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Economic and Financial Feasibility Analysis: Small Hydroelectric Power Plant at the São Bento River Dam

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***Abstract*—** *Small Hydroelectric Power Plants (SHP) are hydroelectric plants that are part of the Brazilian energy matrix and have a low environmental impact. The present work aims to analyze the economic and financial feasibility for the implementation of a Small Hydroelectric Power Plant, in the São Bento River dam, located in the municipality of Siderópolis, state of Santa Catarina. As a methodology, the research is classified as exploratory and uses a case study. As for data analysis, a quantitative approach was adopted, since it is a feasibility study of a project, which involves analysis of data referring to costs, operating profit and expenses. Investments, income and expenses were analyzed, and this made it possible to prepare income statements, cash flows and economic indicators, as a way of analyzing the feasibility of the enterprise. The results were positive, indicating the feasibility of the project, through the analysis of minimum attractiveness rate, net present value and payback.*

I. INTRODUCTION

The National Water Agency (ANA) estimates that 97.5% of the water in the world is salty. Therefore, it is not suitable for human and animal consumption. Only 2.5% is fit for consumption, 69% of this water is in places of difficult access (glaciers), and 30% is in aquifers, leaving only 1% of this water in rivers. Therefore, its use must be thought of responsibly. The FAO - Food and Agriculture Organization of the United Nations - (2011) rainforces that water is a resource that is the basis for maintaining food security, and its efficient management can reduce and alleviate local economic misfortunes, providing a means for individuals to are economic agents participating in the local economy. It is possible to install Small Hydroelectric Power Plants (SHPs) to take advantage of this resource provided by the rivers. This hydroelectric plant is mainly used in small and medium-sized rivers with significant differences in level during their course, generating enough hydraulic power to drive the SHP turbines (BRASIL, 2018).

SHPs, compared to hydroelectric plants, are relatively more minor in size and power, as classified by the National Electric Energy Agency (ANEEL), accounting for about 3.5% of the entire installed capacity of the interconnected national system (SANTA CATARINA, 2021).

According to ANEEL, ventures such as SHPs foster the Brazilian market, as the technology used is national and does not require large transmission lines used in conventional hydroelectric plants. Considering the increase in energy demand in the country, and the increase in debates for the preservation of natural resources and the fight against climate change caused by the greenhouse effect, consequently caused by the burning of fossil fuels,

it is clear that SHPs have the potential to reduce negative impacts related to electricity generation. The power generation stems from a flooded area and water flow (AGÊNCIA NACIONAL DE ENERGIA ELETRICA, 2016).

The São Bento River Dam location is in Siderópolis, south of the Santa Catarina state. Its primary function is to capture water for supply and irrigation in the region. Its unused surplus follows its course. With the repressed water, the hydraulic force could use this surplus to generate electric energy, and the dam could generate energy (WARMLING, 2012).

The feasibility of building a SHP is in line with Agenda 2030, as a Small Hydroelectric Power Plant reduces environmental impacts, producing clean and renewable energy with little aggression to the environment (NAÇÕES UNIDAS BRASIL, 2020). The southern region of Santa Catarina has electricity distribution cooperatives operating in the area, which, following ANEEL's normative resolution nº 414 of 2010, allows the production and purchase of energy from small suppliers (AGÊNCIA NACIONAL DE ENERGIA ELECTRIC, 2016).

Through the Ministry of Mines and Energy, the state of Santa Catarina seeks alternatives with the Federal Government to allocate resources to construct new SHPs with a low environmental impact and a lower cost of energy production (FOLTRAN, 2019). This study analyzes the economic and financial viability of implementing a Small Hydroelectric Power Plant in the São Bento River Dam, located in Siderópolis, Santa Catarina, Brazil.

The present work justification is the lack of studies directly linked to economic feasibility studies for SHPs since their use does not fail to generate an approximate average of 24 Megawatts (MW). Also, given the growing energy demand in the country and consequently the need for new studies for the generation and supply of electricity, thus requiring new scientific means of studies to meet the conditions of new energy sources, less aggressive to the environment.

The present work consists of this first introductory part, followed by a literature review, methodological procedures, results, and final considerations.

II. LITERATURE REVIEW

The present work reviewed, the São Bento river dam, the study's scope, and the fundamentalist theory that structures the theoretical-methodological basis of the present work.

2.1 THE SÃO BENTO RIVER DAM

The idea of building a dam for the São Bento River emerged in the 1980s. Two years later, technical and environmental impact studies began to analyze the feasibility of building the dam (WARMLING, 2012), which would have the main water supply to the municipalities close to the dam. Another function would be irrigation for agriculture (MING, 2007; WARMLING, 2012). The studies pointed to the feasibility of construction. However, environmental and social issues delayed the structure because of the need to flood an area of approximately 450 hectares and evacuate the São Pedros community (MING, 2007; WARMLING, 2012). The dam's construction began in 1999 and finished in 2001. However, only in 2005, the operating license issued for the dam began to exercise its functions (WARMLING, 2012).

The primary function of the São Bento river dam is to supply water to the region. However, it has two other functions: One of them is to control the flow of the São Bento and Serrinha rivers, thus retaining a large part of the flow of the floods that occur, reducing the possibility of economic losses, such as the floods that come from the slope of the Serra Geral, brought by the two rivers. Another critical function is irrigation in cultivating rice grown in the dam's vicinity, which demands large amounts of water. Before the dam's construction, farmers suffered from water shortages, drastically affecting rice cultivation. The dam's construction brought several benefits and strengthened the crops with the abundant water from the reservoir (Ming, 2007).

2.2 FUNDAMENTALIST THEORY

To implement the SHP, in addition to the legal aspects to be observed, an Economic-Financial analysis is necessary to identify its feasibility. The reference theory in this work is Fundamental Analysis. This theory emerged with Benjamin Graham, considered the father of fundamental analysis. The economist proposed in 1934 that the basis of fundamental analysis is a set of instruments that assess the macro and micro scenario in which the company is inserted, thus enabling better decision-making (REIS, 2019).

Among the mechanisms to carry out the analysis, the Balance Sheet is the first item to be analyzed. According to Frezatti (2011), the balance sheet is an accounting report that shows the equity and financial position in a given period (GOMES, 2013).

Next, the analysis instrument is the Cash Flow Statement (DFC), which plays a vital role in a company's financial planning, and comprises the outflows and inflows of all financial resources in a time interval.

Cash flow is fundamental in decision-making, avoiding liquidity and insolvency problems, and helping manage financial resources (FRIEDRICH, 2005; FREZATTI, 2011).

An income Statement for the Year (DRE) is an income statement that has the objective of "recording whether a company has made a profit or a loss" (BARKER, 2008, p.28). if the difference between income and expenses. If income exceeds expenses, it shows profit in the analyzed period. The loss happens if expenses exceed income (BARKER, 2008).

The net present value (NPV) is another mechanism used. A financial formula determines the current value of future payments at a specified interest rate minus the value of the initial investment cost (GOMES, 2013). The analyzed project can continue if the NPV result is more significant than zero; if it is below zero, the project cannot proceed, as it will cause damage (CAMLOFFSKI, 2014). Through equation 1, it is possible to observe the graphic representation and the formula to arrive at the NPV.

$$VPL = \sum_{t=1}^{n} \frac{FC_t}{(1+i)^t}$$

Source: Gomes (2013).

Where:

VPL= net present value,

FC= cash flow,

i= interest rate.

The IRR device is the internal rate of return. This rate indicates whether the projected investment will generate profitability with the defined cash budget (CAMLOFFSKI, 2014). Understanding the IRR means that when evaluating the investment project, the indicator will facilitate the decision-making of the project in its feasibility, and the IRR transforms the NPV of the cash flow into an amount equal to zero and a rate that equals zero outflows and inflows of investment (SILVA, 2018).

The payback means how long the projected investment will return because the lower the payback value, the greater the project's liquidity. Therefore, the lower risk in the projected investment and the discounted payback is a calculation that comes to correct the payback calculation, where the discounted payback considers the money value of the asset at the correct time (CAMLOFFSKI, 2014; SILVA, 2018).

Working capital is a part of the investment that makes up a reserve of resources to meet the company's financial needs over time. These resources stay in inventories, accounts receivable, cashiers, and banks. This set of values is necessary for the company to make its business happen. (GITMAN, 2004).

Working capital needs to meet short-term expenses, including operating expenses, suppliers, salaries, social charges, and taxes. Working capital arises when expenditure flows are faster than the inflow of revenues. That is, the company generally lengthens the time in receipt and shortens the time with suppliers. The need for working capital can often vary, as a reduction in the average terms of suppliers, the greater the need for working capital. Another measure the company adopts to influence the increase in working capital need is when it carries out a policy of increasing sales. Consequently, to reach the established goal, it understands the average payment terms, thus making it look for more capital from rotation (ASSAF NETO, 1997).

III. METHODOLOGICAL PROCEDURES

The research method used was a case study classified as exploratory research (GIL, 2008).

The data analysis method used in this research adopted the quantitative analysis model since it is a project's feasibility study involving data analysis referring to costs, operating profit, and expenses. Quantitative analysis is an evaluation through numbers and information, predominates in statistical and reliable data, to ensure accuracy in the results and seek errors in analysis and interpretation (MARQUES, 2019).

The projection of the DFC and the DRE will correspond to the 20 years of operation of the enterprise. The DFC helps to better control financial flows by preventing possible shortages of financial resources. Moreover, the DRE allows observing the company's process in the accounting system and identifying the profit generated.

NPV, IRR, and Payback indices calculations are the aim of this article. After analyzing the data obtained by the calculations, the author will judge whether there is economic feasibility for constructing a small hydroelectric power plant on the São Bento River dam.

The 38-meter height of the São Bento River Dam defines the estimated power of the SHP. The calculation to determine the hydraulic power will be PH= h x q x g, where PH and hydraulic power to be defined, h will be the hydraulic difference, that is, the height of the dam at 38 meters, q, and the flow, estimated at 75 m/s^3, and q which will be the acceleration due to gravity of 9.81 m/s^3. The result obtained by this calculation is subtracted

from the value of 15%, which means the estimated losses, arriving then at the generating power of the SHP.

IV. SHP ECONOMIC-FINANCIAL ANALYSIS

4.1 INVESTMENT ANALYSIS

To carry out an economic-financial analysis of a Small Hydroelectric Power Plant is necessary to know some critical factors within its operating structure: the installed potential for electricity generation, the energy price, and the financed capital.

For the operation of the SHP, the study estimated an electric power generating power of 24 MW per hour of production, but 60% of the installed capacity corresponds to the physical guarantee, which will be 14.4 MW per hour.

The new energy auction will determine the price of commercialized energy. The calculations used the initial value of R$ 204.32 per MW/hour produced, referring to the average costs of the new energy auction held in 2020.

The calculations stipulated two years as the average construction of the SHP, its useful economic life, and the period of economic-financial analysis considered for 20 years, as observed in table 1.

Table 1 - Summary of attributes used for analysis

Installed Capacity (MW/h)	24
Physical warranty 60% (MW/h)	14.4
Estimated revenue (R$ MW/h)	R$ 204.32
Average annual increase (annual)	3.78%
Construction time (years)	2
Operating time (years)	20
Estimated investment	R$ 119,182,813.45
Equity 30%	R$ 35,754,844.04
BNDES Financing 70%	R$ 83,427,969.42
Financing term (months)	240
Annual financing fee	7.79%
The minimum rate of attractiveness	11%

Source: Composed by the authors.

The financed capital of the project will correspond to 70% of the total cost of construction, which will be direct via BNDES, with a term of 240 months for amortization and a rate of 7.79% p.a., considering the financing operation directly via BNDES. The remaining 30% capital to total the entire enterprise cost becomes own resources, that is, equity of the company that owns the SHP.

For this project, the Minimum Rate of Attractiveness (TMA) is at least 11% to justify the investment risk. To explain this value, we consider the opportunity cost, indexed by the Selic rate of May 2021, which was around 3.5%. Another element is the liquidity premium, which we also use as a reference, the Selic rate of 3.5%. To complement this, we have the business risk that we can account for at around 5%. To arrive at the TMA value, we added the values of these three indicators, which gives us a TMA value of 11%.

4.1.2 Investments

The initial working capital is essential, as the average period for receiving revenues is longer than the period for paying fixed expenses. Therefore, regardless of the completion of the project, with machinery and equipment assembled, transmission lines already in operation, and all the necessary employees already hired, even so, the initial working capital is essential for the company to be able to pay its obligations since it does not have enough cash on hand.

The SHPs do not have stocks of finished products because they do not have a way to store energy or maintain supplies of raw materials. Considering that dammed water is not purchased, it is a natural resource available in nature. The details of the costs of the infrastructure work are in table 2.

Table 2 – Fixed Asset Investments

Item Description	Values
Assets	R$ 37,701,006.00
Services	R$ 67,305,266.00
Others	R$ 13,695,367.00
Working capital	R$ 481,174.45
Total	**R$ 119,182,813.45**

Source: Composed by the authors based on Brazil (2018).

4.1.3 Financing

As a project proposal, BNDES will finance part of the project. The development bank accepts to fund 70% of the project from the FINEM program, with interest rates of 4.61% per year, basic remuneration from BNDES (1.5% p.a.), Credit Risk rate (1.68% p.a.), totaling a rate of 7.79% p.a.

Table 3 - BNDES Financing

Year	Amortization	Fees	Installment
1	R$ 4,171,398.47	R$ 6,134,057.19	R$ 10,305,455.66
2	R$ 4,171,398.47	R$ 5,820,160.87	R$ 9,991,559.35
3	R$ 4,171,398.47	R$ 5,506,264.56	R$ 9,677,663.03
4	R$ 4,171,398.47	R$ 5,192,368.24	R$ 9,363,766.71
5	R$ 4,171,398.47	R$ 4,878,471.92	R$ 9,049,870.39
6	R$ 4,171,398.47	R$ 4,564,575.61	R$ 8,735,974.08
7	R$ 4,171,398.47	R$ 4,250,679.29	R$ 8,422,077.76
8	R$ 4,171,398.47	R$ 3,936,782.97	R$ 8,108,181.44
9	R$ 4,171,398.47	R$ 3,622,886.66	R$ 7,794,285.13
10	R$ 4,171,398.47	R$ 3,308,990.34	R$ 7,480,388.81
11	R$ 4,171,398.47	R$ 2,995,094.02	R$ 7,166,492.49
12	R$ 4,171,398.47	R$ 2,681,197.71	R$ 6,852,596.18
13	R$ 4,171,398.47	R$ 2,367,301.39	R$ 6,538,699.86
14	R$ 4,171,398.47	R$ 2,053,405.07	R$ 6,224,803.54
15	R$ 4,171,398.47	R$ 1,739,508.76	R$ 5,910,907.23
16	R$ 4,171,398.47	R$ 1,425,612.44	R$ 5,597,010.91
17	R$ 4,171,398.47	R$ 1,111,716.12	R$ 5,283,114.59
18	R$ 4,171,398.47	R$ 797,819.81	R$ 4,969,218.28
19	R$ 4,171,398.47	R$ 483,923.49	R$ 4,655,321.96
20	R$ 4,171,398.47	R$ 170,027.17	R$ 4,341,425.64
TOTAL	**R$ 83,427,969.41**	**R$ 63,040,843.63**	**R$ 146,468,813.05**

Source: Composed by the authors

In the base scenario represented in table 3, the projection considered about 70% of the project's total cost, plus an effective rate of 7.79% p.a., with an amortization period of 240 months, through the Constant Amortization System (SAC).

The project's total cost will be the sum of the investment values and the initial working capital, resulting in a total value of R$ 119,182,813.45. Of this amount, 70% will be financed via BNDES, as shown in Table 3. With a financed amount of R$ 83,427,969.41 in 240 months (20 years) with an initial grace period of 2 years, in a constant amortization system, where the amounts of the installments presented decrease according to the amortization of the loan, as the interest values decrease with each amortized installment.

The company will be able to finance only 70% of the budgeted amount. The other percentage of 30%, of R$ 35,754,844.03, will be through its capital.

4.1.4 Revenue Planning

The new energy auction will contract the energy generated by the SHP through the new energy auction promoted by ANEEL, which deals with hiring the energy load generated by the SHP under construction. After the auction, a long-term contract for purchasing and selling electric energy is called the Power Purchase Agreement, a fixed-price contract adjusted annually by the IGP-M.

For analysis, in the state of Santa Catarina, the SHP energy purchase and sale agreement price are at the average cost of the A-5 new energy auction (plants that will come into operation in up to 5 years) held in 2020. The MW/h price was R$ 204.32 MW/h. The SHP's generating capacity is 24 MW, but the physical guarantee corresponds to 60% of the generating capacity, which corresponds to 14.4 MW/h, and the contract signed will be based on the value of the physical security.

Table 4 presents the annual values, considering that the SHP will start operating in 2024. The MW value is 204.32 reais as the energy sale price, which the IGP-M will annually adjust.

During the transmission of the generated energy, until it reaches the final consumer, there is an average loss of 3.5% of the power generated by the SHP. The revenue amounts presented are adjusted for losses incurred during the journey.

Table 4 - Revenue Planning

Reference Year	Projected revenue
2024	R$ 24,530,953.42
2025	R$ 25,458,223.46
2026	R$ 26,420,544.31
2027	R$ 27,419,240.88
2028	R$ 28,455,688.19
2029	R$ 29,531,313.20
2030	R$ 30,647,596.84
2031	R$ 31,806,076.00
2032	R$ 33,008,345.67
2033	R$ 34,256,061.14
2034	R$ 35,550,940.25
2035	R$ 36,894,765.79
2036	R$ 38,289,387.94
2037	R$ 39,736,726.80
2038	R$ 41,238,775.08
2039	R$ 42,797,600.77
2040	R$ 44,415,350.08
2041	R$ 46,094,250.32
2042	R$ 47,836,612.98

2043	R$ 49,644,836.95
TOTAL	**R$ 714,033,290.07**

Source: Composed by the authors

4.1.5 Operating Expenses

In table 5, the operating expenses shown are estimated as a percentage of gross revenue. The IGP-M corrects the values according to the price of energy. The only operating expense not projected on the percentage of revenues is the fee for the distribution system (TUSD), as this is a fixed amount and does not change over the years. The calculation value of (TUSD) and TUSD x Installed Power (KW) X 50%.

Table 5 - Operating expenses planning

Operational expenses	Base values
Maintenance and Operation	7.50%
Spares and Tools	2.10%
Insurance	1.50%
Environmental Expenses	1.30%
Distribution System Usage Fee (year)	R$ 288,000.00
ANEEL Inspection Fee	0.50%
Management	1.40%

Reference Year	Projected expense
2024	R$ 3,776,842.57
2025	R$ 3,896,460.41
2026	R$ 4,020,599.80
2027	R$ 4,149,431.66
2028	R$ 4,283,133.36
2029	R$ 4,421,888.98
2030	R$ 4,565,889.57
2031	R$ 4,715,333.39
2032	R$ 4,870,426.17
2033	R$ 5,031,381.47
2034	R$ 5,198,420.87
2035	R$ 5,371,774.37
2036	R$ 5,551,680.63
2037	R$ 5,738,387.34
2038	R$ 5,932,151.57
2039	R$ 6,133,240.08
2040	R$ 6,341,929.74
2041	R$ 6,558,507.87
2042	R$ 6,783,272.66
2043	R$ 7,016,533.55
2044	R$ 7,258,611.70

TOTAL	**R$ 117,254,544.76**

Source: Composed by the authors

4.1.6 Taxes

The taxation regime follows the presumed profit rule. According to revenue of less than BRL 78,000,000.00, the taxation applied to the presumed profit regime includes the following taxes (Table 6):

- Social Integration and Public Servant Asset Formation Programs (PIS/PASEP): 0.65% x gross revenue;
- Contribution to Social Security Financing (COFINS): 3% x gross revenue
- Social Contribution on Net Income (CSLL): 9% on 12% of gross revenue, i.e., 12% x gross revenue, then multiplying the result by 9%;
- Corporate Income Tax (IRPJ): 8% on 15% of gross revenue, i.e., 15% x gross revenue, then multiplying the result by 8%.

Table 6 - Taxes projection

YEAR	Incident on revenue		Incident on presumed profit	
	PIS	**COFINS**	**CSLL**	**IRPJ**
2024	R$ 159,451.20	R$ 735,928.60	R$ 264,934.30	R$ 294,371.44
2025	R$ 165,478.45	R$ 763,746.70	R$ 274,948.81	R$ 305,498.68
2026	R$ 171,733.54	R$ 792,616.33	R$ 285,341.88	R$ 317,046.53
2027	R$ 178,225.07	R$ 822,577.23	R$ 296,127.80	R$ 329,030.89
2028	R$ 184,961.97	R$ 853,670.65	R$ 307,321.43	R$ 341,468.26
2029	R$ 191,953.54	R$ 885,939,40	R$ 318,938.18	R$ 354,375.76
2030	R$ 199,209.38	R$ 919,427,91	R$ 330,994.05	R$ 367,771.16
2031	R$ 206,739.49	R$ 954,182.28	R$ 343,505.62	R$ 381,672.91
2032	R$ 214,554.25	R$ 990,250.37	R$ 356,490.13	R$ 396,100.15
2033	R$ 222,664.40	R$ 1,027,681.83	R$ 369,965.46	R$ 411,072.73
2034	R$ 231,081.11	R$ 1,066,528.21	R$ 383,950.15	R$ 426,611.28
2035	R$ 239,815.98	R$ 1,106,842.97	R$ 398,463.47	R$ 442,737.19
2036	R$ 248,881.02	R$ 1,148,681.64	R$ 413,525.39	R$ 459,472.66
2037	R$ 258,288.72	R$ 1,192,101.80	R$ 429,156.65	R$ 476,840.72
2038	R$ 268,052.04	R$ 1,237,163.25	R$ 445,378.77	R$ 494,865.30
2039	R$ 278,184.41	R$ 1,283,928.02	R$ 462,214.09	R$ 513,571.21
2040	R$ 288,699.78	R$ 1,332,460.50	R$ 479,685.78	R$ 532,984.20
2041	R$ 299,612.63	R$ 1,382,827.51	R$ 497,817.90	R$ 553,131.00
2042	R$ 310,937.98	R$ 1,435,098.39	R$ 516,635.42	R$ 574,039.36
2043	R$ 322,691.44	R$ 1,489,345.11	R$ 536,164.24	R$ 595,738.04
2044	R$ 334.889,18	R$ 1,545,642.35	R$ 556,431.25	R$ 618,256.94
TOTAL	**R$ 4,976,105.56**	**R$ 22,966,641.06**	**R$ 8,267,990.78**	**R$ 9,186,656.42**

Source: Composed by the authors

4.2 STATEMENT OF INCOME FOR THE YEAR

The income statement projection for the year is important because, from it, it is possible to analyze the income and expenses data, showing its actual performance. It is possible to perceive the company's financial health with this analysis and use the data shown for cost analysis, which allows a better decision-making process to improve the enterprise's performance. In Table 7, we will have the income statement for the next 20 years.

Table 7 - Statement of income for the year

Period: 2022 to 2044

Gross Operating Revenue	**R$ 765,554,701.85**
(-) Taxes on income	R$ 27,942,746.62
PIS	R$ 4,976,105.56
COFINS	R$ 22,966,641.06
Net operating revenue	**R$ 737,611,955.24**
(-) Operational expenses	R$ 140,514,268.75
Maintenance and Operation	R$ 57,416,602.64
Spares and Tools	R$ 16,076,648.74
Insurance	R$ 11,483,320.53
Environmental Expenses	R$ 9,952,211.12
TUSD	R$ 6,048,000.00
Aneel Inspection Fee	R$ 3,062,218.81
Aneel Inspection Fee	R$ 10,717,765.83
Depreciation	R$ 25,757,501.09
Operational result	**R$ 597,097,686.48**
Financial result	**R$ 63,040,843.63**
(-) Interest on Financing	R$ 63,040,843.63
Profit Before IRPJ and CS	**R$ 534,056,842.85**
(-) Taxes	R$ 17,454,647.20
Social contribution	R$ 8,267,990.78
IRPJ	R$ 9,186,656.42
Profit (Loss) for the Year	**R$ 516,602,195.65**

Source: Composed by the authors

The DRE presented in table 7 refers to the results over the 20 years of projected operation. The enterprise generates profit, according to the statements presented. Over the years, the observed profit has increased, showing that the enterprise is in good financial health. The DRE shows over the years projected all inflows and outflows, showing in detail which income and expenses.

4.3 CASH FLOW

The Cash Flow is built based on data extracted from the DRE. Cash flow refers to the movement of money in the past period, while the budget is equivalent for future periods. It is a financial management instrument that projects for future periods all the inflows and outflows of financial resources of the company, indicating how the cash balance will be for the projected period. Table 8 presents the projected cash flow for the first years, showing the inflows and outflows.

Table 8 - Cash Flow

YEAR	**2022**	**2023**	**2024**	**2025**
Inflows				

Gross Operating Revenue	R$ -	R$ -	R$ 24,530,953.42	R$ 25,458,223.46
BNDES Financing	R$ 83,427,969.41	R$ -	R$ -	R$ -
Equity Contribution	R$ 35,754,844.03	R$ -	R$ -	R$ -
Total inflow	**R$ 119,182,813.45**	**R$ -**	**R$ 24,530,953.42**	**R$ 25,458,223.46**
Outflows				
Total Investments	R$ 119,182,813.45	R$ -	R$ -	R$ -
Total Expenses	**R$ -**	**R$ -**	**R$ 4,672,222.37**	**R$ 4,825,685.56**
Operational expenses	R$ -	R$ -	R$ 3,776,842.57	R$ 3,896,460.41
(-) Operation and maintenance	R$ -	R$ -	R$ 1,839,821.51	R$ 1,909,366.76
(-) Spare parts and Tools	R$ -	R$ -	R$ 515,150.02	R$ 534,622.69
(-) Insurance	R$ -	R$ -	R$ 367,964.30	R$ 381,873.35
(-) Environmental Expenses	R$ -	R$ -	R$ 324,349.58	R$ 324,349.58
(-) Management	R$ -	R$ -	R$ 343,433.35	R$ 356,415.13
(-) TUSD	R$ -	R$ -	R$ 288,000.00	R$ 288,000.00
(-) Aneel Inspection Fee	R$ -	R$ -	R$ 98,123.81	R$ 101,832.89
Total Taxes on Revenue	R$ -	R$ -	R$ 895,379.80	R$ 929,225.16
(-) PIS	R$ -	R$ -	R$ 159,451.20	R$ 165,478.45
(-) COFINS	R$ -	R$ -	R$ 735,928.60	R$ 763,746.70
BNDES Financing Amortization	**R$ -**	**R$ -**	**R$ 4,171,398.47**	**R$ 4,171,398.47**
BNDES Financing Interest	**R$ -**	**R$ -**	**R$ 6,134,057.19**	**R$ 5,820,160.87**
Total Income Taxes	**R$ -**	**R$ -**	**R$ 559,305.74**	**R$ 580,447.49**
(-) Social contribution	R$ -	R$ -	R$ 264,934.30	R$ 274,948.81
(-) IRPJ	R$ -	R$ -	R$ 294,371.44	R$ 305,498.68
Total outflow	**R$ 119,182,813.45**	**R$ -**	**R$ 15,536,983.77**	**R$ 15,397,692.41**
Shareholder Cash Flow	**-R$ 35,754,844.03**	**R$ -**	**R$ 8,993,969.65**	**R$ 10,060,531.06**

Shareholder Accumulated Cash Flow	-R$ 35,754,844.03	R$ -	-R$ 26,760,874.39	-R$ 16,700,343.33

Source: Composed by the authors

4.4 NET PRESENT VALUE AND INTERNAL RATE OF RETURN

To calculate the NPV of cash inflows and outflows, the calculation uses the Minimum Attractive Rate (TMA) as a discount rate. This rate does not have a specific calculation. The company's shareholders define it as a rate they expect to receive in return for the investment. If the NPV is greater than 0, the project will cover both the initial investment and the minimum remuneration required by the investor, generating a financial surplus, which means that the decision is favorable to its realization.

The IRR is an indicator that compares a project's initial investment and future expenses with the potential return it can bring—expressed as a percentage value. Based on the venture's cash flows, that is, capital inflows and outflows, to show whether the investment is advantageous or not.

If the Internal Rate of Return is greater than the TMA, the investment is attractive, as it would yield more than a risk-free investment. Like the TMA, the investment would be neither good nor bad, as it would yield the same thing as a risk-free minimum rate. Smaller than the TMA, the investment would not be attractive, as an investment surpasses its profitability with the minimum return already defined. Table 9 presents the values of the NPV and IRR calculations.

Table 9 - Investment Analysis

Initial Investment: R$ 119,182,813.45

TMA: 11%

Year	Period	Cash flow	Present Value (PV)	Accumulated VP
2022	**0**	-R$ 119,182,813.45	-R$ 119,182,813.45	-R$ 119,182,813.45
2023	**1**	R$ -	R$ -	-R$ 119,182,813.45
2024	**2**	R$ 11,944,267.63	R$ 9,694,235.56	-R$ 109,488,577.89
2025	**3**	R$ 12,998,774.53	R$ 9,504,591.91	-R$ 99,983,985.98
2026	**4**	R$ 14,081,276.51	R$ 9,275,772.99	-R$ 90,708,212.99
2027	**5**	R$ 15,192,831.78	R$ 9,016,206.20	-R$ 81,692,006.79
2028	**6**	R$ 16,334,538.56	R$ 8,733,111.35	-R$ 72,958,895.44
2029	**7**	R$ 17,507,536.57	R$ 8,432,652.25	-R$ 64,526,243.20
2030	**8**	R$ 18,713,008.63	R$ 8,120,070.27	-R$ 56,406,172.92
2031	**9**	R$ 19,952,182.26	R$ 7,799,802.29	-R$ 48,606,370.64
2032	**10**	R$ 21,226,331.36	R$ 7,475,584.45	-R$ 41,130,786.19
2033	**11**	R$ 22,536,778.02	R$ 7,150,543.62	-R$ 33,980,242.57
2034	**12**	R$ 23,884,894.28	R$ 6,827,277.85	-R$ 27,152,964.71
2035	**13**	R$ 25,272,104.06	R$ 6,507,927.06	-R$ 20,645,037.65
2036	**14**	R$ 26,699,885.09	R$ 6,194,235.16	-R$ 14,450,802.49
2037	**15**	R$ 28,169,770.95	R$ 5,887,604.57	-R$ 8,563,197.92
2038	**16**	**R$ 29,683,353.23**	**R$ 5,589,144.01**	**-R$ 2,974,053.91**
2039	**17**	R$ 31,242,283.63	R$ 5,299,710.31	R$ 2,325,656.41
2040	**18**	R$ 32,848,276.32	R$ 5,019,945.10	R$ 7,345,601.50
2041	**19**	R$ 34,503,110.25	R$ 4,750,306.68	R$ 12,095,908.18
2042	**20**	R$ 36,208,631.63	R$ 4,491,098.05	R$ 16,587,006.24

2043	**21**	R$ 37,966,756.4,	R$ 4,242,491.12	R$ 20,829,497.35
2044	**22**	R$ 39,635,603.92	R$ 3,990,064.78	R$ 24,819,562.13

Sum VPsR$ 144,250,755.82

NPV: R$ 25,067,942.37

IRR: 13.12%

Profitability Rate: 1,21

Payback: 16.51

Source: Composed by the authors

Analyzing the values obtained by the calculations performed, it is clear that IRR is higher than TMA, indicating that the project is attractive and economically viable.

Payback is a company indicator to calculate the payback period of investment in a project, from the initial investment until the accumulated income becomes equal to the value of that investment.

The payback gives an estimate of how long it will take for it to recover its initial application. It depends on the value of the investment and the type of business; it can take months or years to return the capital invested.

The results obtained in the payback indicate how long the investment will have returned, that is, how long this investment will take to pay off. The calculated payback indicates that the investment will have a return in 16.51 years. 11% was the attractiveness rate used at the discounted payback

V. CONCLUSION

The present work aimed to conduct an economic-financial feasibility study for implementing a SHP in the São Bento River Dam.

With an investment of R$ 119,182,813.45, all evaluation methods for project approval were positive. The net present value was positive at R$ 25,067,942.37 and will cover the initial investment, generating an excellent financial surplus for the investor. With a minimum attractiveness rate set at 11%, the IRR result was 13.12%, indicating a positive value over the minimum attractiveness rate, which means that it is suitable for investment, signaling a higher return than projected. At first. The payback results were positive, showing that the investment in the project will take 16.51 years, as it shows the long period that the project will have to mature. Therefore, the study concludes that the results presented indicate positive economic-financial viability.

It is worth considering that the project will depend exclusively on water, and may be affected by periods of drought, which will directly affect the production of electricity, as the lake level of the SHP would not provide the flow of water necessary for the movement of the generating turbines. For future research suggestions, a study of improvements for hydroelectric power generation, scenarios with dam level variations and different Brazilian energy demands, and diversification of the energy matrix.

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