SIMT ITS
Interdisciplinary School of Management and Technology
Institut Teknologi Sepuluh Nopember

JURNAL TEKNOBISNIS
2023 Vol. 9(1), 103-113

Received 28 Dec, 2022; Revised 8 Feb, 2023; Accepted 1 Mar, 2023 | DOI: 10.12962/j24609463.v9i1.939

# Financial Feasibility Analysis of Cilampuyang Hydropower Plant Project (2X15 MW)

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## ABSTRACT

*The Cilampuyang Hydropower Plant (2x15 MW) project is deemed feasible based on the financial analysis conducted. The electricity demand in West Java is projected to reach 20.1 million customers by 2030, with a growth rate of 3.27%. In light of the renewable energy policy, hydropower is considered a viable solution. The project is undertaken by PT Bangun Daya Utama and PT Bukaka Teknik Utama. According to the Renewable Power Generation Costs in 2021 report by IRENA, the construction costs for new hydropower plants from 2010 to 2021 ranged from USD 600/kW to USD 4,500/kW, equivalent to approximately Rp. 8,907,990/kW to Rp. 66,809,925/kW. Hence, the estimated costs for implementing the Cilampuyang Hydropower Plant project (2x15 MW) are substantial. Therefore, a financial analysis is crucial to determine the project's feasibility. This study aims to evaluate the economic viability and identify associated risks through the TPEM and LCOE investment feasibility analysis methods. Monte Carlo simulations were employed to assess project implementation risks. The research findings indicate that the TPEM and LCOE values for the Cilampuyang Hydropower Plant project are superior to the minimum required values. The NPV is Rp. 32,112,681,609,569, the IRR is 275%, and the LCOE is 0.013 USD/kWh. These results indicate that the investment in the Cilampuyang Hydropower Plant is financially viable. Furthermore, project implementation risks were measured using Mean NPV and minimum NPV parameters from 10,000 Monte Carlo simulations, yielding a Mean NPV of Rp. 33,867,831,000,000 and a minimum NPV of Rp. 26,331,417,000,000. In conclusion, the Cilampuyang Hydropower Plant presents a promising alternative for meeting the electricity needs in West Java while adhering to renewable energy policies. From an economic perspective, the investment in the Cilampuyang Hydropower Plant is feasible based on the favorable NPV, IRR, and LCOE values. However, project implementation risks should be considered based on known significant variables.*

**KEYWORDS:** Financial Feasibility Analysis, LCOE, Monte Carlo, TPEM

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## 1. INTRODUCTION

Electricity serves as a fundamental energy source catering to the demands of modern society. As social civilization progresses, there is a growing human inclination towards renewable energy, hydropower, nuclear power, and biomass fuels (Zou et al., 2016). Consequently, there arises a pressing need to exponentially address the provision of adequate electrical supply through the development of utility infrastructures, encompassing power generation plants, electrical transmission networks, and distribution grids.

Power generation plants constitute the facilities responsible for producing electrical energy. This process involves the conversion of various forms of energy, including wind, solar, and water, into electrical energy. Particularly, hydropower plants harness the potential of water resources for electricity generation. These installations are favored due to their distinctive attributes, such as controllable energy output, minimal greenhouse gas emissions, and heightened safety levels relative to conventional fossil fuel-based power plants (Kirmani et al., 2021). Nonetheless, it is important to acknowledge that hydropower plants entail significant capital investments (Okot, 2013). Consequently, meticulous project planning becomes imperative within the context of hydropower initiatives.

Projects are transient endeavors pursued to achieve specific objectives. Generally, projects are divided into two main phases, namely pre-implementation and implementation stages. The pre-implementation phase encompasses a comprehensive assessment of project feasibility, wherein economic viability serves as a critical dimension. The economic aspect of project evaluation pertains to the anticipation of profitability and financial prospects stemming from the undertaken initiative.

Within the scope of ongoing endeavors, the Cilampuyang Hydropower Plant (2x15MW) represents a notable project currently in the pre-implementation stage. This undertaking entails a joint venture between PT Bukaka Teknik Utama and PT Bangun Daya Utama, with the primary objective of facilitating electricity provision for the West Java Province community.

This study endeavors to ascertain the financial feasibility of the Cilampuyang Hydropower Plant (2x15MW) project, while simultaneously conducting a comprehensive analysis of the project's implementation risks from an economic perspective.

## 2. LITERATURE REVIEW

Indonesia is a country with abundant hydropower potential. According to (Nippon Koei Co., 2011), the hydropower potential in Indonesia amounts to 26.321 MW. However, only 4.980 MW or 18% of this potential is currently utilized for electricity generation. The government is actively promoting the utilization of hydropower for electricity generation. This is evident in the inclusion of hydropower plant construction in the General Electricity Supply Plan (RUPTL) of PT Perusahaan Listrik Negara (PLN) for the period of 2021-2030. According to the RUPTL PT PLN 2021-2030 (Perusahaan Listrik Negara, 2021), the government plans to develop hydropower plants with a total capacity of 9.272 MW within the 2021-2030 timeframe.

The implementation of power infrastructure development projects follows various schemes. According to the Ministry of Energy and Mineral Resources (Direktorat Jenderal Ketenagalistrikan, 2016), there are three private sector participation schemes in power plant development: Engineering Procurement and Construction (EPC) Contract, Independent Power Producer (IPP) - Regular/Acceleration, and Independent Power Producer (IPP) cooperation between the government and business entities (KPBU)/Public-Private Partnership. An Independent Power Producer (IPP) is a special company established by sponsors to enter into power purchase agreements with PLN and to develop, build, own, and operate power plants.

The electricity selling tariff by IPPs is regulated based on the type and capacity of the power plants built. According to Presidential Regulation Number 112 of 2022 on the Acceleration of Renewable Energy Development (2022), there are four tariff categories based on hydropower plant classification, namely hydropower plants utilizing water flow, hydropower plants utilizing water from reservoirs/dams or irrigation channels owned by the ministry, expansion hydropower plants, and excess power hydropower plants.

PLTA Cilampuyang is a hydropower project located in the Cimanuk River area, administratively situated in Cipasang Village, Cibugel District, Sumedang Regency, West Java Province. This hydropower plant has a catchment area of 1.206 km2, an average annual rainfall of 2.800 mm/year, a planned flood discharge of 1.314,8 m3/s (100 years), an average annual discharge of 75,2 m3/s, a planned discharge of 52 m3/s, and a head drop of 68 m. The infrastructure to be constructed for this project includes a dam, cofferdam, intake, headrace tunnel, surge tank, penstock, powerhouse, tailrace, and substation.

Financial aspect is one of the considerations in assessing the feasibility of a project from an economic perspective. A project can be deemed financially feasible if it can generate profits according to predetermined targets, such as profit figures and investment duration. To evaluate the economic feasibility of a project, a method is required to analyze the project.

The selection of methods is usually tailored to the analyzed project object. Hydropower plants are categorized as renewable energy power plants. According to (Delapedra-Silva et al., 2022) the analysis methods for renewable energy power plants consist of several types, such as the Traditional Project Evaluation Method (TPEM), Levelized Cost of Electricity (LCOE), Return on Investment (ROI), and Real Option Analysis (ROA).

In any project, there are always risks that can hinder or cause project failure during implementation. One of the main causes is the uncertainty associated with variables used as assumptions in planning. Therefore, it is necessary to take steps to identify the potential risks that may impede or jeopardize the project. Subsequently, the identified risks are analyzed to determine.

## 3. METHODS

This research data consists of primary and secondary data. The primary data consists of information obtained directly by the author from PT Bangun Daya Utama, which includes the background of the Cilampuyang 2x15 MW hydropower project, the project implementation mechanism, and the financial targets of the project. On the other hand, secondary data refers to supporting data obtained from company reports that contain information on power generation in Indonesia, the potential and electricity demand in Indonesia, technical aspects of the Cilampuyang hydropower project, inflation, exchange rates, and taxes.

The investment criteria used in this study are the Traditional Project Evaluation Method (TPEM) and the Levelized Cost of Electricity (LCOE). TPEM is a method that employs two calculation techniques, namely Net Present Value (NPV) and Internal Rate of Return (IRR). The minimum NPV value is set at Rp239.055.200.000, while the Minimum Acceptable Rate of Return (MARR) is 8%. Therefore, the hydropower project is considered feasible if the NPV value is equal to or greater than Rp239.055.200.000, and the IRR is considered feasible if the NPV value is equal to or greater than 8%.

LCOE is the ratio of the generation cost incurred to the amount of energy produced. The resulting ratio is compared with the expected selling price of electricity. If the ratio of the generation cost to the amount of energy produced (LCOE) is lower than the expected selling price of the hydropower plant's electricity, the investment is deemed feasible (LCOE < Expected Selling Price of Electricity = Feasible). However, if the ratio of the generation cost to the amount of energy produced (LCOE) is higher than the expected selling price of the hydropower plant's electricity, the investment is considered not feasible (LCOE > Expected Selling Price of Electricity = Not Feasible).

Risk analysis is conducted using Monte Carlo simulation. The Monte Carlo simulation is applied to revenue, fixed costs, and variable cost parameters. The number of iterations applied in the Monte Carlo simulation is 500 iterations with three scenarios, namely the most likely scenario, optimistic scenario, and pessimistic scenario. The analysis of these scenarios is based on historical data of electricity consumption in West Java Province.

## 4. RESULTS

### Define Assumption

#### Assumption of Economic Factor

The assumption of economic factors is a parameter derived from historical data and secondary data from several references. This assumption comprises inflation, exchange rates, loan interest rates, and corporate taxes. The detailed data can be seen in Table 1.

**TABLE 1.** Inflation, Loan Interest, and Corporate Taxes

| Component | Value |
|---|---|
| Inflation | 4,7% |
| Loan Interest | 4,86% |
| Corporate Taxes | 25% |
| Inflation | 4,7% |

## Assumption of Investment

The investment assumptions consist of engineering, procurement, and construction (EPC) costs, development costs, and funding sources. EPC costs refer to expenses incurred for preparation, civil works, and the purchase of mechanical and electrical equipment for the project. Development costs are fundamental expenses incurred in addition to EPC costs to facilitate project operational activities. These costs include contingency costs, licenses, environmental fees, and bank fees. The detailed data can be seen in Tables 2 and 3.

**TABLE 2.** EPC Costs and Development Costs

| Component | Value (Rp. 000.000) |
|---|---|
| EPC Costs | |
| Preparation | 119.832 |
| Civil Work | 502.071 |
| Hydrolic Structure / Metal WorkEquipment | 50.986 |
| Mechanical and ElectricalEquipment | 120.137 |
| Total | 793.021 |
| Development Cost | |
| Contigency | 2.137 |
| License & Permit | 1.527 |
| Environmental | 2.137 |
| Bank Fee | 1.069 |
| Land Acquisition | 31.904 |
| Total | 38.773 |

**TABLE 3.** Funding Sources

| Component | Value | Value (Rp. 000.000) |
|---|---|---|
| Bank Loan | 80% | 742.157,09 |
| Self Finance | 20% | 185.750,31 |
| Total | 100% | 928.731,73 |

## Assumption of Operational

The operational assumptions consist of production capacity, revenue, fixed costs, variable costs, depreciation and amortization, and debt payments. The Cilampuyang Hydroelectric Power Plant (PLTA) has a yearly net power generation capacity of 172.368 MWh, with an operational time of 8.760 hours. Cilampuyang PLTA falls under the classification of a hydroelectric power plant that utilizes energy from water flow/fall, resultingin an electricity purchase price of 8,86 USD/kWh for years 1 to 10 and 5,54 USD/kWh for years 11 to 30.

Fixed costs are expenses that do not change in amount regardless of increases or decreases in electricity production. Variable costs are expenses that vary in amount based on changes in electricity production. Depreciation and amortization are performed using the straight-line method, where depreciation is applied to the EPC cost component, and amortization is applied to the development cost component. The debt is obtained from a bank loan amounting to Rp742.157.093.761. The debt repayment is spread over 25 years with agrace period of 4 years. Payments are made quarterly with equal payment amounts.

### Assumption of Financial Statement

The financial assumptions include the profit and loss projection and the cash flow projection. Based on the profit and loss projection, it is determined that the operational activities of the Cilampuyang Hydroelectric Power Plant (PLTA) generate net profit for the company each year. The net profit is obtained starting from the first year of operation in 2029 until 2058. The value of net profit increases each year, starting from Rp1.809.562.274.861 in 2029 to Rp2.658.092.320.132 in 2058.

Upon completion of the cash flow projection, it is determined that the cash flow generated from the operational activities of the Cilampuyang PLTA is positive and increases each year.

## Analysis of Project Financial

### Traditional Project Evaluation Method (TPEM)

The Traditional Project Evaluation Method (TPEM) consists of calculating the Net Present Value (NPV) and Internal Rate of Return (IRR). Based on the calculations, the NPV value obtained during the operational period from 2029 to 2058 is positive, amounting to Rp32.112.681.609.569. Therefore, referring to the minimum NPV value set by the company, which is Rp239.055.200.000, investing in the Cilampuyang Hydroelectric Power Plant (PLTA)project is considered feasible.

Furthermore, the calculated IRR value is 275%, which is greater than the minimum IRRvalue set by the company, which is 8%.

### Levelized Cost of Electricity (LCOE)

After conducting the calculations, the Levelized Cost of Electricity (LCOE) for the Cilampuyang Hydroelectric Power Plant (PLTA) is determined to be 0,013 USD/kWh. This calculation is derived by accumulating the operational costs incurred during the operational period, which amount to Rp1.042.789.782.364, and dividing it by the total net power generated,which is 5.242.860.000 kWh. The result is Rp198,90/kWh, or equivalent to 0,013 USD/kWh at an exchange rate of 1 USD equals Rp14.941.

The ratio between the incurred generation costs and the amount of energy generated (LCOE) is lower than the selling price of electricity (0,013 USD/kWh < 0,089

USD/kWh & 0,0554 USD/kWh). Therefore, investing in the Cilampuyang PLTA project is considered feasible.

**Analysis of Project Risk**

There are three scenarios in identifying the risks of the Cilampuyang Hydroelectric Power Plant (PLTA) project, namely the most likely scenario, optimistic scenario, and pessimistic scenario. The creation of these scenarios is based on historical data of electricity consumption in West Java Province from 2011 to 2021, which can be seen in Table 4. Referringto the data, statistics regarding the growth of electricity consumption can be determined, including the mean, standard deviation, minimum value, and maximum value of the electricityconsumption growth rate in West Java Province, as shown in Table 5.

**TABLE 4.** Electricity Consumption in West Java Province

| Year | Electricity Consumption (GWh) |
|---|---|
| 2011 | 34.053,60 |
| 2012 | 36.655,28 |
| 2013 | 39.092,56 |
| 2014 | 43.096,46 |
| 2015 | 44.071,43 |
| 2016 | 45.045,40 |
| 2017 | 50.791,20 |
| 2018 | 52.878,86 |
| 2019 | 54.480,28 |
| 2020 | 49.542,25 |
| 2021 | 53.318,02 |

**TABLE 5.** Statistics of Electricity Consumption Growth in West Java Province

| P | Value |
|---|---|
| Mean | 4,23% |
| Deviation Standard | 5,85% |
| Minimum Value | -9,97% |
| Maximum Value | 11,31% |

### Most Likely Scenario

The most likely scenario is created based on the mean growth rate of electricity consumption in West Java Province, which is 4,23% with a standard deviation of 5,85%. Otherparameters included as inputs are exchange rate, electricity selling price, power capacity, income, fixed costs, and variable costs.

After performing 500 iterations, NPV data was obtained with a total of 500 data points.The average NPV value is Rp1.975.491.002.608, and the probability of NPV being less than Rp239.055.200.000 is 0%. The histogram of NPV can be seen in Figure 1.

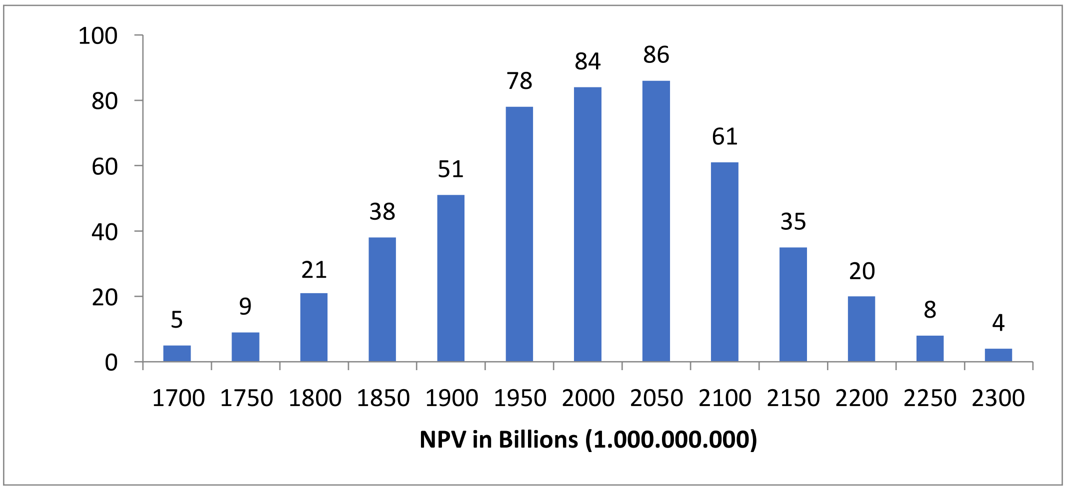


**FIGURE 1.** NPV Histogram of Most Likely Scenario

## Optimistic Scenario

The optimistic scenario is created based on the maximum growth rate of electricity consumption in West Java Province, which is 11,31% with a standard deviation of 5,85%. Other parameters included as inputs are exchange rate, electricity selling price, power capacity,income, fixed costs, and variable costs.

After performing 500 iterations, NPV data was obtained with a total of 500 data points.The average NPV value is Rp2.111.242.191.004, and the probability of NPV being less than Rp239.055.200.000 is 0%. The histogram of NPV can be seen in Figure 2.

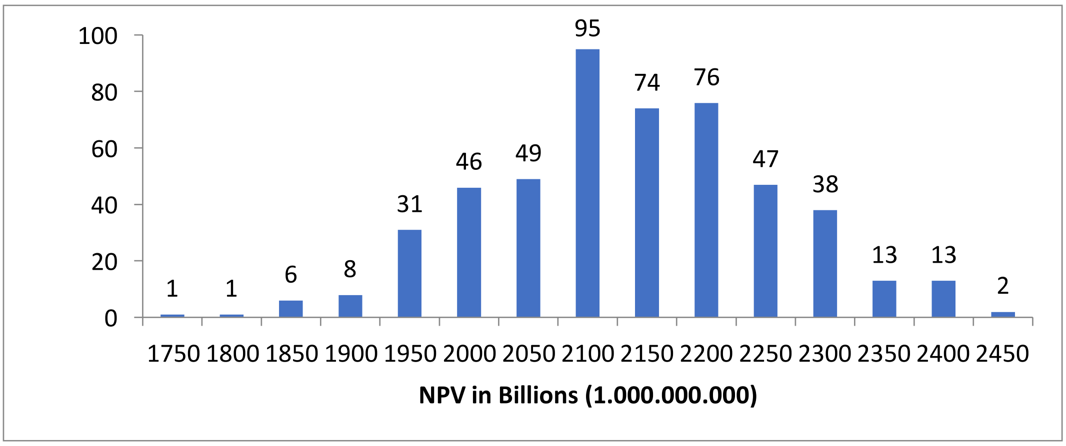


**FIGURE 2.** NPV Histogram of Optimistic Scenario

## Pessimistic Scenario

The pessimistic scenario is created based on the minimum growth rate of electricity consumption in West Java Province, which is -9,97% with a standard deviation of 5,85%. Otherparameters included as inputs are exchange rate, electricity selling price, power capacity, income, fixed costs, and variable costs.

After performing iterations, NPV data was obtained with a total of 500 data points. Theaverage NPV value is Rp1.708.700.519.930, and the probability of NPV being less than Rp239.055.200.000 is 0%. The histogram of NPV can be seen in Figure 3.

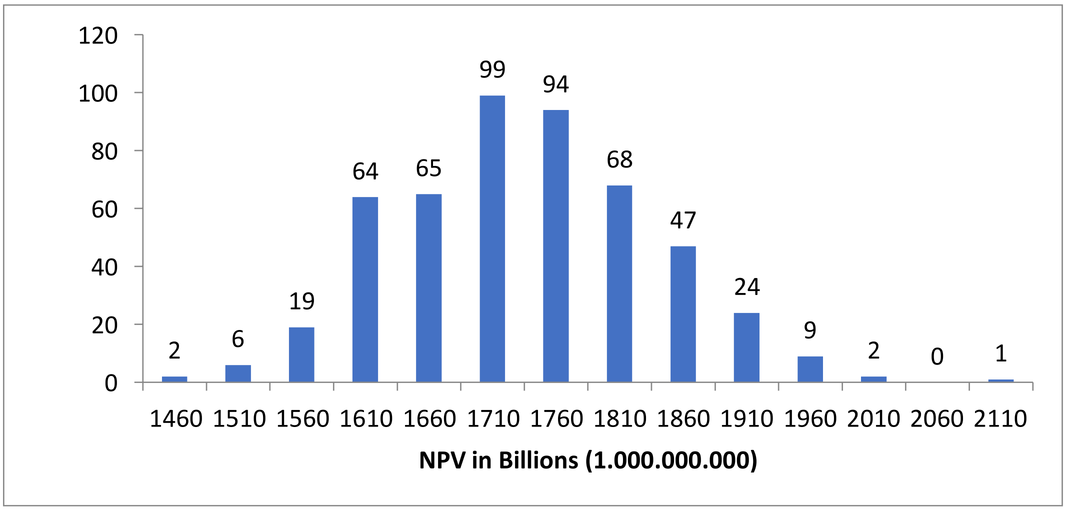


**FIGURE 3.** NPV Histogram of Pessimistic Scenario

## 5. CONCLUSIONS

Based on the financial aspect study of the feasibility analysis of the Cilampuyang Hydroelectric Power Plant (2x15 MW) investment project, the following conclusions can be drawn: a) The NPV value obtained is Rp32.112.681.609.569, which is greater than the minimum NPV value of Rp239.055.200.000. Additionally, the IRR value obtained is 275%, which is greater than the minimum NPV value of 8%. Furthermore, the LCOE value is 0.013 USD/kWh, which is lower than the reference values of 0.089 USD/kWh and 0.0554 USD/kWh. Therefore, based on the NPV, IRR, and LCOE parameters, the investment project of the Cilampuyang Hydroelectric Power Plant (2x15 MW) is financially viable. b) Based on the Monte Carlo simulation results of the three risk projection scenarios, namely the most likely scenario, optimistic scenario, and pessimistic scenario, with 500 iterations each, the data show that the smallest average NPV value is obtained from the pessimistic scenario, which is Rp1.708.700.519.930. Additionally, the probability of NPV being less than Rp239.055.200.000 is 0% for all these scenarios. Therefore, the risk projection for the Cilampuyang Hydroelectric Power Plant project is considered low.

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**How to cite this article:**

Saputra, M. R., & Syairuddin, B. (2023). Financial Feasibility Analysis of Cilampuyang Hydropower Plant Project (2X15 MW). *Jurnal Teknobisnis, 9*(1): 103-113. DOI: 10.12962/j24609463.v9i1.939