Economic Impact of 300 KWp PV Rooftop Penetration on Soy Sauce Companies

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Abstract *– One of the greatest potentials of renewable energy is solar energy, which can produce electricity. The industry welcomed this to utilize solar energy to produce electricity through a PV rooftop system. The advantage of PV rooftops in producing electrical energy is in terms of investment costs that can eliminate the land component because it utilizes the roof of an industrial building as a place for PV rooftops to produce electrical energy. Soy Sauce companies, as one of the industries engaged in food, can utilize a PV rooftop with 300 kWp to produce electricity. The electrical energy produced by the PV rooftop can reduce 17,23% of the total electrical energy consumed by soy sauce companies in one day from PT. PLN electrical energy sources. A rooftop PV investment capacity of 300 kWp has a payback period of 12 years with an IRR value of 7% and a lifetime of using PV rooftop for 25 years.*

Keywords*: Rooftop Penetration, renewable energy, solar energy.*

1. Introduction

Today, the development of electricity supply technology continues to develop rapidly with the primary goal of reducing fossil fuels in supplying electrical energy. Many countries are competing to replace the fuel in generating electricity from fossil fuels with new renewable energy-based fuels [1]. The most popular new renewable energy sources to replace fossil fuels in the generation process include: geothermal, wind, solar, biomass, and water [2].

As a developing country, Indonesia is trying to be part of a country that campaigns to use renewable energy in generating electricity [3]. One proof is the issuance of Government Regulation No. 79 of 2014 concerning the National Energy Policy, which one of the points is to instruct that PT. PLN as a national electricity energy manager is required to have the plan to develop new renewable energy-based power plants of at least 23% in 2025 and 31% in 2030 [4].

The potential use of renewable energy for electricity generation in Indonesia is extensive, one of which is solar energy. Based on RUPTL 2018-2017, there is the potential for solar energy for electricity generation of 207,898 MW (80 kWh / m2 / day) that can be utilized [5]. The use of solar PV in the utilization of solar energy for electricity generation can reduce the production cost of a generation because the cost of fuel which is the primary component, is zero [6]. Utilization of solar energy using solar PV to produce electricity is prevalent to implement, especially among industries, because it can reduce the cost of electricity that must be paid to electricity supply companies.

The implementation of the use of solar PV to produce electricity, of course, requires investment costs that are not small, so companies need to calculate well the investment costs incurred with the benefits to be obtained. In this research, we will discuss the economic effect of using solar PV to produce electricity in the industry with a case study on soy sauce companies.

2. Methodology

2.1. Flowchart

The steps taken in the research methodology of load curve analysis and economics on the utilization of PT XYZ rooftop PV can be seen in Figure 1.

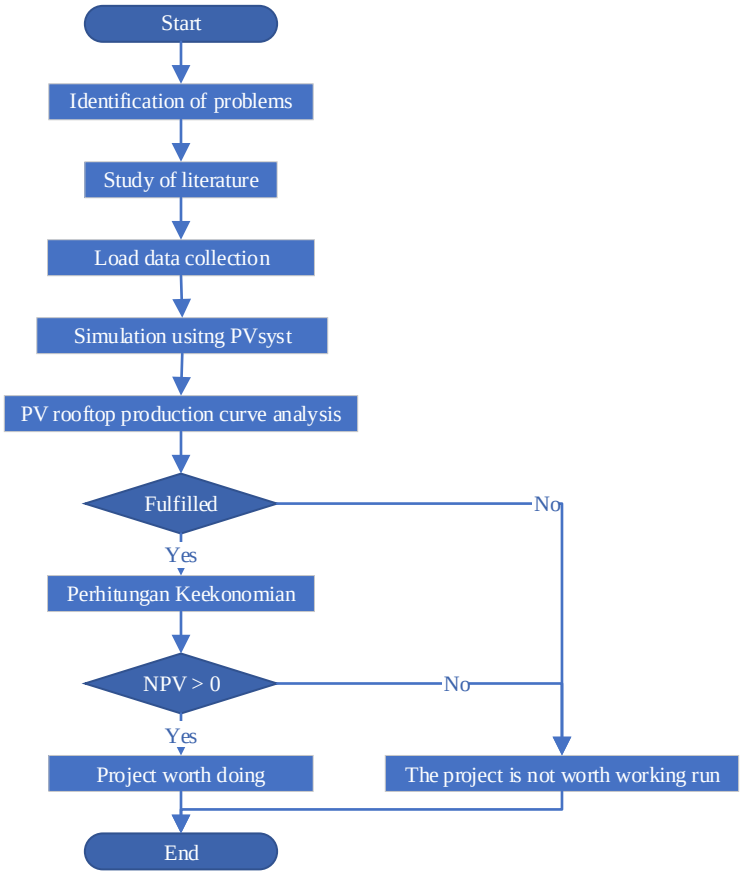

Figure 1. Research methodology flowchart.

2.2. Solar Cell

Solar PV is an electrical energy generation system that utilizes solar radiation and is converted into electrical energy, which can be widely used by solar cells as a media converter.

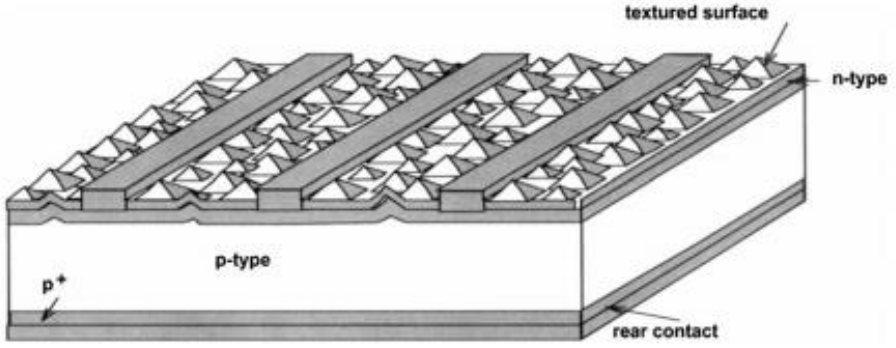

Figure 2. The working principle of solar cell.

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Figure 2 [7] explains about the working system of solar cells is when solar cells are exposed to solar radiation, the photons produced from the irradiation have energy that is equal to or wider than the energy band of the material affected by the radiation and will cause the existence of electrons from the valence band to the conduction band. Furthermore, the electron will leave a hole in the valence band. In principle, these electrons and holes can move in the material to produce electron-hole pairs. If the type of resistance is placed at the terminal of the solar cell, electrons from the n-area will return to the p-region so that the potential difference and current will flow.

2.3. *PV Rooftop System*

PV Rooftop is a power generation system that utilizes solar energy to produce electrical energy through solar cell media and is installed on the roof of a building. The advantage of PV rooftop systems compared to solar PV farms is the efficiency of investment costs used to purchase land and reduce power losses due to the distance of electric energy sources and adjacent loads. A PV rooftop system is generally used in homes, office buildings and industrial buildings [8] as shown in Figure 3 [9].

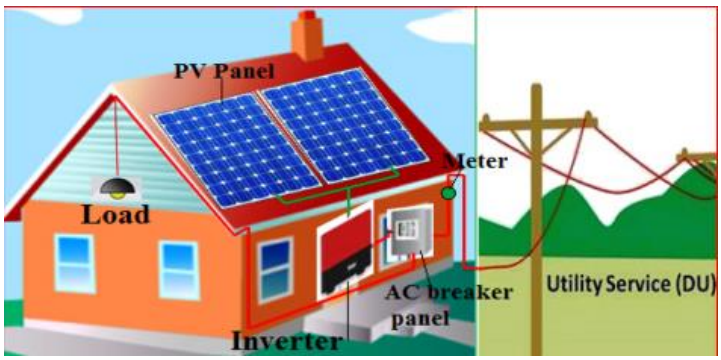

Figure 3. PV rooftop system.

The working principle of the PV rooftop system is that when solar panels absorb radiation emitted by the sun to the earth to produce electrical energy in the form of direct current (DC), the output of electrical energy is processed on an inverter that aims to convert the output into alternating current so that it can be used by machines industrial machinery. Furthermore, electrical energy is channeled to the Main Distribution Panel (MDP) to distribute to industrial loads.

2.4. *Pay Back Period (PBP)*

PBP is a method used to calculate the time needed to return capital on an investment value issued so that the units used are years, months and days. In principle, if the PBP value is shorter than what has been required, then the investment in the project can be said to be profitable, whereas if it takes longer, the investment in the project is rejected [10]. PBP calculations can be explained mathematically in the equation

$$k_{(PBP)} = \sum_{t=0}^{k} CF \geq 0, \quad (1)$$

which k is return period, and CF_t *is* a period of cash flow to t. If the cash flow benefit and cost component is annual, then the equation becomes

$$k_{(PBP)} = \frac{Investasi}{Annual\ Benefit}\ x\ Time. \quad (2)$$

In the decision-making process in an investment, the project is continued because it is economical or not, then certain criteria are needed. In this PBP method, an investment plan for a project can be

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said to be feasible if $k \leq n$ and vice versa, $k =$ number of return periods, and $n =$ Age of investment.

3. Result and Discussion

In this research, the potential economic calculation from the penetration of rooftop PV with a capacity of 300 MWp in the soy sauce industry using the calculation method using Microsoft Excel with the parameters of the cost of electricity bills, soy sauce company electricity consumption and return on investment.

3.1. Profile of Electric Energy Industry Load of Soy Sauce

The industry is one of the burdens that consumes the most electricity after households. In its operational process, the industry needs electricity to produce a product that is beneficial to the community. One component of the industry that consumes the largest electricity is the type of food and beverage industry.

The soy sauce industry is one part of the type of food and profit industry, in the production process, the industry uses electrical energy to drive electric motors, production machines, and other needs that support the soy sauce production process. In meeting electricity needs, the industry is a regular customer of PT PLN and allocates the electricity bill as a variable cost. the cost of electricity consumption that is charged by PT PLN to the industry falls into the business cost group 3 with the breakdown rates as in Table 1.

Table 1. Electrical energy rate soy sauce companies.

Rate / Power	B3 / 1,110,000 VA
LWBP	Rp. 1,035.78
WBP	Rp. 1,553.67
kVarh	Rp. 1,114.74

This type of electrical energy subscription to PT PLN uses a medium voltage of 20 kV so that the voltage reduction process is carried out with a step-down transformer capacity of 2,200,000 VA to 380 Volts. It is to the needs of the motor and industrial machines used. The soybean industry load consumption is divided into three main categories: the burden of production process machines at 26% of total consumption, utility machines that support the production process 47% of total consumption, and support for lighting illumination consume 27% of total consumption.

The burden on one of the soy sauce industries in the city of Bekasi has a variety that varies every hour because it relates to the activities of the production process that runs for 24 hours, so the reliability of the electrical energy significantly required affects production results. Load curves show the variety of loads from the soy sauce industry hourly by taking one sample at a load on September 5, 2019 like in the figure 4.

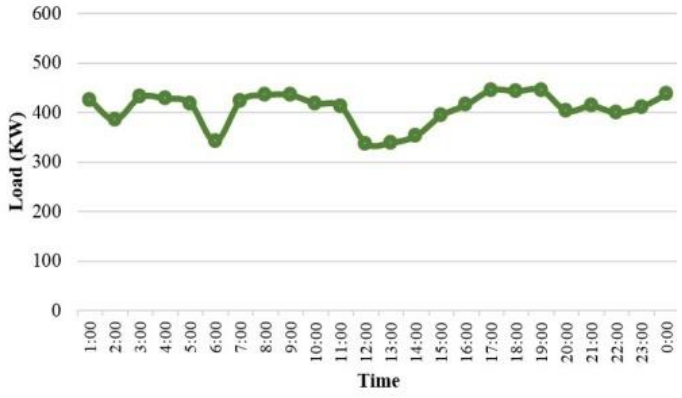

Figure 4. Load curve.

3.2. Penetration of 300 kWp PV Rooftop

Solar cells have the power received and the power produced. The power received can be calculated by mathematical equations by calculating the multiplication of the received solar radiation intensity with the cross-sectional area of the solar panel. The equation is as in equation.

$$P_{in} = I_r \, x \, A \tag{7}$$

which P_{in} is the input power due to solar radiation (Watt), I_r is the intensity of solar radiation (Watt/m^2), and A is the surface area of the solar cell (m^2).

Based on solar irradiation data obtained from Automatic Weather Station (AWS), the sun irradiation data in the JABODETABEK area has a good value with a peak value of 80% square meter irradiation. From the AWS data, the sun's irradiation value is converted to the form p.u (per unit) to facilitate the calculation process like in the Figure 5.

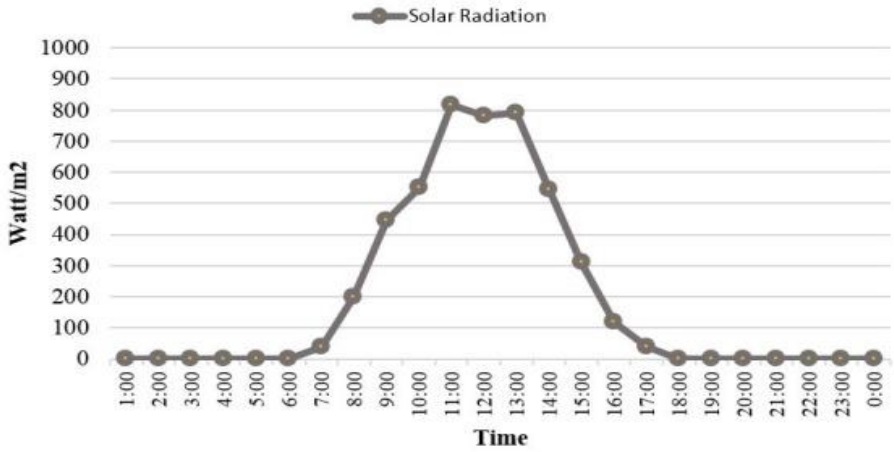

Figure 5. Sun irradiator curves.

The p.u value data is then multiplied by the internal PV capacity installed in a system installation. The final result of using solar irradiation data is knowing the amount of electrical energy that may be generated by a PV rooftop system in one day according to installed capacity because the energy pattern produced is by the solar irradiation curves.

Like In this research, PV rooftop with a capacity of 300 kWp is injected by considering the lowest daytime load value in the soy sauce industry, which is the research object. Using p.u data from solar irradiation, the value of electrical energy generated by the PV rooftop system is obtained by multiplying the p.u value by the PV rooftop system capacity.

Figure 6 explains about the electrical energy generated by a PV rooftop with a capacity of 300 kWp is maximally generated at a vulnerable time of 10:00 to 14:00. The amount of daily energy that can be generated by the PV rooftop is 1.686 kWh. Daily energy generated by rooftop PV with a capacity of 300 kWp when injected into the soy sauce industry's electric power system, can help reduce daily electricity consumption from PT PLN by 17,23% of the total daily consumption of electrical energy by 9.782 KWh.

3.3. Economic Analysis

In this study, in the process of economic analysis conducted to obtain conclusions related to the feasibility of rooftop PV investment to be carried out, then the material needs of the construction of a rooftop PV capacity of 300 kWp are determined. In analyzing the investment of a project to be carried out, parameters and assumptions are first determined that can support the calculation process of the economic impact that will result from a 300 KWp rooftop PV investment.

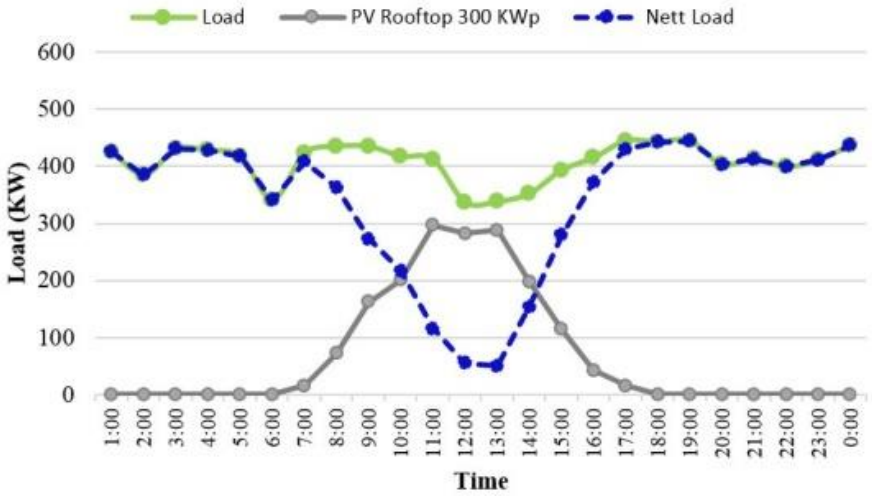

Figure 6. Netload of PT. PLN on Soy Sauce Companies.

This study assumes that capital is obtained from bank loans with a percentage of 50%: 50% with capital from the company's cash. Also, the period for capital lending to the bank is 12 years, with interest during the 10% return process like in the Table 2.

Table 2. Material Specification PV Rooftop.

No	Material Type	Capacity	Type	Amount
1	Solar Panel Luminous	250 Wp	Monocrystalline	1200 Panel
2	Inverter Luminous	50 kVA	3 Phase sine wave	7 Unit
3	Civil	1200 Panel	Alumunium	1 AU
4	Panel and cable	250 kW	Powder Coating	1 AU

Operational and Maintenance (O&M) costs are mandatory costs that need to be taken into account in the investment process because they are expenses that will inevitably occur due to the running of a system or production process, in this case, the production of electrical energy. This study determined that O&M costs in the first year were 2,5% of the total investment spent.

In addition, O&M costs will increase each year following the inflation rate in the country where the infestation occurs. In this study, O&M costs will increase annually by 3%, so the O&M costs allocated to the second and subsequent years are 2,5% of the investment value multiplied by the inflation rate of 3% each year.

The annual income derived from this 300 kWp rooftop PV investment is Rp. 713.020.594,20. This value is obtained from the production of electrical energy that can be produced during one day is 1.886 kWh multiplied by one year so the total electricity produced during one year is 688.390 kWh.

The final step in investment analysis is to provide an overview of the decision of whether the investment is feasible to proceed or not. The method used to determine whether an investment is said to be feasible or not to be realized is the Present Net Value (NPV) method. The NPV value is sought to find the net value (net) at present of an investment.

In this study, the NPV value obtained from the roof PV investment of 300 kWp using the calculation method of the Microsoft Excel application is Rp. 588,490,607 with an investment period of 25 years. The NPV value is said to be feasible to continue investing because if the NPV value > 0, then the investment project is feasible to continue, whereas if the NPV < 0, then the project is not feasible to continue. In addition, the IRR value obtained on the 300 Wp roof PV capacity investment is 7% with a payback period of 12 years.

4. Conclusion

From the discussion and analysis carried out in the previous chapter, the conclusion data can be obtained as follows:

- The construction of a rooftop PV capacity of 300 kWp injected into the electricity system in a food company in the city of Bekasi can reduce the daily dependency of electricity consumed by the electricity source of PT PLN by 17,23% of the total electricity consumption of 9.782 kWh.
- The investment of building a rooftop PV capacity of 300 kWp is feasible because it has a positive NPV value greater than zero at Rp. 588.490.607 with an investment life of 25 years, while the IRR value obtained from the investment is 7% with a long payback period (payback period) of 12 years.

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