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Technical Performance and Economic Feasibility Simulation of 200kWP Rooftop Solar Photovoltaic On grid on Industrial Estate Factory Building with Helioscope Software

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***Abstract*—Renewable energy resources are currently being developed in Indonesia. The government is also targeting renewable energy mix of 23% to be achieved in 2025. Solar Photovoltaic Generation System is one of a form of renewable energy that is currently being developed in Indonesia. Several industrial estates in Indonesia are filled with factories with fairly large buildings and have great potential for the development of Rooftop Solar Photovoltaic with the advantage of reducing land investment costs and of course without reducing the functionality of factory operational. The purpose of this research is to simulate the technical and economic performance of Solar Photovoltaic on grid 200kWP installed on the roof of a factory building using Helioscope software in an industrial estate area in West Java. The simulation results show that the average value for Global Horizontal Irradiance (GHI) is 138.2 kWh/m2, Electrical Energy Production is 21,977 kWh, and the Performance Ratio (PR) in one year is 78.06%. Meanwhile, the total annual Electrical Energy Production is 263,723.6 kWh. The total investment value of the Rooftop Solar Photovoltaic on Grid system in this factory building is Rp. 2,457,850,800. Based on the economic feasibility study made, it can be concluded that the Rooftop Solar Photovoltaic on Grid system with a power of 200 kWP in the factory building is economically feasible as long as the interest rate is less than 12.71% (Internal Rate of Return / IRR).**

Keywords: ***economic feasibility, helioscope, industrial estate, rooftop solar photovoltaic, technical performance***

***Abstrak*—Sumber daya energi terbarukan saat ini sedang banyak dikembangkan di Indonesia. Pemerintah juga menargetkan bauran energi terbarukan sebesar 23% untuk dapat tercapai pada tahun 2025. Sistem Pembangkit Solar Photovoltaic adalah salah satu bentuk dari energi terbarukan. Saat ini pada beberapa kawasan industri di Indonesia dipenuhi oleh pabrik-pabrik dengan gedung yang cukup besar dan memiliki potensi besar untuk pengembangan *Rooftop Solar Photovoltaic* dengan keuntungan mengurangi biaya investasi lahan dan tentunya tanpa mengurangi fungsi operasional pabrik. Tujuan dari penelitian ini adalah untuk mensimulasikan kinerja sisi teknis dan ekonomi dari *Solar Photovoltaic on grid* 200kWP yang terpasang pada atap gedung pabrik dengan menggunakan perangkat lunak *Helioscope* di kawasan industri di Jawa Barat. Hasil simulasi menunjukkan bahwa nilai rata-rata untuk *Global Horizontal Irradiance* (GHI) sebesar 138,2 kWh/m2, Produksi Energi Listrik sebesar 21.977 kWh, dan *Performance Ratio* (PR) dalam satu tahun adalah 78,06%. Sedangkan total Produksi Energi Listrik tahunan adalah 263.723,6 kWh. Nilai investasi total dari sistem pembangkit *Rooftop Solar Photovoltaic on Grid* pada gedung pabrik ini adalah sebesar Rp. 2.457.850.800. Berdasarkan studi kelayakan ekonomi yang dibuat, dapat disimpulkan bahwa sistem pembangkit *Rooftop Solar Photovoltaic on Grid* dengan daya 200 kWP pada gedung pabrik dinyatakan layak secara ekonomi selama suku bunga kurang dari 12,71% (Internal Rate of Return/IRR).**

Kata kunci: ***kelayakan ekonomi, helioscope, kawasan industri, rooftop solar photovoltaic, kinerja teknis***

I. Preliminary

Energy is the main driving factor in the development of human civilization, but currently most of the energy still comes from fossil energy which causes many negative effects, such as air pollution, limited availability of fuel / energy sources, and the national security issues due to most of this energy sources are still imported. We need a big plan in the process of energy transition to renewable energy that is more green (ecological), cheap (economical), sustainable and abundant in nature. [1]. Renewable energy development is also supported by national development priorities that have been stated in the Energy Law No. 30 of 2007, PP. 79 of 2014 concerning National Energy Policy

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(KEN), Nawa Cita, RPJMN 2015–2019, and Permen No. 12 of 2017 concerning Utilization of Renewable Energy Sources for the Provision of Electricity [2]. In the National Energy Policy (KEN), the Government has also targeted 23% to achieve renewable energy by 2025 [2]. Of course, in the program to increase the capacity of electrical energy, the government will also pay attention to the use of renewable energy.

One of the abundant energy sources on earth is solar energy with a potential energy received of 3.9 x 106 EJ (1 EJ = 1018 J) every year [3]. The intensity of solar radiation on a clear day reaches 1 kW / m^2 and globally the power of solar energy reaches 160,000 TW [4]. Indonesia, in the Report of Indonesia's Clean Energy published by IESR, has 207.8 GW as potential for electric power from solar that can be generated [5]. Data from the Ministry of Mineral Resources and Energy of the Government of Indonesia states that the energy potential from solar power that can be generated throughout mainland Indonesia is 4.8 kWh / m^2 / day with a radiation duration of 10 to 12 hours per day [6]. With an area of $\pm$ 9.8 million km^2, the potential for electrical energy that can be generated by solar energy reaches 47 million GWh / day [7] [8]. For this reason, solar energy is a renewable energy source that has enormous potential.

On the other hand, industrial estates are areas filled with buildings and factories that are large enough to have great potential for developing solar power plants. The solar power plant can take advantage of the factory roof so that it can reduce the cost of land investment without reducing the operating function of the factory. The development of Solar Photovoltaic on the factory roof also has advantages when compared to large-scale Solar Photovoltaic that is easier and cheaper integration with existing electricity systems, reduces land investment costs, reduce the use of electrical energy from electricity supply companies, and reduce greenhouse gas emissions [9]. The government is also serious in developing Rooftop Solar Photovoltaic, especially in industrial areas with the issuance of PERMEN ESDM NO. 49/2018 jo. PERMEN ESDM NO.13 / 2019 jo. PERMEN ESDM NO.16/2019 which regulates in terms of installation, operating permits, and transactions with PLN as electricity supply companies in Indonesia [9]. For this reason, study in the development of Rooftop Solar Photovoltaic in Industrial areas is very necessary.

Previous study conducted by DJ Damiri et al. in 2019 discussed the design of the 52.5 kWp Rooftop Solar Photovoltaic On grid on the roof of a factory building in the West Java industrial area. The analysis made includes a technical simulation of the Solar Photovoltaic performance [10]. Another study conducted by M.R. Wicaksana et al. in 2019 also discused the design of solar photovoltaic 158kWp on Bali's government office [11]. However, this study has not discussed the economic feasibility study of the design. This economic feasibility study is very important to do, especially in determining the decision making whether a project will be invested or not [12]. Therefore, in this study a simulation of the technical performance and economic feasibility of a 200 kWP Rooftop Solar Photovoltaic will be made using the Helioscope software on the roof of a factory building in an industrial area in West Java. The parameters to be used are Global Horizontal Irradiance (GHI), Total Electrical Energy Production, and Performance Ratio (PR) as a result of simulation using Helioscope software and by adding the calculation and analysis of economic feasibility study.

The approach taken to determine the economic feasibility refers to study conducted by Camilo et al in 2017 and I.B.K Sugirianta et al in 2016, where the Life Cycle Cost method is used to determine the economic feasibility of a project as a further analysis of whether the design of the project is economically feasible and profitable or not [13] [14]. This method calculates the overall cost consisting of planning, project execution, Operation&Maintenance, replacement, and salvage value over the life of the system. The parameters which be calculated is Levelized Cost of Energy (LCoE), Net Present Value (NPV), Internal Rate of Return (IRR), Profitability Index (PI) and Discounted Payback Period (DPP).

II. Method / Design

This study was conducted in PT XYZ factory building in an Industrial Estate in West Java. This factory has a power contract capacity of 200 kVA to PLN (the rates of group B2 / Low Voltage). Based on the Minister of Energy and Mineral Resources regulation number 49 of 2018, the maximum capacity of the rooftop solar system is 100% of the customer's connected power [9]. So in this study the capacity of 200kWp solar photovoltaic was chosen to maximize the potential of the factory building roof top.

Previous study conducted by I.H.Rosma et al in 2018 discussed about the optimum solar photovoltaic energy production using sun tracker. The purpose is to get the optimum solar radiation based on the direction of the sun. It can be seen from the results that using sun tracker could increase the energy production 20%-60% [15] [16]. Research on the factory building rooftop was carried out on the north side of the building to get optimum solar energy radiation because the West Java industrial area is located on the south of the equator line.

In general, the steps in this study are:

1. Retrieval of data (location on google maps, the area of the factory roof, and the placement location of electrical equipment and inverters).
2. Creating a 200kWp Rooftop Solar Photovoltaic design on the roof of the factory building from electrical, civil design, and determining the type of material used with standard references based on instructions from the Directorate General of EBTKE - KESDM.
3. Simulating technical performance of the 200kWp Rooftop Solar Photovoltaic On grid on the roof of the factory building using Helioscope software which will produce the parameters of Global Horizontal Irradiance (GHI), Total Electrical Energy Production,

and Performance Ratio (PR).

4. Calculating economic feasibility parameters of the 200kWp Rooftop Solar Photovoltaic using the Life Cycle Cost method with the calculation of the parameters Levelized Cost of Energy (LCoE), Net Present Value (NPV), Internal Rate of Return (IRR), Profitability Index (PI) and Discounted Payback Period (DPP). The different variable of interest rates is used to analyse the optimum method of investment.

In order to calculate the technical performance parameters of solar photovoltaics, meteorological parameters are needed to obtain accurate simulation results for each specified location [17]. These data include solar radiation, air temperature, water relative humidity, wind, etc. In this study, Helioscope software was used in which there was already complete meteorological parameter data spread across all locations on earth. Helioscope is a WEB based program released by Folsom Labs. We can determine the study approach in calculating the performance of Solar Photovoltaic, that is an approach by determining the total power of the system or an approach by utilizing the total available area. In this study, the approach taken is to determine the total power of the system, which is 200 kWp [18].

Helioscope analyzes using weather data from meteonorms which provides accurate and representative data with more than 30 different weather parameters for typical year data, has more than 8,000 weather station data, 5 geostationary satellites, and aerosol climatology that is globally calibrated [19].

Technical databases are also available on Helioscope such as solar modules and inverters. Array configurations can also be made in the program. The simulation results will provide Solar Photovoltaic performance parameters, namely Global Horizontal Irradiance (GHI), Total Electrical Energy Production, and Performance Ratio (PR), as well as other supporting parameters [20].

1. Global Horizontal Irradiance (GHI)

Global Horizontal Irradiance (GHI) is the total solar radiation on a horizontal surface. Basically, this GHI is the sum of Direct Normal Irradiance (DNI), Diffuse Horizontal Irradiance, and radiation reflected from the ground [10] [21]. The unit of GHI is kWh / m^2.

2. Total Electrical Energy Production

The total electrical energy production of a Solar Photovoltaic is the result of the sum of the AC current generated by the system for a certain duration of time [10]. The unit of the total electrical energy production of Solar Photovoltaic is kWh.

3. Performance Ratio (PR)

Performance Ratio (PR) is the quotient between the total AC electrical energy of Solar Photovoltaic and the theoretical calculated output of Solar Photovoltaic with the assumption that the Irradiance received is converted into electrical energy according to the generating capacity. PR is fully defined in IEC 61724 [10]. The complete PR can be calculated with the following equation:

$$PR = \% \frac{AC\ yield\left[kWh\right] \times 1\left[\frac{kW}{m^2}\right]}{DC\ Inst.Cap.\left[kWp\right] \times PlaneArrayIrrad.\left[\frac{kW}{m^2}\right]} \times 100 \quad (1)$$

The overall losses from Solar Photovoltaic such as module losses, reduced low light efficiency, temperature, inverters, shading, cables, and fouling are included in the factors calculated in PR [20].

In calculating the economic feasibility study, the following parameters are used:

A. *Levelized Cost of Energy (LCoE)*

Levelized Cost of Energy (LCoE) is the cost of electrical energy generated from a certain energy source to reach break even for a certain period of time. Usually the time period is determined based on the life time of a generating system [10] [14] [22].

To calculate LCoE, Life Cycle Cost modeling is used. Life Cycle Cost Modeling is modeled by the United States Department of Energy and regulated in the National Bureau of Standards, 1980. This model considers the total relevant costs of an energy system ranging from design costs, civil buildings, materials, components and operating costs, especially the initial investment costs, maintenance costs, future equipment replacement costs, security, insurance value and salvalge value [10] [14].

The LCoE equation is as follows:

$$LCoE \frac{I + \sum_{t=1}^{n} \frac{LCC}{(1+r)^t}}{\sum_{t=1}^{n} \frac{Et}{(1+r)^t}} \quad (2)$$

Where:

It : the investment cost for the t-year period of generating

LCCt : Life Cycle Cost (life cycle cost) for the t-year period of the power plant

r : the prevailing interest rate

Et : Production of electrical energy (kWh) for the period year t

n : generator life

B. *Net Present Value (NPV)*

Net Present Value (NPV) is the sum of the income and expenditure of a project in a time period that has been made in the present value. [13] [14]. The NPV equation is as follows:

$$NPV = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t} \quad (3)$$

Where

Bt : gross profit during year t

Ct : gross investment cost during year t
n : project life (lifetime)
i : interest rate

Projects can be accepted if NPV> 0 and rejected if NPV <0. If NPV = 0 then the project is neither profitable nor loss.

C. Internal Rate of Return (IRR)

Internal Rate of Return (IRR) is the interest rate where total income in present value with total expenditure / investment in present value will be the same, in other words, the interest rate where the NPV parameter is equal to zero. [13] [14]. The IRR equation is as follows:

$$IRR = i + \left\{ \frac{NPV}{NPV^1 - NPV^2} \left(i^1 - i^2 \right) \right\} \quad (4)$$

Where
i : interest rate
i^1 : interest rate with a positive NPV result
i^2 : interest rate with a negative NPV result
NPV^1 : positive NPV value
NPV^2 : negative NPV value

If IRR> i_u then the project is economically profitable, on the other hand, if IRR <i_u then the project is rejected (i_u = the prevailing general interest rate).

D. Profitability Index (PI)

Profitability Index (PI) is the ratio of income in present value with expenditure in present value [13] [14]. The PI equation is as follows:

$$PI = \frac{Income\ in\ PV}{Expenditure\ in\ PV} \quad (5)$$

If PI> 1 then the project is economically profitable, on the contrary, if PI <1 then the project is rejected

E. Discounted Payback Period (DPP)

Discounted Payback Period (DPP) is the time required to return investment costs from future income by considering the time value of money [14]. The DPP equation is as follows:

$$DPP = \frac{\text{Investment costs}}{\text{Future income in } PV} \quad (6)$$

When the DPP <n, then the project can be done (n = time required).

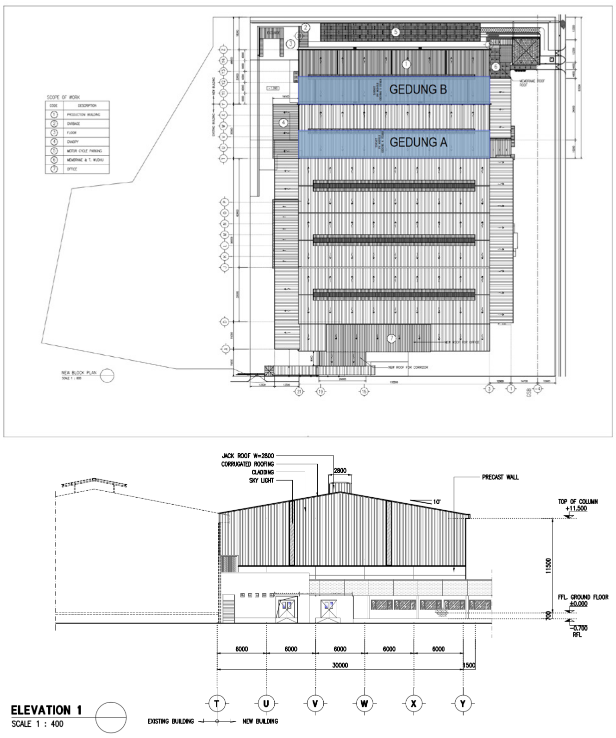

Figure 1. Roof layout

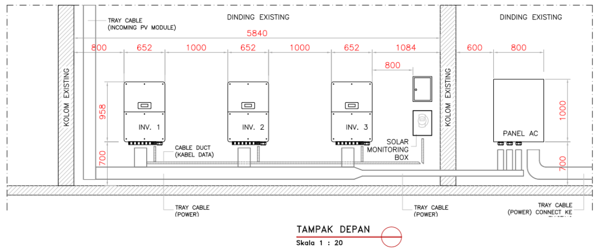

Figure 2. Inverter layout and other electrical equipment

III. Results and Discussion

A. The study location details

This study was conducted in a factory building located in the industrial area of West Java with latitude 6.3^0 S and longitude 107.1^0 E. The location of the roof of the building as a study location is shown in Figure 1, namely North Building A and North Building B with total dimensions in each building is 105 meters long and 15 meters wide with an area of 1,575 m^2. So that the total area of the factory building roof for study is 3,150 m^2. The roof height from the ground is 11.5 meters with the slope of the roof angle is 10^0, while the azimuth angle of this building is -20^0. The

The location of inverters and other electrical equipment such as AC Panel and Solar Monitoring in the west side of the building is shown in Figure 2.

B. 200kWp Solar Photovoltaic design plan on the factory

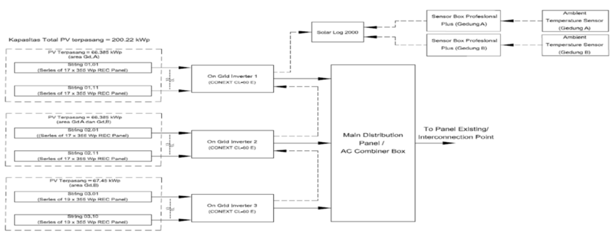

Figure 3. Solar Photovoltaic block diagram system plan

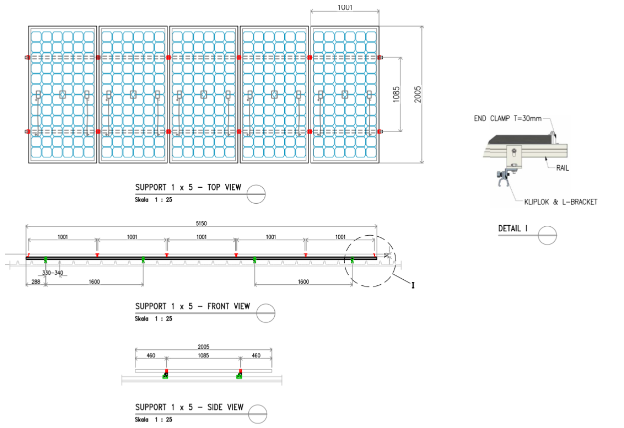

Figure 4. Details of Solar Photovoltaic module support

building rooftop

The Solar Photovoltaic system is planned to be installed with a total capacity of 200.22 kWp using a Solar Photovoltaic module with a capacity of 355Wp , total of 564 units, with the type of module is REC TWINPEAK 2S72 355Wp as seen in Figure 3. The Solar Photovoltaic will be connected to 3 inverters with a capacity of 66kVA with the type of inverter is Conext CL-60E Schneider. The total number of strings connected to the 3 inverters is 32 strings with each string 17 to 19 Solar Photovoltaic modules arranged in series. The monitoring tool used is Solar Log 2000 with monitored data including irradiance, ambient temperature, and module temperature.

In civil design, the Solar Photovoltaic module placement will use the Klip-lok system with L-Bracket. Detailed appearance of how to install the module is presented in Figure 4.

With the Solar Photovoltaic design plan as explained earlier, the total investment required to build a 200 kWp Solar Photovoltaic on the rooftop of the factory building is:

Solar Photovoltaic module	838,538,400 IDR
Solar Photovoltaic Forwarder	206,312,000 IDR
Inverters	420,000,000 IDR
Installation (including installation materials & services)	993,000,400 IDR
Total Investment	2,457,850,800 IDR
Total Investment/Wp	12,275.75 IDR/Wp

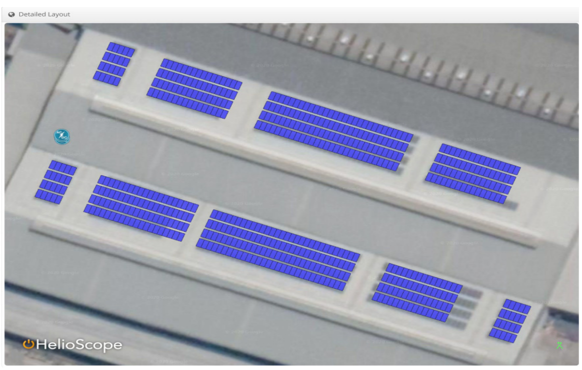

Figure 5. Solar photovoltaic configuration on helioscope

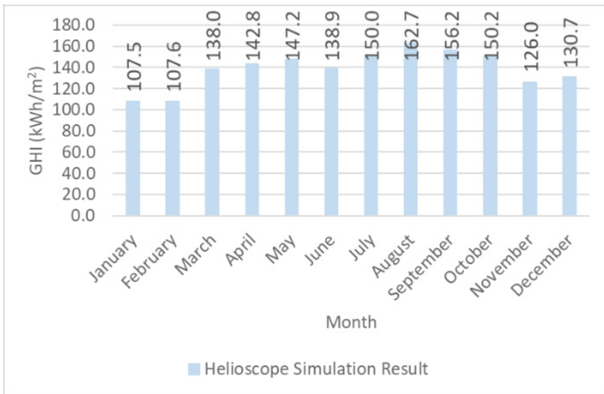

Figure 6. Global horizontal Irradiance (GHI kWh / m2)

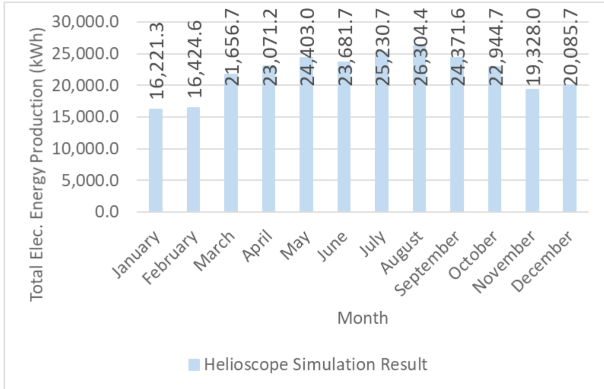

Figure 7. Total Electrical Energy Production (kWh)

The total investment is calculated in Rupiah depend on assumption 1 US$ = 14,800 IDR per September 2020 [23].

C. Analysis of the technical performance simulation for the 200kWp Rooftop Solar Photovoltaic On grid

The technical performance of 200kWp Rooftop Solar Photovoltaic On grid on the factory building rooftop is simulated on Helioscope Software. The configuration of Rooftop Solar Photovoltaic modules on Helioscope can be seen in Figure 5. This simulation produces parameter data in the form of Global Horizontal Irradiance (GHI), Total Electrical Energy Production, and Performance Ratio

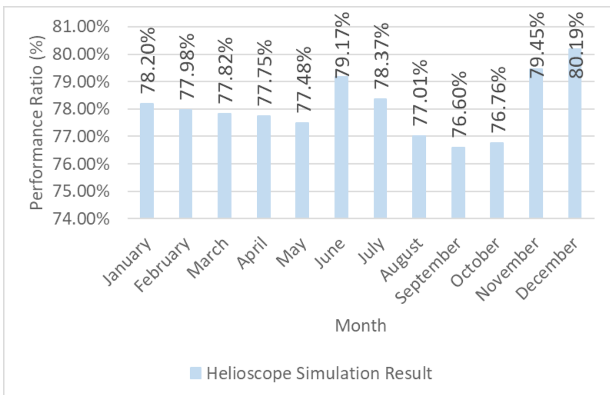

Figure 8. Performance ratio (PR)

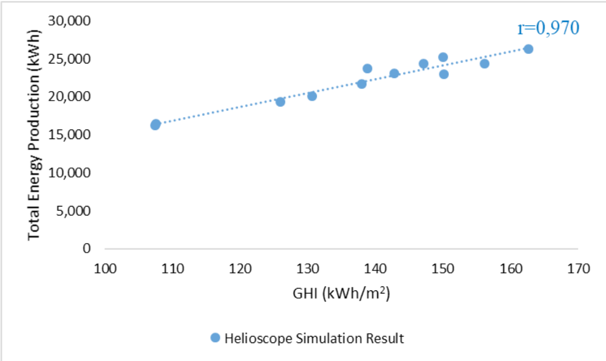

Figure 9. GHI and electrical energy production correlation

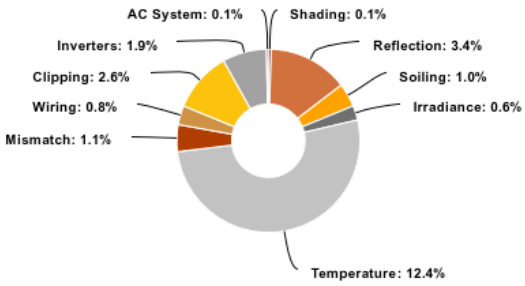

Figure 10. The losses of the solar photovoltaic system from helioscope simulation results

(PR).

The GHI (Figure 6) at the factory site varies from January to December with the highest GHI of 162.7 kWh/m² in August and the lowest GHI of 107.5 kWh/m² in January. The average GHI in one year is 138.2 kWh/m² and the total GHI in one year is 1,657.8 kWh/m².

Total Electrical Energy Production (Figure 7) of Rooftop Solar Photovoltaic produces the highest energy of 24,304.4 kWh in August and the lowest energy is 16,221.3 kWh in January. The average electrical energy production in one year is 21,977.0 kWh and the total electrical energy production in one year is 263,723.6 kWh.

Performance Ratio (PR) (Figure 8) of the Rooftop Solar Photovoltaic varies with the highest value of 80.13% in December and the lowest value of 76.60% in September with an average PR in one year of 78.06%.

From the simulation results obtained from the Helioscope software, it shows that the energy production

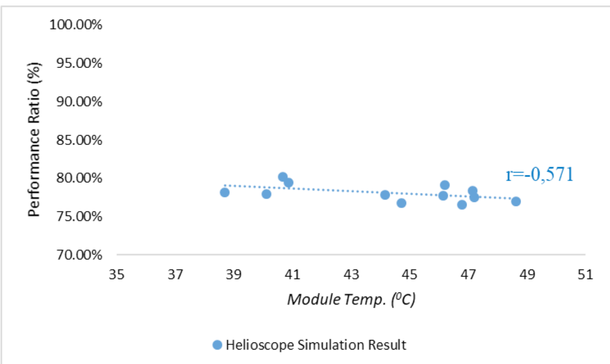

Figure 11. Solar photovoltaic modules temp. and PR correlation

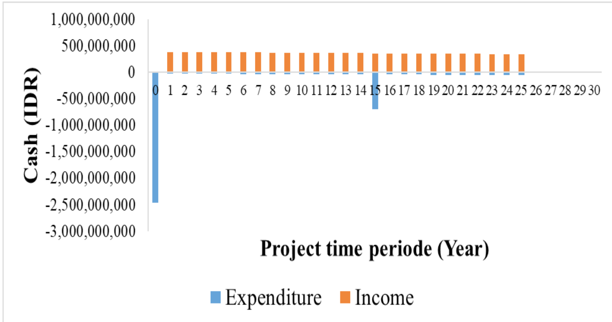

Figure 12. 200kWp rooftop solar photovoltaic project yearly cash flow

results from Solar Photovoltaic are very dependent on the irradiance value of sunlight. This can be seen in Figure 9 where the correlation between GHI and Energy Production has a value of 0.970 which means it has a very strong positive correlation, which means that the greater the GHI value, the greater the value of energy production obtained.

The Performance Ratio value is the overall value of Solar Photovoltaic losses in the form of module losses, reduced low light efficiency, temperature, inverters, shading, cables, and impurities/dust. From the simulation results obtained in Figure 10, it can be seen that the temperature in the Solar Photovoltaic module is the biggest factor that contributes to system losses, which is 12.4%. Base on this situation, the study is continue to analyze the correlation factor between the module temperature and the PR obtained from the Helioscope simulation results. The results in Figure 11 show that the correlation between the temperature of the Solar Photovoltaic module and the PR is -0.571 which means it has moderate negative correlation, meaning that the greater the module temperature value, the PR value tends to decrease.

D. Analysis of the economic feasibility calculation of the 200kWp Rooftop Solar Photovoltaic

Analysis of the economic feasibility calculation of the 200kWp Rooftop Solar Photovoltaic On grid on the factory building rooftop is done by calculating the parameters of Levelized Cost of Energy (LCoE), Net Present Value (NPV), Internal Rate of Return (IRR), Profitability Index (PI) and Discounted Payback Period (DPP). Some predefined input data such as:

1. The total investment cost of the 200kWp Rooftop Solar Photovoltaic On grid is 2,457,850,800 IDR.
2. The total life time of the Solar Photovoltaic system is 25 years, which is obtained from the Power Output Warranty of the Solar Photovoltaic Module [24].
3. The total life time of the inverter is 15 years [25].
4. The operational and maintenance costs of the Solar Photovoltaic system are 1% of the total investment value [24].
5. The annual degradation for the energy output of the Solar Photovoltaic system is 0.5%/year [24].
6. The interest rate used is 0% (assumed that the investment prices uses own capital), 10%, & 15% (assumed that the investment prices uses bank loan

Table 1. Economic Parameter Calculation Results of 200kWp Solar PV

No	Economic Parameters	Interest Rate 0%	Interest Rate 10%	Interest Rate 15%
1	Levelized Cost of Energy (LCoE) (IDR/kWh)	649.55	1,259.68	1,652.22
2	Net Present Value (NPV) (IDR)	5,079,930,439	478,959,393	-306,226,374
3	Internal Rate of Return (IRR) (%)	12.71	12.71	12.71
4	Profitability Index (PI)	3.07	1.19	0.88
5	Discounted Payback Period (DPP) (Year)	6.95	12.80	>25

capital in Indonesia) [26]

7. The average annual inflation is 3%/year based on the average inflation for the last 5 years [27].
8. The selling price of Solar Photovoltaic energy production uses the applicable electricity rates from PLN which similar with the rates of group B2 / LV, which is 1,467.28 IDR/kWh [28] because the electrical energy produced by Solar Photovoltaic is used for its own use in order to reduce the use of electrical energy from the electricity supply companies.

From the data above, a project cash flow can be made during the life time of the Solar Photovoltaic system as seen in Figure 12.

From the project cash flow, the Economic parameters can be calculated and the result is shown in Table 1. The value of LCOE, DPP increase and NPV, PI decrease when the interest rate value increases. It means that interest rate value affect the economic feasibility result. The profit of the project when uses the own capital will be higher than when uses the bank loan capital. The limit of the interest rate that is allowed to keep the project feasible is by looking at the value of the IRR. From the calculation results, it can be seen that the IRR value is 12.71%. For this reason, if the interest rate is more than the IRR value, it can be ascertained that the economic feasibility study of the project is not feasible.

Based on the economic feasibility limitations which has been stated earlier in the Method / Design chapter, it can be concluded that the 200kWP Rooftop Solar Photovoltaic On grid on the factory building rooftop with the rates of group B2 / LV is economically feasible as long as the interest rates is less than 12.71%. The most optimum investment is obtained when the interest rate uses 0% or when the investment prices uses own capital.

IV. Conclusion

From the study results, it was found that the simulation of technical performance and the calculation of economic parameters for 200kWp Rooftop Solar Photovoltaic On grid on the factory buildings rooftop in industrial areas has been successfully carried out on the rooftop building with the total area used is 3.150 m^2, the roof height from the ground is 11.5 meters with a slope of the roof angle is 10^0, while for the azimuth angle of this building is -20^0. The Solar Photovoltaic module is installed using the Klip-lok method with L-bracket by adjusting with the shape of the roof at the study location. The total capacity of Solar Photovoltaic is 200.22 kWp by using a Solar Photovoltaic module with a capacity of 355Wp and total 564 pieces using REC TWINPEAK 2S72 355Wp type. The Solar Photovoltaic is connected to 3 inverters with a capacity of 66kVA using Conext CL-60E Schneider inverter. The total number of strings connected to the 3 inverters is 32 strings with each string 17 to 19 Solar Photovoltaic modules arranged in series. The monitoring tool used is Solar Log 2000 with monitored data including irradiance, ambient temperature, and module temperature.

The technical performance simulation of the 200kWp Rooftop Solar Photovoltaic On grid on the factory building rooftop has an average GHI and Electrical Energy Production with value 138.2 kWh/m^2 and 21,977.0 kWh with total electrical energy production of 263,723.6 kWh in one year. The Performance Ratio (PR) of the 200kWp Rooftop Solar Photovoltaic On grid has an average PR in one year of 78.06%. The energy production results from Solar Photovoltaic are very dependent on the irradiance value of sunlight with a correlation value of 0.970 which means that it has a very strong positive correlation, meaning that the greater the GHI value, the greater the energy production value obtained. The PR value itself is a factor that shows the total system losses as a whole system where the temperature in the Solar Photovoltaic module is the biggest factor that contributes to system losses, which is 12.4%. The correlation value between the temperature of the Solar Photovoltaic module and the PR is -0.571 which means that it has moderate negative correlation, meaning that the greater the temperature of the module, the PR value tends to decrease.

The total investment value of 200kWp Rooftop Solar Photovoltaic On grid on the factory building rooftop is 2,457,850,800 IDR. Based on the economic feasibility calculation, it can be concluded that the 200kWP Rooftop Solar Photovoltaic On grid on the factory building rooftop with the rates of group B2 / LV is economically feasible as long as the interest rates is less than 12.71%. The most optimum investment is obtained when the interest rate uses 0% or when the investment prices uses own capital.

This study only focuses on one study location and with a fixed capacity of 200kWp. For further study, it can be carried out for several locations and several variations in the capacity level of Solar Photovoltaic so that in the end it can be further developed, especially in the preparation of standardized Rooftop Solar Photovoltaic designs for industrial estates both in terms of technical performance and economic feasibility aspects.

This study also focuses on design, technical performance and economic feasibility simulation of 200kWP rooftop solar photovoltaic on grid. The current study has not explained further about the potential for saving electrical energy that can be generated from solar PV by comparing the electrical energy from solar PV and PLN. For further studies, the calculation of electricity savings and the calculation of the potential for carbon footprint reduction can be carried out to be able to provide further information on the advantages of developing solar PV, especially in industrial estate areas.

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