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Feasibility Analysis of Rooftop Solar Power Investment at Sahid University

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Abstract. This research aims to conduct a financial feasibility study related to the implementation of Solar Power Plants (PLTS) at Sahid University. The research includes a detailed analysis of the investment costs, operational savings, and potential return on investment of solar PV installations on the roofs of campus buildings. Electricity expenditure data were obtained from monthly bills collected from the Campus Finance Department. The research methodology includes the theory of Capital Budgeting obtained in the Financial Management course, the calculation of Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period and Benefit Cost Ratio to evaluate the financial feasibility of solar PV projects at Sahid University. The result indicate financial feasibility with an NPV of IDR 287 Million, IRR of 8.5% and payback period of approximately 10 Years. Based on data collection and desktop financial calculation the results show that the implementation of solar power plants has the potential to provide significant savings in operational costs and a positive contribution to environmental sustainability. This research shows that the solar PV project at Sahid University has strong financial feasibility and can be an attractive investment for the university and other stakeholders. This research provides valuable insights into the potential economic benefits. Furthermore, the implications of this study could help in strategic decision-making regarding investment in sustainable infrastructure at Sahid University and other educational institutions. Furthermore, the implication of this study could support decision making related to sustainable infrastructure development at Sahid University and other educational institutions. By Presenting a calculation based financial assessment, this research provides valuable insight. Overall, the study reinforces the importance of integrating clean energy as part of long term cost savings and institutional planning.

Keywords: Capital Budgeting Theory; Investment Scheme; IPP; NPV; Payback Period.

1. INTRODUCTION

The Increasing Renewable energy, such as solar power plants, utilizes natural resources that produce minimal pollution and have limited impact on global climate change, solar power plant does not contribute significantly to global climate change. According to data published by the United States Space Agency (NASA, NOAA, 2023), global warming has increased at an almost exponential rate due to increasing carbon emissions. The global energy crisis arises from imbalance between energy availability and demand for fossil fuels, influenced by sudden changes in social, political, economic, and environmental aspects. This has led to soaring energy prices, such as coal, natural gas, crude oil, and electricity, which were 2-4 times higher in mid-2022 compared to 2019. Akbar, AB, Anindita, H., Kurniawan, D., Tumiwa, F., Vianda, F., Adnan, FP, Sabbiha, F., Wismadi, DH, Puspitarini, D., Firdausi. (2020). Indonesia Clean Energy Outlook 2020.

The development of renewable energy is also supported by Energy Law No. 30 of 2007, PP 79 of 2013 concerning National Energy Policy, the 2015-2019 National Medium-Term Development Plan and Ministerial Regulation (PERMEN) number 12 of 2017 concerning the use of renewable energy sources (Ministry of Energy and Mineral Resources, 2017). Data from the Ministry of Mineral Resources and Energy of the Indonesian Government states that the

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potential energy from solar power that can be generated throughout Indonesia is 4.8 kWh/m2 / day (Sun for Solar Power Plants in Indonesia, 2012) with a radiation duration of 10 to 12 hours per day (Efeca et al., 2021; Atmadja et al., 2025).

Before implement a solar energy project or making an investment decision, it is necessary to conduct an economic assessment that estimates investment needs, evaluates carbon emission reduction, and determine financial feasibility using capital budgeting method that estimate the amount of investment required, environmental saving contribution by carbon emission reduction, calculate the return on investment, and determine the feasibility of building a solar power plant using a capital budgeting process or basic financing model (Khamharnphol et al., 2023). Researchers note gaps and inconsistencies in research regarding the scope of the study. Some studies have not yet found the Cost Benefit Ratio or the Percentage Rate of Return. This research presents a novelty in terms of investment costs at Sahid University, Jakarta.

2. LITERATURE REVIEW

Capital Budgeting

According to Riyanto (2010), capital budgeting is a broad procedure that combines planning and spending for a period of more than one year. According to Samsuddin (2004), capital budgeting requires the evaluation and selection of assets that are expected to provide benefits to the company in the long term. According to Van Horne & Wachowicz, (2008), capital budgeting is the process of finding, assessing, and selecting investment projects with cash flow returns (expected to exceed a maximum of one year).

$$ICO = \frac{CF_1}{(1+IRR)^1} + \frac{CF_2}{(1+IRR)^2} + \ldots + \frac{CF_n}{(1+IRR)^n}$$

Internal Rate of Return

IRR is the discount rate at which the net present value of a project becomes zero. IRR can determine the value of future net cash flows from an investment project relative to the project's initial cash outflows (Van Horne & Wachowicz, 2008; Ariesta & Sarumpaet, 2026) .

Payback Period

The payback period is the time required for an investment to recover its initial cost through net cash inflows or energy savings to cover its initial investment. (Riawan et al., 2022; Sandra & Budiantara, 2026) .

$$\text{Payback Period} = \frac{\text{Initial Investement}}{\text{Cash Flow}} \times 1 \text{ tahun}$$

Net Present Value

Following the capital budgeting framework established by Van Horne (2002), this study utilizes Net Present Value as criterion for the economic study. According to Van Horne in his book *Fundamentals of Financial Management, Net Present Value* is the present value of an investment project net cash flows minus the project initial cash outflows. As an alternative way to express acceptance criteria, one could say that a project will be green-lit if the cash inflows are worth more than the cash outflows (Van Horne & Wachowicz, 2008) .

$$\mathrm{NPV} = \sum_{t=1}^{n} \frac{R_t}{(1+i)^t} - I_0$$

Discounted Cash Flow

This enviro economic viability of the proposed rooftop PV System is evaluated using DCF methodology. This approach is over static financial metric as it accounts for the temporary distribution of cost and benefits over the project and system lifespan. Discounted cash flow (DCF) defined as method of investment project evaluation and selection that adjusts cash flows over time for the time value of money (Van Horne & Wachowicz, 2008) .

Levelized Cost of Electricity (LCOE)

Is The Product Of The Total Cost Of The Generator And The Lifetime Cost Of The Energy Produced By That Technology. In This Study Lcoe Will Be Utilized As A Fundamental Benchmark For Evaluating The Unit-Cost Of Electricity Generation (Idr/Kwh). Lcoe Is The Preferred Method For Comparing The Costs Of Generating Energy From Different Technologies. (Zailani & Ghafar, 2023) .

Benefit Cost Ratio

Within this enviro-economic context, The Benefit Cost Ratio serves as indicator of investment efficiency. The BCR is a general indicator of the profitability of an investment or investment project. Cost-Benefit Analysis is the primary tool for evaluating the gains or losses of an investment (O'Mahony, 2021) .

Carbon Emission Reduction

According to the United States National Renewable Energy Laboratory (NREL), the use of energy generated by solar panels reduces greenhouse gas emissions compared to coal-fired power plants. A solar panel system that produces 1 kWh of electricity also produces Greenhouse Gas (GHG) of 40 grams of CO_2/ kWh produced. This is significantly lower than the GHG produced by coal-fired power plants, which is 1,000 grams of CO_2 . (NREL, 2012) . NREL emphasizes that the sheer volume of solar required for carbon reduction creates a spatial challenge, to reach the goals, there is a need to utilize potential building rooftops

To calculate the potential reduction in CO2 emissions from the use of solar power plants in this study, researchers will use a calculation reference by multiplying the amount of electricity consumed by the emission factor of the electricity network (Environmental, 2024) .

Emission = *Electricity* x EF

Electricity = *Quantity of Electricity Purchased*

3. METHOD

The research method is a case study, with Capital Budgeting Analysis.

Data Collection Methods. The study collected monthly electricity bill reports from the building management department at Sahid University. The study also sought investment prices for solar power plants from various publications and references (Khomarudin et al., 2023). The research methods are presented in Table 1 below.

Table 1. Method of collecting data

Data Requirements	Data Revenue Process	Calculation and Calculation Process
Roof Area Data	Existing data from internal	Calculation of NPV, IRR, PBP, monthly *income*
Electricity Bill Data	Existing info from finance dept.	Capital value
Initial Investment Cost	Literature study of investment costs	Carbon emission reduction value
	Literature study of carbon emission values	Interpretation of results

Theoretical Framework. This research has a conceptual framework solely from the Capital Budgeting perspective, identifying energy needs, analyzing financial risks, and measuring greenhouse gas emission reductions based on the analysis. Finally, it assesses feasibility and provides recommendations for investment decision-making. The conceptual framework for this research is shown in Figure 1 below.

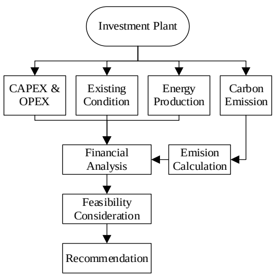

Figure 1. Framework of Thought

Table 2. Scenario Test

Information	Definition	Indicator	Scale
P	In the context of solar power plants (PLTS), it refers to the percentage of reliable energy production over a period, with production decreasing. We can calculate whether the BCR value is still positive or not.	Annual Production	KiloWatt-Hour

Increase in Operating Costs from Inflation	An increase in component cost for system maintenance could impact investment costs and lower the BCR.	Increase in Operating Costs per Year = Operating Costs in Year N − Operating Costs in Year N-1	Percentage
Tariff Changes	Current electricity subscription rates may be affected by subsidies. However, subsidies could be eliminated, resulting in non-subsidized electricity rates.	((New Rate / Old Rate) − 1) × 100%	Percentage

4. FINDINGS AND DISCUSSION

The usable rooftop area is 615 M^2, assuming each 375 WP module occupies 1.8 Meter to max 2 M^2, This study therefore adopts 125 Kwp

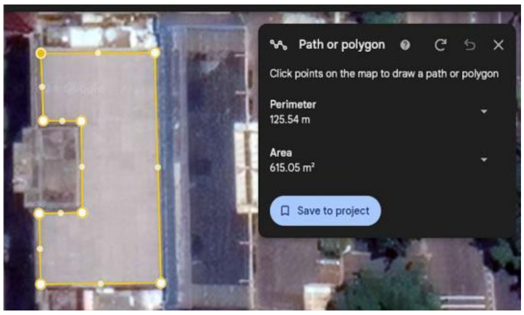

Figure 2. Available space

The university's installed Electricity power capacity is 360 kVA. Therefore, the installed capacity does not exceed the university's installed capacity. This capacity value is based on the available roof space on the university's buildings.

Capital Budget Plan. After determining the solar power plant (PLTS) plan, the next step is to determine the capital expenditure (capex) or installation costs for a 125 kWp solar power plant. The capital expenditures can be seen in Table 3 below:

Table 3. Capital Expenditure Budget Estimate

Items	Amount	Total price (Rp)
375 Wp Mono PERC, 72-cells, Tier-1	333 Pcs x Rp 2.175.000	725,000,000
String Inverter 25 KW, 3 P, Transformer less, MPPT	5 unit	217,500,000
4G/Wi-Fi inverter data logger	1 unit	15,000,000
Aluminum roof mounting kits for 72-cells module	125Kwp	150,000,000
PV1-F Single Core 1 x 4mm cable	900mtr	22,500,000
NYA 1C x 6 mm cable	200mtr	2,000,000
MC4 connector	30set	720,000
cable conduit and accessories (PVC) 25mm	100mtr	2,500,000
DC duct cable and accessories (PVC) 100x50mm	100mtr	16,666,667
NYY 3 C x 10 mm cable	200	22,000,000
NYY 4 C x 50 mm cable	90	31,500,000
AC cable tray 100 x 50 mm	50	8,333,333
NYA 1C x 25 mm cable	200	16,000,000
Switchgears and Equipment Protection (AC and DC)	1	30,000,000
installation and supervision	1	175,000,000
Logistics and misc.	1	10,000,000
Total		1,444,720,000

Contractor benefits	144,472,000
Total	1,589,192,000
Total + VAT	1,764,003,120

Operational Budget

Operational expenses are the planned operational costs for the duration of the solar power plant's operation. Operational costs for solar power plants are often considered minimal, as maintenance only requires panel cleaning. This study budgeted Rp 3,000,000.00 every three months, resulting in a year-long operational cost of Rp 12,000,000.00 for panel cleaning.

Baseline Scenario LCOE Energy Costs

LCOE combines initial capital costs, operating and maintenance costs, and the estimated lifetime of the equipment to produce an estimated cost per unit of electricity (usually expressed in cents or kilowatt-hours). In this baseline scenario, the LCOE for solar power generation is Rp586.3/kWh as this study baseline without any tariff increase.

Savings Achieved

Figure 2 below shows the projected savings that can be achieved from implementing a Solar Power Plant (PLTS) in operational costs. These savings are calculated based on an analysis of energy substituted from PLN electricity, using electricity from the PLTS partially.

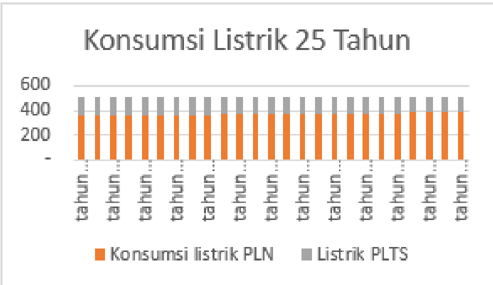

Figure 3. Electricity Consumption 25 Years

NPV Analysis

Based on the calculation results *the Cash Flow* series yields savings in this study. We use Table 4 below.

Table 4. NPV Analysis

Year	Cash Flow (Rp)
0	–1,589,192,000
1	166,158,451
2	157,776,064
3	156,417,856
..	...
24	136,106,762
25	134,921,908

IRR Calculation

According to Excel calculations, the IRR for this scenario is 8.5%. This indicates that the project is expected to generate significant returns sufficient to compensate for the investment risk. More specifically, if the expected discount rate or minimum required rate of return is lower than 8%, the project is considered worthy of investment.

Payback Period Analysis

To calculate the payback period for a solar power plant project, we need information on the cash flow savings after the plant is operational and generating savings. We then divide the project's initial investment cost by the net cash flow. The payback period without an increase in PLN tariffs is shown in Table 5 below.

Table 5. Payback Period Without PLN Tariff Increase.

Operation Period	Year 0	Year 1	Year 7	Year 11
FCFF	–	–	–	–
EBITDA × (1 − Tax Rate) (IDR)	–	166,158,451	157,776,064	152,408,077
Depreciation × (Tax Rate) (IDR)	–	–	–	–
Capex (IDR)	(1,589,192,000)	–	–	–
Cash Flow to Firm (IDR)	(1,589,192,000)	166,158,451	157,776,064	152,408,077
IRR	**8%**	–	–	–
Accumulated Investment (IDR)	(1,589,192,000)	(1,423,033,549)	(455,617,563)	(162,012,831)

The criteria for determining whether a solar power plant project is feasible is that researchers assess the investment as feasible if the payback period is shorter than the power plant's production period. By examining this series of data, the payback period value is obtained as shown in Figure 3 below:

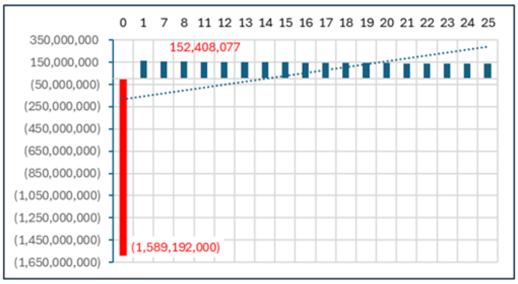

Figure 4. Annual Savings

Benefit Cost Ratio Analysis

To obtain the BCR, researchers divided the accumulated cash flow by all operational and capital expenditures (OPEX) and operational and capital expenditures (CAPEX). The calculation below assumes no increase in electricity tariffs.

Baseline Scenario Summary

In this baseline scenario, we take the parameters we have obtained, calculate the project's cash inflows and outflows over a specified time period, and apply an appropriate discount rate to calculate the present value of those cash flows. A schematic of this baseline scenario is shown in Table 6 below.

Table 6. Basic Scenario Summary

Profit	Mark	Unit
IRR	8%	%
NPV	287,236,526	IDR
Payback period	10	Year
Benefit Cost Ratio	1.7	
Accumulated Cashflow	3,533,989,784.7	IDR
Total Cost	2,106,692,000	IDR
Operational drivers		
Capacity	125.00	kW
Annual Production Capacity	158	MWh
Panel Degradation Ratio (0.3-1%)	0.8%	DaD
Project duration	25.0	Year
PV generation costs	586.3	IDR/kWh
Revenue drivers		
PLN Tariff Increase in Percentage	–	% pa
PLN basics	1,128	IDR/kWh
Expense drivers		
Capex	(1,589,192,000)	IDR
Inverter replacement	217,500,000	IDR
Replacement year	15	Year
Fixed O&M	12,000,000	IDR/Year
Cost Inflation	–	% pa
FX rate	0	IDR/USD
Discount rate	6.0%	%

2% Inflation Scenario, 2% Electricity Tariff Increase. In this scenario, investments are tested against rising inflation and rising electricity tariffs. Therefore, the simulation calculations show that a 2% increase in inflation and a 2% increase in electricity tariffs in the investment pattern will result in an increase in cash flow to approximately Rp 4,763,793,871.00.

However, the Benefit-Cost Ratio remains above 1, meaning that, despite the impact of inflation and rising electricity rates, rooftop solar investments still provide greater benefits than their costs. The scenario of a 2% increase in inflation and electricity costs is shown in Table 8 below.

Table 8. 2% Inflation Scenario, 2% Electricity Tariff Increase.

Profitable	Mark	Unit
IRR	9.9%	%
NPV	611.518.789	IDR
Payback period	10	Year
Benefit Cost Ratio		
Accumulated Cashflow	4.476.807.240	IDR
Total Cost	2.260.542.228	IDR
Operational drivers		
Capacity	125.00	kW
Annual Production Capacity	158	MWh
Panel Degradation Ratio (0.3-1%)	0.8%	DaD
Project duration	25.0	Year
PV generation costs	629,1	IDR/kWh

Revenue drivers		
PLN Tariff Increase in Percentage	2.0%	% pa
PLN basics tariff	1,128	IDR/kWh
Expense drivers		
Capex	1,589,192,000	IDR
Opex	–	% Capex pa
Inverter replacement		IDR
Replacement year	15	Year
Fixed O&M	12,000,000	IDR/Year
Cost Inflation	2.0%	% pa
FX rate	0	IDR/USD
Discount rate	6.0%	%

Carbon Emission Reduction Contribution. The carbon emission calculation value obtained after installing a solar power plant in the first year is as follows. The table below shows that the carbon emission reduction after installing a rooftop solar power plant is 125.6 tons of CO2 / year. This capacity value is influenced by the size of the solar power plant installed.

Table 9. Calculation of Carbon Emissions After Solar Power Plant Installation in Year 1

Carbon Emissions Before	Carbon Emissions After	Difference in Decrease
411.2 Tons of CO2 / Year	285 Tons of CO2 / Year	125.6 Tons of CO2 / Year

5. CONCLUSIONS

125 kWp solar power plant investment on the roof of Sahid University, with using performance ratio of 85.0%, given 125 kWp DC, the implied year-1 specific yield has the potential to generate 158 MWh of energy per year. Furthermore, from a carbon emission reduction perspective, Sahid University will contribute to reducing 125 tons of CO2 emissions. This number obtained by replacing the energy consumed from the grid, which generates carbon emission, using Solar PV System which is cleaner.

This can be an additional benefit if there is an incentive policy from the Government in the future if an entity plays a role in reducing carbon emissions, as well as a positive image if Sahid University is one of the universities that plays a role in using environmentally friendly energy.

With adequate maintenance and the absence of disasters or worst-case scenarios, this study calculates a 25-year operational life, meaning the project has a long enough timeframe to achieve a return on investment.

It is recommended that further research incorporate bank financing schemes and their cost implications to obtain a more realistic picture of investment feasibility and funding. Operations and maintenance management also needs to be standardized to maintain performance. ratio The PLTS assets remain above 85%.

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