Economic analysis of planning for utilization of tabang hydro power plant

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Abstract. From the technical side, analyzing the hydropower design planning that matches the conditions of the Belayan River. From the economic side, analyzing the feasibility of hydropower projects through investment costs along with cash flow to the economic life of the project, using several methods, namely Net Present Value (NPV), Payback Period (PBP), Benefit Even Point (BEP), Benefit-Cost Ratio (B-CR), and Internal Rate of Return (IRR). The results of technical analysis with reliable discharge Q (10%) produce an output power of 439,4 MW with 4 generators, the power is then transmitted to the Melak Main Station with a distance of ± 100 km. Investment costs incurred in the planning of the construction of the Tabang hydro power plant (PLTA) in East Kalimantan is 3.673.356.951.235. The net present value (NPV) obtained is Rp.3.911.323.016.835 with a return on investment of 7.77 years and a break-even point for expenses and income in the 11,36 year. The ratio of project cost and benefit ratio is 1,32 and IRR (Internal Rate of Return) calculation is 19.53%. These results indicate that the plan to build a Tabang hydropower unit in East Kalimantan is economically feasible.

1. Introduction

Many alternative energy can reduce the greenhouse effect or global warming. One of alternative energy which has the potential in Indonesia is hydropower. Based on the results of the research that has been done before, Indonesia will be efficient when implementing alternative energy for hydropower [1]. One of them is in the province of East Kalimantan which has the potential of water energy because it is supported by the many river channels with a fairly large discharge. According to data that published by the government's RUEN (National Energy General Plan) stated that East Kalimantan, South Kalimantan and Central Kalimantan have a water energy potential around 16,844 MW. However, a number of that size is also a question, could this potential be realized as a hydropower plant in Kalimantan rivers. Considering that to utilize the potential of hydropower, in general it requires a large investment cost. Even though the operation cost of hydropower is relatively very low [2], the factor of the high investment cost and the length of development causes the relatively low utilization of hydropower in Indonesia.

Specifically in this study an analysis of the planning and utilization of water in East Kalimantan as a hydropower will be carried out by analyzing the economic feasibility of the potential of the poweplant.

2. Methods

2.1. Feasibility study methode

Techno-economic principle contains the way how to make a decision where the decision is limited by several problems related to a technician so as to produce the best choice from a variety of alternative choices that have been determined [3]. Decisions are made based on a process of technical analysis and economic calculation. Engineering is often said to be knowledge of mathematics and natural sciences obtained by study, experience, and practice [4]. The science is used wisely in developing ways as economical use of materials and natural resources for the benefit of humans. Alternatives arise because of limited resources. With these various alternatives, a calculation is needed to get the best choice economically, both when comparing various alternative designs, making capital investment decisions, evaluating financial opportunities, etc [5]. .

Techno-economic analysis involves decision makers about a limited range of resource uses [6]. The consequences for the results of decisions usually have a far-reaching effect in the future where the consequences cannot be known with certainty and are decision-making under uncertainty. Therefore, it is important to predict future conditions, technological developments, and synergies among funded projects [7].

The estimation of construction costs or estimated volume of work can be calculated using the estimated volume formula of each building which, in this case, is a reservoir for water to be used as a hydropower plant[8]. Unit prices used to compare the construction costs of each alternative are estimated based on several preliminary studies conducted by the consultants. Some parameters used to measure the feasibility of a business or project in this study are Net Present Value (NPV), Period Pay Back (PBP), Break Event Point (BEP), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR) [9].

2.2. Research site

East Kalimantan Province with a land area of 198,441.17 km^2 and sea management area of 10,216.57 km^2 is located between 113°44' East Longitude and 119°00' West Longitude and between 4°24' North Latitude and 2°25' South Latitude. With the development and expansion of the region, the second largest province after Papua, was divided into 10 (ten) districts, 4 (four) Cities, 136 sub-districts and 1,445 villages. The ten districts are Pasir with the capital of Tanah Grogot, West Kutai with the capital of Sendawar, Kutai Kartanegara with the capital of Tenggarong, East Kutai with the capital of Sangatta, Berau with the capital of Tanjung Redeb, Malinau with the capital of Malinau, Bulungan with the capital of Tanjung Selor, Nunukan with the capital of Nunukan, Penajam Paser Utara with the capital of Penajam and Tana Tidung with the capital of Tideng Pale. Meanwhile, the four cities include Balikpapan, Samarinda, Tarakan, and Bontang. Basic data from the potential of Tabang to be used as hydropower can be obtained through preliminary studies, surveys, and data analysis. The survey is divided into several aspects including the implementation, aspects of hydrological conditions, rainfall, water availability, and regional geology. Figure 1 is the Location of Tabang Hydro Power from Tenggarong City.

Figure 1. Location of tabang hydro power from tenggarong city

2.3. Research variable

The research variables are obtained from the techno-economic analysis to determine the advantages and feasibility of the construction of hydroelectric power plants. Calculation of Economic analysis consists of the followings:

- Capital Investment;
- Manufacturing Cost;
  a. Construction Cost or Direct Cost.
  b. Indirect Cost
  c. Operation and Maintenance Cost.
- General Cost; and
- Economic Feasible Analysis.
  a. Net Present Value (NPV).
  b. Pay Back Period (PBP).
  c. Break Event Point (BEP).
  d. Benefit Cost Ratio (BCR).
  e. Internal Rate of Return (IRR).

This study uses primary data and secondary data. Primary data is data that is directly obtained from the results of measurements and observations on the location of research, while secondary data comes from the literature study in the form of data that supports the analysis related to research. Data analysis techniques use the techno-economic concept which is a decision making from economic calculations with a variety of limitations of problems related to the technicians [10]. Limitation of the problem comes from the results of detailed field observations by determining the best engineering design and in accordance with the conditions at the Tabang Hydroelectric Power Plant location. Economic calculation with quantitative method will be compared with Indonesian government standards so that the benefits can be obtained. It will als determine whether or not a Tabang hydropower plant is feasible by considering economic feasibility variables such as construction costs obtained based on technical design adjustments with goods and services procurement companies that work with PLN (Perusahaan Listrik Negara), energy costs and economic costs [11].

3. Results and discussion

Analysis of electricity potential of generating electricity, the main cost of hydropower development, revenue of electricity sales, and economic analysis of the Tabang hydropower project have been conducted and the results are as follows.

3.1. Potential of generating electricity

Hydropower generation capacity basically depends on the availability of primary energy. The availability of primary energy includes water discharge and height of water fall at the potential locations.

The greater the discharge and the higher the fall of water, the greater the potential energy and the power produced. the data obtained to calculate the generation capacity is as follows [12].

Discharge (10%)	: 670,24 m^3/s
Head	:76,5 m
Efficiency generator	: 0,97
Efficiency turbine	: 0,9
Earth gravity	: 9,8 m/s^2

From the data above, obtained the PLTA generation capacity in Tabang, East Kalimantan using dischage (10%) is 439,369 kW or 439,4 MW. The result of this generation is used as a design of the electricity generating equipment.

3.2. The main cost of tabang hydropower project

The main costs for hydropower development activities consist of 3 (three) parts, namely direct costs, indirect costs, and operating and maintenance costs. Direct costs include civil works, electro-mechanical hydro work, transmission work (electricity distribution), as well as tests and commissioning throughout the project. Indirect costs include land acquisition, the costs of planning and supervising consultant services, licensing fees and other costs. And then, operational and maintenance costs include maintenance costs for the power plant and also the cost of labor that operates and maintains the power station. Recapitulation of the cost components of the construction of Hydropower in Tabang, East Kalimantan as follows.

Table 1. Estimated investment cost tabang hydropower plant

Num.	Items	Amount (Rupiah)
A	Direct Cost	3.071.023.337.487
1	Civil Works	1.879.132.595.000
2	Electrical and Mechanical Works	1.069.390.742.487
3	Transmission Line	122.500.000.000
B	In-direct Cost	602.333.613.748
1	Preparation Works	1.000.000.000
2	Certificate of Deposit	151.271.806.874
3	Planning Consultant	75.635.903.437
4	Supervising Consultant	75.635.903.437
5	Development permit	2.000.000.000
6	Land Acquisition	296.790.000.000
C	Total Cost	3.673.356.951.235

From Table 1, it can be noted that to build a Tabang hydropower plant that has an output power of 439,4 MW, a total investment of Rp. 3.673.356.951.235 is spent. these costs are incurred gradually, according to the hydropower development process.

Table 2. Estimated annual expenditures of hydropower in tabang

Num.	Items	Amount (Rupiah)
1	Maintenance Cost	92.130.700.125,00
2	Onsite Staff	26.226.886.000,00
3	Water Retribution Tax	651.824.438.128,00
	Total Cost	877.182.024.253,00

From Table 2, it was found that the hydropower in generating electricity requires an annual expenditure of Rp. 877.182.024.253,00. These costs is used by selling the electricity of hydropower.

3.3. Electricity sales revenue

Project revenue is derived from the results of sold energy, based on electricity production costs with monthly average discharge output, given the fluctuations in rainfall that affect water discharge. So that the basic assumptions for economic calculations are near real, they are taken from the average flow of water throughout the year based on measurements of water discharge.

Table 3. Hydropower monthly water discharge in tabang, east kalimantan per year

Num.	Month	Water Discharge (m^3/s)
1	January	484,5689
2	February	458,8726
3	March	434,6289
4	April	468,7758
5	May	460,6553
6	Jun	379,7026
7	July	320,1768
8	August	295,4611
9	September	274,9195
10	October	296,6911
11	November	440,9874
12	December	486,2768
Average water discharge		400,143

Table 3. shows the average water discharge from monthly discharge measurements from 1998 to 2008 was 400,143 m^3/s. Thus, the total gross power (kW) is 262.327,46 kW or 262,32 MW.

Considering the transmission losses of electricity production (kW) of 2.7866% of the total electricity production and overhaul for 10 calendar days, so the total energy output (TEO) is 2.172.748.127,09 kWh/year. Thus, the annual revenue for generating electricity from Tabang hydropower plant is Rp2.783.181.713.401, include BPP (Basic Cost of Supply) of electric power is 85% from BPP East Kalimantan of Rp1507,00.

3.4. Economic analysis of the tabang hydropower development project

From the overall data that has been presented, the next step is to analyze the economic development of the Tabang hydropower project. The results of this analysis are presented in the following details.

Table 4. Project feasibility PLTA in Tabang

Num.	Parameter	Result	Project Feasibility Criteria
1	Net Present Value	Rp.3.911.323.016.835	NPV > 0
2	Pay Back Periode	7,77 year	PBP < economic life of project
3	Break Even Point	11,36 year	BEP < economic life of project
4	Benefit Cost Ratio	1,32	BCR > 0
5	Internal Rate of Return	19,53%	IRR > 0

Table 4, shows the results of processing hydropower project feasibility data to review each investment feasibility parameter. On the results of calculating the NPV at an interest rate of 12% obtained Rp3,641,932,277,819.00, based on the project feasibility criteria requiring NPV> 0, indicating this project is profitable. The time for capital payment is not more than the life of the economic project for 7.77 years. Obtained from the BEP calculation, the BEP value of 11.36 last year the project could break even before the project's economic life ended. The ratio between profits and costs incurred by the BCR is a positive number that is 1.32. Similarly, the IRR value obtained from the calculation is equal to 19.53%. Based on the project feasibilty of the power plant project in the Belayan River, can be said to be feasible.

4. Conclusion

From the research that has been done, it can be concluded that the construction of hydropower in Tabang, Kutai Kertanegara Regency is feasible because because of its very strategic geographical position and very large reservoir capacity. In addition, the economic calculation uses the investment feasibility method by calculating the value of NPV, BCR, PBP, BEP, and IRR is feasible. As a result, it could produce energy up to 400 MW. From the results of the economic analysis calculation shows that the profit is Rp.2.783.181.713.401 per year.

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