



Techno-Economic Household-Scale Solar Power Plants in Support of The Policy of Presidential Regulation Number 112 of 2022 Concerning the Acceleration of Renewable Energy Development

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ABSTRACT

This study evaluates the economic feasibility of household-scale solar power generation businesses using a content analysis approach, focusing on financial performance over a 20-year projection period. Key indicators analyzed include gross profit margin, internal rate of return, payback period, and net present value. The study also provides an overview of potential material utilization for production. Results show that, although initial production costs are significant, household-scale solar power plants offer high profitability with a rapid return on investment. The break-even point is reached relatively quickly, indicating that this business model is economically viable and sustainable in the medium term. The feasibility is further supported by the growing potential of renewable energy alternatives, which present economic opportunities while contributing to environmental preservation. This research highlights the strategic role of household-scale solar power plants in accelerating renewable energy development, in line with Presidential Regulation of the Republic of Indonesia Number 112 of 2022, and in supporting Sustainable Development Goal (SDG) 7 by promoting access to clean and affordable energy for the community.

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1. INTRODUCTION

Solar power plants are an innovative solution in presenting alternative renewable energy that can be utilized to address the challenges arising from Indonesia's rapid population growth over the past decades [1-14]. Basic needs remain a fundamental issue that must always be fulfilled to ensure a good quality of life for the community [15-19]. Consumer culture, both in meeting primary and secondary needs, is an unavoidable phenomenon. However, consumer culture also introduces new problems, such as pollution, which contributes to environmental issues. The limited availability of energy resources further hinders communities from continuously innovating in developing alternative renewable energy. National energy fulfillment, which still relies heavily on coal and fossil fuels, is increasingly constrained and has a profound impact on environmental degradation [20-23]. To overcome the ecological impacts resulting from consumer energy-use habits, the government has anticipated these issues by issuing the Presidential Regulation of the Republic of Indonesia Number 12 of 2022 concerning the acceleration of renewable energy development in electricity supply, as a form of national commitment toward a clean and sustainable energy transition [24-26].

One of the applications of environmentally friendly renewable energy that can be utilized by the community is household-scale solar power plants, which can reduce the burden of electricity demand from the main grid. The potential of renewable energy through the use of solar power plants represents an opportunity that can be further developed, particularly in business, as the manufacturing of solar power plants offers profitable prospects. However, several challenges remain in initiating such efforts, including initial financing for the procurement of raw materials, equipment, infrastructure, and ensuring economic feasibility [27-30]. Research related to techno-economics and discussions on renewable economics through solar power plants are presented in **Table 1**.

Table 1. Research related to techno-economics and solar power generation.

No	Topic	Ref
1	Techno-Economic Analysis of Sawdust-Based Trash Cans and Their Contribution to Indonesia's Green Tourism Policy and the Sustainable Development Goals (SDGs)	[31]
2	Production of pen holders from can waste for supporting sustainable development goals (SDGs): Technology and cost analysis	[32]
3	Techno-Economic Analysis of Production of Organic Fertilizer from Cooking Oil Waste to Support Sustainable Development Goals (SDG's)	[33]
4	Economic analysis of power generation from floating solar chimney power plant." <i>Renewable and Sustainable Energy Reviews</i>	[34]
5	Economic feasibility of solar power plants based on PV module with levelized cost analysis	[35]

This study aims to analyze the techno-economic evaluation of household-scale solar power generation as part of efforts to accelerate the use of renewable energy [36-38]. The novelty of this study lies in two aspects: (i) the utilization of renewable energy through solar panels as household-scale solar power generators to support the policy of Presidential Regulation of the Republic of Indonesia Number 12 of 2022 on the acceleration of renewable energy development in electricity provision as a form of national commitment to a clean and sustainable energy transition, and (ii) an illustration of the profit prospects for the solar power generation industry [39].

2. LITERATURE REVIEW

Figure 1 illustrates the stages of manufacturing a household-scale solar power plant, consisting of eight steps. Step 1 is the preparation of raw materials, which serves as the initial stage for arranging the components to be assembled, including solar cells, glass, ethylene vinyl acetate (EVA), a back sheet, a frame, and other supporting parts. Step 2 is the tabbing stage, where the prepared solar cells are connected in series using solder at a temperature of approximately $\pm 350^\circ\text{C}$, producing six to seven strings, with each string consisting of six solar cells. Step 3 is the layout stage, in which the solar cell strings are positioned appropriately on top of the EVA and glass layers, followed by the lamination process. Step 4 is lamination, where layers consisting of glass, EVA, solar cells, EVA, and the back sheet are arranged and processed in a laminator machine through a vacuum and heating process for about 20 minutes, after which the laminated structure is cooled for 10 minutes before being removed. Step 5 is the cleaning stage, which involves removing any dust or residues from the laminated panel to ensure optimal performance. Step 6 is framing, in which the laminated solar panel is fitted with an aluminum frame to protect the structure and enhance its durability against weather conditions. Step 7 is the installation of the junction box on the rear panel to connect the solar panel to an inverter or the electrical system. Step 8 is quality testing, in which all components are examined to ensure safety and performance, including measurements of open-circuit voltage (Voc), short-circuit current (Isc), and electrical output power. After passing the quality tests, the results are recorded on the control card, and the solar panels are ready to be used in household-scale solar power plant installations.

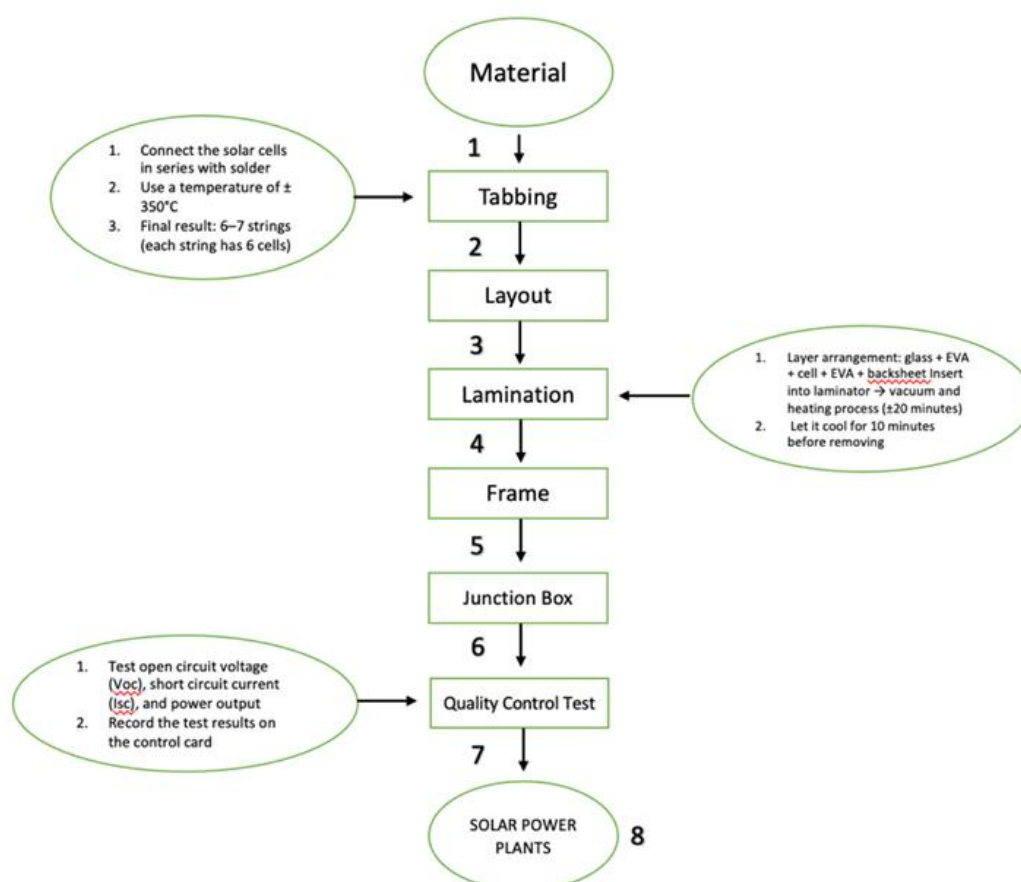


Figure 1. The process of making a household-scale solar power generator.

3. METHODS

The research was conducted using content analysis based on the economic feasibility evaluation of solar power plant production. Data sources were obtained from product prices listed on online websites or e-commerce platforms, representing current market prices for materials. Each dataset was analyzed using simple mathematical calculations performed in Microsoft Excel. To assess the economic feasibility, several key indicators were employed, including Cumulative Net Present Value (CNPV), Gross Profit Margin (GPM), Payback Period (PBP), and Break-Even Point (BEP). Additionally, the feasibility evaluation considered various scenarios, such as changes in sales capacity, raw material costs, interest rates, and labor conditions.

4. RESULTS AND DISCUSSION

In conducting the techno-economic analysis of household-scale solar power plant production, several cost components were identified as primary focuses, including raw material costs, initial capital, employee salaries, marketing, and sales expenses. Among these, raw material costs represent the most significant component, providing an overview of the essential materials required for producing solar panels for use in power plants. Utility costs, such as electricity consumed during the production process, and labor costs directly involved in manufacturing are also included within the raw material and direct operational costs. The detailed requirements for manufacturing are presented in **Table 2**.

Table 2. Total Manufacturing Cost.

Total Manufacturing Cost				
No	Item	Factor		Harga
	Total Life Time	20	years	
1	Raw Materials			Rp 181,800,000,000
2	Utilites			Rp 11,089,920
3	Loan Interest	7%	of loan	Rp -
4	Operating Labor			Rp 492,000,000
5	Labor related cost			
	a. Payroll overhead	30%	of labor	Rp 147,600,000
	b. Supervisory, misc. labor	25%	of labor	-
	c. Laboratory charges	12%	of labor	-
6	Capital related cost			
	a. maintenance	6%	of labor	Rp 29,520,000
	b. Operating supplies	15.00%	of maintanance	Rp 4,428,000
	c. Enviromental	15.00%	of (equipment)	Rp 4,275,000
	d. Depreciation	10.00%	of (FCI)	Rp 21,485,450
	e. Local taxes, insurance	4%	of (FCI)	Rp 8,594,180
	f. Plant overhead cost	100%	of (OL)	Rp 214,854,496
7	Sales related cost			
	a. Packaging	1%	of sale	Rp 10,500,000,000
	b. Administration	2%	of sale	Rp 21,000,000,000
	c. Distribution and marketing	2%	of sale	Rp 21,000,000,000
	d. Research and development	1%	of sale	Rp 10,500,000,000
	e. Patents and royalties	1%	of sale	Rp 10,500,000,000
	Total Product Cost (TPC)			Rp 256,233,847,045

Table 2 presents a detailed overview of the overall costs associated with the mass production of household solar panels. The data in this table are essential for supporting calculations of Return on Investment (ROI), Break-Even Point (BEP), and long-term profitability estimates. Additionally, **Table 2** includes information on the initial fixed capital expenditures.

Figure 3 illustrates the diagram of Cumulative Net Present Value (CNPV) and Total Investment Cost (ITC) for the production of household-scale solar power plants. The long-term financial feasibility is depicted over a 20-year production period. During the initial production phase, from year 1 to 2, the CNPV is below zero, indicating initial losses due to high upfront costs for raw materials, equipment, and employee salaries, combined with low cash inflows at the beginning of production. However, between years 3 and 5, the graph shows a sharp increase, surpassing the break-even point, indicating that net cash flows begin to cover the initial investment. After year 5, the CNPV continues to rise significantly, suggesting that the project can generate cumulative net profits, reaching a maximum point approaching year 20.

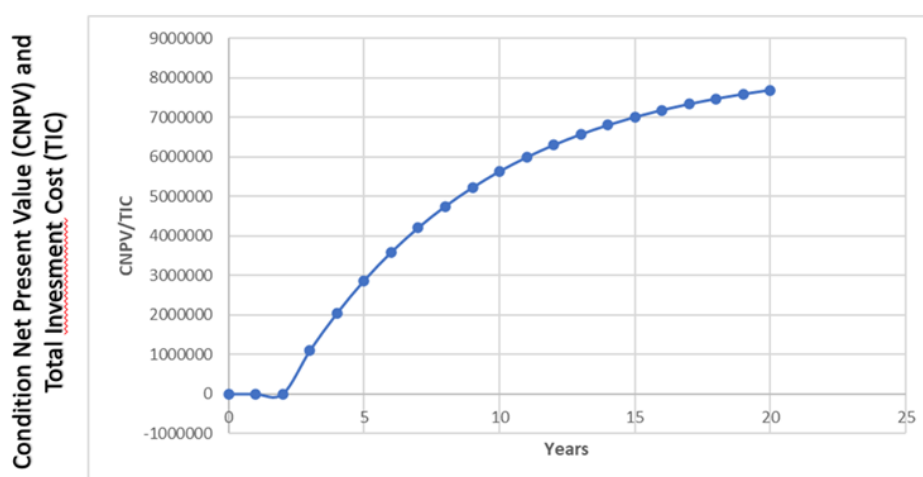


Figure 3. Diagram of Cumulative Net Present Value (CNPV) and Total Investment Cost (TIC).

In general, **Figure 3** indicates that long-term investment in the household-scale solar power plant production business can be profitable and financially feasible, particularly after the payback period of five years. The CNPV diagram shows a gradual increase in production, illustrating that net cash flows can progressively surpass the total initial investment. An overview of the overall financing for household-scale solar power plant production is presented in **Table 3**.

The analysis demonstrates that the development of household-scale solar power plants offers highly promising prospects in terms of both economic feasibility and energy sustainability. Although the initial investment costs are relatively high, the Cumulative Net Present Value (CNPV) calculation shows that the break-even point can be achieved within three to five years, meaning that capital recovery occurs relatively quickly and long-term profits can be secured over more than 20 years of operation. Furthermore, the high profitability and significant Return on Investment (ROI) indicate that this initiative is not only financially viable but also strongly supports the government's clean energy transition agenda as mandated in Presidential Regulation Number 112 of 2022. In this way, households can serve not only as energy consumers but also as producers of renewable energy, thereby contributing to the achievement of Sustainable Development Goal (SDG) 7, which seeks to

ensure access to clean and affordable energy. These findings reinforce the strategic role of household-scale solar power plants as a solution to reduce dependence on fossil fuels, minimize carbon emissions, and create new economic opportunities through renewable energy innovations. Finally, this study adds new information regarding techno-economic analysis, as reported elsewhere (Table 4).

Table 3. Summary of techno-economic analysis.

Component	Parameter	Cost (Rp)
Fixed Cost	Loan Interest	
	Capital Related Cost	Rp 283.157.125
	Fixed cost+Depresiasi	
	Depreciation	Rp 21.485.450
	Fixed Cost less depreciation	
Variable Cost	Total Fixed Cost	Rp 304.642.575
	Raw material	Rp 181.800.000.000
	Utilities	Rp 11.089.920
	Operating Labor (OL)	Rp 492.000.000
	Labor Related Cost	Rp 147.600.000
	Sales Related Cost	Rp 73.500.000.000
	Total Variable Cost	Rp 255,950,689,920
% Profit Estimated	Sales	Rp 1,050,000,000,000
	Manufacturing Cost	Rp 256,233,847,045
	Investment	Rp 230,294,565
	Profit	Rp 0,76
	Profit to Sales	Rp 3,447
BEP	Unit	30000
	Fixed Cost	Rp 304,642,575
	Variable cost	Rp 255,950,689,920
	Variable cost	Rp 0
	sales	Rp 1,050,000,000,000
	sales	Rp 0
	BEP	11.51
	Percent Profit on Sales	0.76
	Return on Investment	3694.44
	Pay Out Time	0.00027067

Table 4. Previous studies on techno-economic analysis.

No	Title	Ref
1	Techno-economic analysis of solar panel production from recycled plastic waste as a sustainable energy source for supporting digital learning in schools based on Sustainable Development Goals (SDGs) and science-technology integration	[40]
2	Techno-economic feasibility of educational board game production from agro-industrial waste in support of Sustainable Development Goals (SDGs) through science and technology integration	[41]
3	Resin-based brake pad from rice husk particles: From literature review of brake pad from agricultural waste to the techno-economic analysis	[42]
4	Techno-economic evaluation of biodiesel production from edible oil waste via supercritical methyl acetate transesterification	[43]
5	Techno-economic analysis for the production of silica particles from agricultural wastes	[44]
6	Techno-economic analysis for the production of LaNi5 particles	[45]

Table 4 (continue). Previous studies on techno-economic analysis.

No	Title	Ref
7	Computational bibliometric analysis on publication of techno-economic education	[46]
8	Optimal design and techno-economic analysis for corncob particles briquettes: A literature review of the utilization of agricultural waste and analysis calculation	[47]
9	Techno-economic feasibility and bibliometric literature review of integrated waste processing installations for sustainable plastic waste management	[48]
10	Production of wet organic waste ecoenzymes as an alternative solution for environmental conservation supporting sustainable development goals (SDGs): A techno-economic and bibliometric analysis	[49]
11	Techno-economic analysis of production ecobrick from plastic waste to support sustainable development goals (SDGs)	[50]
12	Techno-economic evaluation of the production of resin-based brake pads using agricultural wastes: Comparison of eggshells/banana peels brake pads and commercial asbestos brake pads	[51]
13	Techno-economic analysis of sawdust-based trash cans and their contribution to Indonesia's green tourism policy and the sustainable development goals (SDGs)	[52]
14	Techno-economic analysis of the business potential of recycling lithium-ion batteries using hydrometallurgical methods	[53]
15	Techno-economic evaluation of hyaluronic acid production through extraction method using yellowfin tuna eyeball	[54]
16	Techno-economic analysis on the production of zinc sulfide nanoparticles by microwave irradiation method	[55]

5. CONCLUSION

The techno-economic analysis of household-scale solar power plant production demonstrates that it is a feasible investment, offering significant benefits, particularly when implemented over a long-term period of more than 20 years. This production not only provides financial returns but also supports the acceleration of renewable energy development, fully endorsed by the Government of the Republic of Indonesia through Presidential Regulation Number 112 of 2022, and contributes to the achievement of SDG 7 by providing clean and affordable energy for the community.

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7. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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