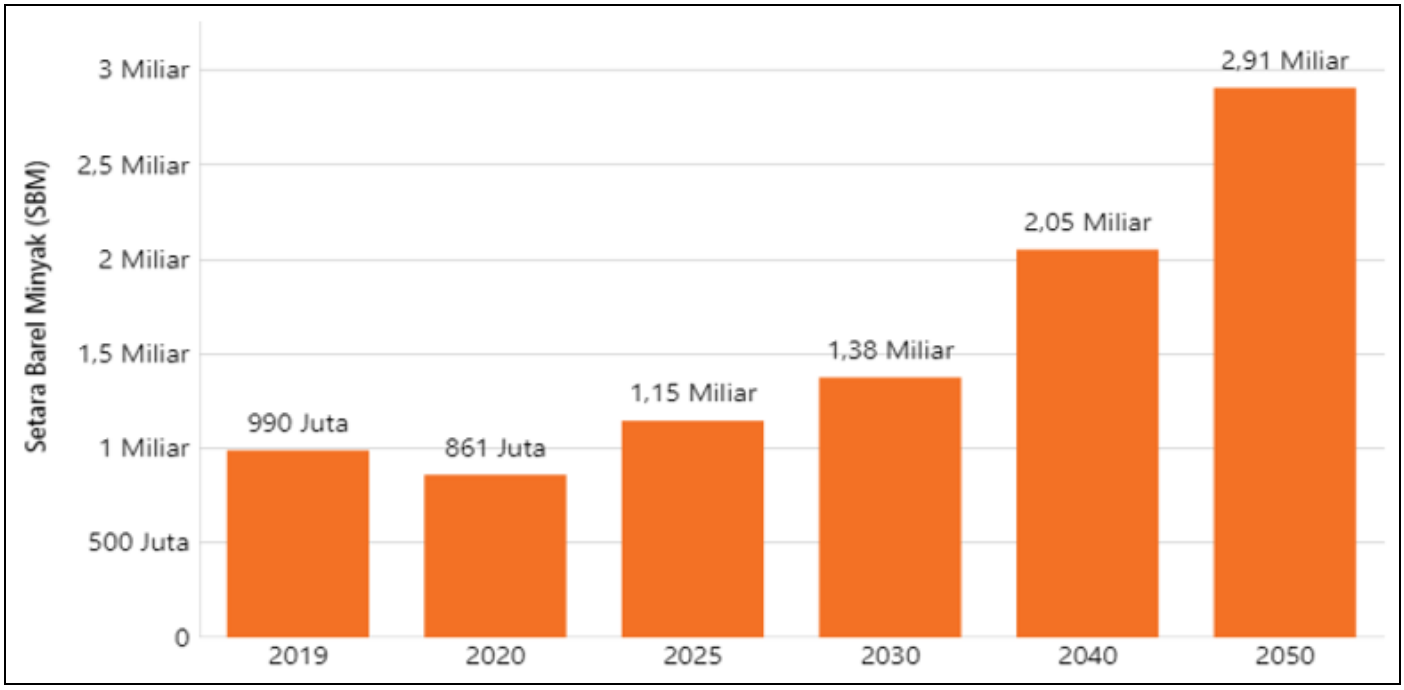

Fig 1 Projected Energy Demand in Indonesia (2019-2050)
Source: BPS (2023)

While fulfilling this energy demand is generally not an issue due to Indonesia's 2023 Electrification Ratio (ER) achievement of 99.78%, environmental consequences arise from relying heavily on fossil fuels as the primary energy source. Coal and oil contribute 40.46% and 30.18% of total energy, respectively, while natural gas accounts for around 16.28%. In contrast, renewable energy still plays a minor role at only 13.09% (Paramita et al., 2024).

Globally, the energy sector has generated a record 34.37 billion tons of CO2, with Indonesia ranked sixth in global energy sector emissions, contributing 691.97 million tons of CO2 in 2022 (Institute, 2023). According to regular reports by Climate Transparency, electricity generation is the most dominant sector in carbon emissions compared to others.

As energy demand in Indonesia continues to grow, heavy reliance on fossil fuels not only poses negative environmental impacts but also threatens the achievement of Net Zero Emission targets. To address this, PT PLN (Persero) is accelerating clean energy development, including the Mini-Hydropower Plant (PLTM) project. The General Plan for Electricity Supply (RUPTL) 2021-2030 recommends 168 renewable energy projects, including the Batanghari PLTM, with a potential capacity of 5.1 MW.

The Batanghari PLTM project, to be executed by PT Brantas Total Energi, a subsidiary of PT Brantas Energi, is designed to produce environmentally-friendly electricity by harnessing the flow of the Batanghari River. Given the substantial investment required, financial feasibility evaluations are critical to avoid potential losses. The feasibility analysis employs methods including Internal Rate of Return (IRR), Net Present Value (NPV), Discounted Payback Period (DPP), and Profitability Index (PI). Additionally, sensitivity analysis on key variables, such as electricity tariffs and capital costs, is conducted to identify risks that may impact investment feasibility.

This study also highlights both methodological and empirical gaps in previous research, which used varying approaches to investment analysis. By employing a comprehensive approach through quantitative methods and sensitivity analysis, this study is expected to provide a significant contribution to risk management and renewable energy investment project management in Indonesia.

The mini-hydropower plant construction project undertaken by PT Brantas Energi represents a commitment to green principles and innovation, which PT PLN (Persero) upholds in its approach to electricity management in Indonesia. As the project implementer, PT Brantas Energi must ensure that the financial aspects of this investment are carefully considered, aligning with the goals of enhancing competitiveness and efficiency within the green energy and green economy frameworks. A feasibility study is essential to ensure that this project not only yields financial benefits but also supports government efforts, both short-term and long-term, in sustainable energy development. This research aims to analyze the feasibility and investment risks of the Batanghari mini-hydropower project using evaluation methods such as IRR, NPV, DPP, and PI, along with sensitivity analysis to account for potential risks.

II. LITERATURE REVIEW

➢ *Financial Management in Infrastructure Projects*

Financial management is a crucial component in infrastructure projects, encompassing the planning, control, and evaluation of fund allocation to ensure the project proceeds according to plan with optimal results. In the context of energy infrastructure projects, financial management

involves in-depth analysis of cash flows, capital structure, and risks. One commonly used method in infrastructure projects is Capital Budgeting, which includes various techniques to assess the financial viability of long-term investments.

Infrastructure projects such as PLTM require substantial investment and long payback periods, necessitating careful evaluation through methods like the Internal Rate of Return (IRR), Net Present Value (NPV), Discounted Payback Period (DPP), and Profitability Index (PI). IRR provides insight into the project's internal rate of return, enabling management to compare it with other investment alternatives. NPV calculates the project's added value by considering future cash flows and discounting them to present value. DPP estimates the time required to recover the initial investment, essential for assessing project liquidity and short-term risk. Meanwhile, PI provides a picture of the project's capital efficiency, showing the present value of cash flows generated for each investment unit.

- *Risk and Sensitivity Analysis in Energy Projects*

Risk is an inherent part of every energy project, especially renewable energy projects like PLTM, which face unique challenges related to environmental variability and reliance on government regulations. Key risks in energy projects include fluctuations in raw material prices, changes in electricity tariff regulations, and uncertainty in electricity production estimates. Sensitivity analysis is a valuable tool in this context, allowing companies to simulate various scenarios and understand how changes in key variables affect the project's financial outcomes.

In the context of PLTM, key variables that require sensitivity analysis include electricity tariffs, investment costs, and electricity production levels. For example, a decrease in electricity tariffs will directly impact the project's revenue, while an increase in capital costs will reduce profit margins. Sensitivity analysis provides insights into the project's dependence on market conditions and policies and aids management in developing effective mitigation strategies.

- *Empirical Studies on Investment Feasibility in Energy Infrastructure Projects*

Various empirical studies have evaluated the investment feasibility of energy projects, both in Indonesia and globally. Studies by Wiratama (2020) and Zativita & Chumaidiyah (2019) suggest that energy projects with high IRR, positive NPV, and PI greater than one are generally considered viable. Additionally, research findings indicate that energy infrastructure projects involving large investments, such as PLTM, require a more cautious approach in risk management, especially for variables like tariffs and capital costs.

Moreover, Setiadi et al. (2020) found that in the healthcare sector, NPV and DPP methods provide the best decisions in project feasibility evaluation, despite not being energy projects. The similarity between energy infrastructure and healthcare projects is that both require substantial investment and directly impact society, making the financial feasibility criteria often similar.

- *Theoretical Framework and Research Novelty*

This study emphasizes a combination of financial evaluation and sensitivity risk analysis, considered a holistic approach to evaluating renewable energy projects like PLTM. Unlike previous research that focused on traditional financial analysis, this study offers a new contribution by integrating sensitivity analysis as an essential part of investment risk assessment. This approach is expected to provide more comprehensive recommendations for managing the PLTM project and preparing the company to face potential challenges arising from market or policy changes.

III. RESEARCH METHODOLOGY

This study adopts a quantitative research approach focused on collecting numerical data from projected cash flows and investment costs. The data includes estimates of capital costs, electricity tariffs, and cash flows from electricity production during the operational period of the PLTM project at the Batanghari Dam. This data is used to analyze the financial feasibility and investment risk aspects, providing a comprehensive overview of potential profits and risks that may arise.

To evaluate investment feasibility, four primary methods are applied: Internal Rate of Return (IRR), Net Present Value (NPV), Discounted Payback Period (DPP), and Profitability Index (PI). IRR is used to measure the investment return rate, where an IRR value exceeding the discount rate is considered feasible for continuation. NPV assesses the added value of the project; if positive, the project is deemed profitable. DPP estimates the time required to recover the initial capital, while PI serves as an indicator of investment efficiency, with a value greater than one indicating potential for good capital returns.

Furthermore, to assess investment risk, a sensitivity analysis is conducted by examining the impact of changes in electricity tariffs, investment costs, and production levels on the project's cash flows. This analysis simulates scenarios such as a 10% increase in investment costs or a 10% decrease in electricity tariffs, providing insights into the project's financial resilience against fluctuations in these key variables. The results of this sensitivity analysis will help in developing appropriate risk mitigation strategies to minimize potential negative impacts from market or policy changes.

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Table 1 Measurement Scale for Variables

No.	Variable	Operational Definition	Formula	Scale
1	Internal Rate of Return (IRR)	The Internal Rate of Return (IRR) is the interest rate that equates the present value of total net cash flows received to the present value of the investment costs (Rahmana et al., 2022; Hasan et al., 2022).	$\sum \frac{CF_t}{(1+IRR)^t} = 0$ where CF_t is cash flow at time t	Ratio
2	Discounted Payback Period (DPP)	The Discounted Payback Period (DPP) is the time required to recover the investment costs (Suni et al., 2023).	$DPP = \frac{\text{Initial Investment}}{\text{Annual Net Cash Flow}}$	Ratio
3	Net Present Value (NPV)	Net Present Value (NPV) is the present value of a project investment. It is calculated by taking the projected net cash flows for the economic life of the project and subtracting the present value of the investment costs (Suni et al., 2023).	$NPV = \sum \frac{CF_t}{(1+r)^t} - \text{Initial Investment}$ where r is the discount rate	Ratio
4	Profitability Index (PI)	The Profitability Index (PI) is calculated by dividing future cash flows by the initial cash investment (Shapiro, 2023).		Ratio
5	Sensitivity Analysis	Sensitivity analysis is a risk assessment method that evaluates investment returns by estimating cash flows under various scenarios: sensitive and non-sensitive (Rusydi et al., 2018). This includes 1) increase in investment value, 2) changes in interest rate, and 3) variation in electricity production (Hadi & Amirul, 2018).		Ratio

IV. RESULTS AND DISCUSSION

This study analyzes the investment feasibility of the Minihydro Power Plant (PLTM) project at the Batanghari Dam, managed by PT Brantas Total Energi as part of PT Brantas Energi's efforts to support renewable energy development in Indonesia. The evaluation is based on four primary financial indicators—Internal Rate of Return (IRR), Net Present Value (NPV), Discounted Payback Period (DPP), and Profitability Index (PI)—to determine the project's feasibility. Additionally, a sensitivity analysis is conducted on several key variables to understand the risks that may impact the project's financial stability under various scenarios.

Table 2 Investment Feasibility Evaluation Results

No	Variable	Result
1	Internal Rate of Return (IRR)	12,25%
2	Net Present Value (NPV)	IDR 31,257 billion
3	Discounted Payback Period (DPP)	7,4year
4	Profitability Index (PI)	1,18

Source: Secondary Data, processed, 2024

This study evaluates the financial feasibility of the Mini-Hydro Power Plant (PLTM) project at Batanghari Dam, managed by PT Brantas Total Energi as part of PT Brantas Energi's commitment to supporting the development of renewable energy in Indonesia. The evaluation relies on four key financial indicators—Internal Rate of Return (IRR), Net Present Value (NPV), Discounted Payback Period (DPP), and Profitability Index (PI)—to assess the project's viability. Additionally, a sensitivity analysis was conducted on several critical variables to understand potential risks that may impact the financial stability of the project under various scenarios.

The financial feasibility assessment indicates that the Batanghari PLTM project has the potential to generate long-term profitability. The IRR obtained is 12.25%, which is above the projected discount rate, indicating that the project is expected to yield a return exceeding the capital costs. In infrastructure investments, a high IRR is a key indicator that the project is attractive to investors and stakeholders as it meets expected investment criteria.

The NPV of IDR 31.257 billion demonstrates that the project will add substantial value to the company. A positive NPV implies that the total cash flows generated over the project's operational life will exceed the initial investment, highlighting the economic benefits of this project. Projects with a positive NPV can strengthen the company's financial position and add value for shareholders.

Furthermore, the Discounted Payback Period (DPP) is recorded at 7.4 years, relatively short compared to the project's economic life. A shorter payback period suggests that short-term liquidity risks can be effectively managed. This is crucial as it reduces exposure to market fluctuations that could impact cash flow during the early operational phase. A shorter DPP also increases investor interest due to the potential to reach the break-even point relatively quickly.

The Profitability Index (PI) of 1.18 indicates that for every unit of invested capital, the project is expected to generate a return of 1.18 times the initial investment. A PI greater than one is a good indicator of capital efficiency, suggesting that the project can yield a return that matches or exceeds the initial capital outlay. A positive PI confirms that the project is financially viable and profitable in the long term.

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A sensitivity analysis was conducted to understand how changes in key variables, such as investment costs, electricity tariffs, and electricity production levels, could impact the project's financial outcomes. Simulations involved various scenarios, including a 10% increase in investment costs, a 10% decrease in electricity tariffs, and a 5% decrease in electricity production. This analysis provides insights into the extent to which fluctuations in these variables could affect cash flows and project viability.

The sensitivity analysis results indicate that the Batanghari PLTM project remains financially feasible despite variations in key variables. In a scenario with a 10% increase in investment costs, the project still yields a positive NPV and an IRR above the discount rate, although the Discounted Payback Period (DPP) extends to 24.5 years. This suggests that while higher investment costs could delay the break-even point, the project's long-term profitability remains intact. In the context of investment risks, this finding underscores the importance of cost control during the construction phase to ensure optimal financial results.

Changes in electricity tariffs also have a significant impact on project outcomes. A 10% decrease in tariffs indicates that although NPV and IRR remain positive, the payback period extends, and the PI slightly decreases. This underscores the importance of tariff stability in supporting the project's long-term feasibility, given that the project's primary revenue depends on electricity prices.

In the worst-case scenario involving a 5% reduction in electricity production, the project still shows positive results across all indicators, although there is a noticeable impact on long-term cash flow. Reduced production directly affects the volume of electricity sold to PT PLN, potentially lowering project revenues. This sensitivity analysis demonstrates that while the Batanghari PLTM project has sufficient resilience against market fluctuations, effective management is necessary to maintain cash flow stability.

Overall, the sensitivity analysis results suggest that the project carries manageable financial risks, although external factors such as electricity price changes and increased investment costs should be closely monitored. Given that this project represents a long-term investment with reliance on electricity prices and capital costs, PT Brantas Total Energi is advised to implement comprehensive risk mitigation strategies to minimize the adverse effects of changes in these variables.

These findings hold significant implications for PT Brantas Energi and PT Brantas Total Energi in considering long-term strategies for clean energy investments in Indonesia. First, the financial viability demonstrated by this evaluation aligns with the national need to increase renewable energy in the energy mix, which supports PT PLN (Persero)'s vision of fostering green energy transition. Second, the project's resilience against changes in investment costs and electricity tariffs indicates that investment in PLTM could be a strategic move for diversifying sustainable energy resources.

However, the findings also suggest that PT Brantas Total Energi should develop specific risk mitigation plans to maintain project efficiency. The sensitivity analysis indicates that while the project remains viable, cost and tariff variables significantly impact long-term profitability. Therefore, the company should ensure the project is supported by stable electricity pricing policies and exercise strict control over construction costs to secure sustainable financial performance.

V. CONCLUSION AND RECOMMENDATION

A. Conclusion

This study focuses on using Net Present Value (NPV), Internal Rate of Return (IRR), Discounted Payback Period (DPP), and Profitability Index (PI) methods to evaluate the financial feasibility of the PLTM Batanghari project. These calculations help assess whether the investment is financially viable. Given the long-term nature of the project, with an operational period of 25 years, it is essential to account for uncertainty and possible impacts of changing conditions through sensitivity analysis. The conclusions derived from the analysis are as follows:

- Based on the financial analysis using IRR, NPV, DPP, and PI methods, the Batanghari Minihydro Power Plant (PLTM) project initiated by PT Brantas Total Energi is deemed feasible. The project's IRR stands at 12.25%, exceeding the discount rate of 9.88%, indicating that the project can yield a return higher than the capital costs. Additionally, the project's NPV shows a positive value of IDR 31.257 billion, signifying a surplus in net present value that can enhance corporate value. The project's DPP, recorded at 15 years, is within the 25-year economic life of the project, albeit reflecting a relatively long payback period for this type of investment. With a Profitability Index (PI) of 1.18, the project is expected to generate greater cash flows than the initial investment, demonstrating efficient capital utilization. Collectively, the IRR, NPV, DPP, and PI indicators suggest that the Batanghari PLTM project possesses sound financial feasibility and is suitable for implementation.
- The investment risk assessment for the Batanghari PLTM project, conducted through sensitivity analysis, indicates that the project is quite sensitive to fluctuations in electricity sales tariffs, investment costs, and electricity production levels. In negative scenarios, such as a 5% reduction in electricity production or a 10% decrease in electricity sales tariffs, the project remains viable, though with a decrease in NPV, IRR, and PI values. Scenarios involving a 5% increase in investment costs show a rise in liquidity risk, particularly in extreme cases where NPV turns negative and PI falls below 1, indicating that the project may struggle to cover capital costs. Overall, sensitivity analysis suggests that while the project is feasible under baseline conditions, it is vulnerable to fluctuations in key variables, necessitating robust risk mitigation strategies to maintain financial viability amid economic volatility and changes in electricity tariff policies.

B. Recommendations

Based on the conclusions above, the following recommendations are offered to prevent adverse scenarios and minimize risks:

➢ *Recommendations for PT Brantas Energi*

As the parent company overseeing various renewable energy projects, including the Batanghari PLTM, PT Brantas Energi should develop strategic policies to enhance the competitiveness and financial stability of this project. A key step could involve establishing closer collaborations with regulatory bodies, such as PT PLN (Persero), to secure long-term, stable electricity sales tariff agreements. Furthermore, PT Brantas Energi should consider flexible financing schemes to anticipate potential increases in investment costs or fluctuations in raw material prices. Risk mitigation strategies addressing tariff, production, and investment cost risks should be deeply embedded within the strategic plan, given the significant exposure to these variables. PT Brantas Energi might also allocate adequate cash reserves to maintain project cash flow stability amid uncertainties, thus ensuring liquidity during the payback period.

➢ *Recommendations for PT Brantas Total Energi*

As the Special Purpose Company (SPC) directly managing the Batanghari PLTM project, PT Brantas Total Energi should focus on operational efficiency and rigorous oversight of each project phase, particularly during construction and operation. Effective management of investment costs is essential to prevent budget overruns that could compromise the project's profitability. Additionally, PT Brantas Total Energi is advised to optimize technical performance through regular maintenance and routine supervision of key equipment, such as turbines and generators, to maintain stable electricity production and reduce the risk of revenue declines. To address unforeseen external fluctuations, the company should also develop contingency strategies for tariff or production changes, including financial emergency plans such as refinancing options or revenue diversification. These strategies will help better manage project risks and strengthen long-term investment feasibility.

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