Optimization of Photovoltaic Potential in On-Grid Solar Power Plants

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Abstract. Solar power plants are power plants that use solar radiation to convert photon energy from the sun's light into electrical energy. The installation of solar power plants is very important because the majority of solar panel installations are carried out on the roof. In this paper discussed the installation of a solar power plant in Karawang site. On - Grid system means the solar power plant is connected to the main power from electricity company. Therefore, this system does not require energy storage. The sunlight potential is explored using global solar atlas. Solar energy in Karawang has great potential with a value of 1483.9 kWh/kWp per kilowatt which has the potential to be used as a solar power plant. The total savings from the number of installed solar PV capacity can be calculated by multiplying the total installed solar PV capacity, which is Rp. 8,032,151,808/month

Keywords: Solar Power Plant, On-Grid, solar energy, main power

1. Introduction

In this modern era, Indonesia has made rapid progress in the provision of electrical energy. Almost the entire archipelago is now illuminated, signaling the nation's commitment to developing infrastructure and improving people's lives. However, along with the times and global demands, energy sources no longer rely solely on PLN. That's where the role of renewable energy, especially solar energy, begins to shine brightly. Indonesia, with its tropical climate that is rich in sunlight for most of the year, has tremendous potential to utilize solar energy. Solar energy is not only an alternative solution, but also an opportunity to realize a more sustainable future.

In response to concerns about environmental pollution, many policy makers together with governments and have been continuously striving to promote clean and non-polluting technologies in the electricity sector. The promotion of renewable energy sources such as solar, wind, biomass, fuel cells, geothermal, hydro, etc. is important for the electrical industry. On the other hand, solar photovoltaic systems have become significantly more important and prioritized among all renewable energy sources. In the past, photovoltaic systems were mostly off-grid and operated in isolated conditions. But due to advances in PV technology and power electronics, these started to boom as on-grid PV systems [1].

Solar power plants are those that use solar panels to convert photon energy from the sun's light into electrical energy. Weather and geographical conditions, which have a

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significant impact on the efficiency of solar power plants, are the drawbacks of using solar energy [2].

The need for more environmentally friendly energy sources has grown in recent decades. Decision-makers in all countries have therefore developed plans to rely on renewable energy sources as part of a long-term strategy. These strategies reduce dependence on conventional energy sources and replace conventional energy sources with alternative energy technologies. As a result, there is a growing movement in the global community to use sustainable energy sources instead of relying so heavily on conventional fossil fuels [3]. In [4][5], the optimization using real-time and hybrid two-stage stochastic in renewable energy application.

2. Method

2.1. On-Grid Solar Power Plants

The system is connected to the mains power grid, delivering electricity directly from the solar panels to the power grid. Excess or insufficient energy can be channeled back into the power grid. So this system does not require energy storage [6]. Solar power plants are power plants that use solar radiation. The use of solar cells (*photovoltaic*) functions to convert solar radiation into DC (*Direct Current*) electrical energy which can be converted into AC electricity (*Alternating Current*) using a device called an inverter. During that day there is still the sun even though it is cloudy, solar panels can still produce oscillatory energy because the main function of solar panels is to capture radiation from the sun's heat.

2.2. The main components of solar power plants

2.2.1 Solar Panel

Solar panels are a collection of solar cells that are arranged in such a way that they are effective in absorbing sunlight The absorption of sunlight is carried out by solar cells. Solar cells themselves are made up of various *photovoltaic* components or components that can convert light into electricity. Generally, solar cells consist of silicon layers that are semiconductor, metal, anti-reflective, and metal conductor strips in figure 1 as follows.

Fig.1. Solar panel

2.2.2 Inverter

Inverter in solar PV is a component or tool in a solar panel system. The inverter can convert the DC current generated by the solar panel into AC electric current. Inverters are also divided into 3, namely On Grid, Off Grid and hybrid inverters in figure 2 as follows [7]. The functions of the inverter include:

1. Changing the current
2. Import excess power
3. Stabilizing voltage
4. Export of electrical energy

Fig.2. Inverter On-Grid

2.2.3 Battery

Solar panel batteries in figure 3 are components of Solar Power Plants to store the energy produced by solar panels during sunlight. Not only does it function to store energy temporarily, solar panel batteries will also supply electricity when the solar panels are not producing energy.

Fig. 3. Battery

2.2.4 Cable

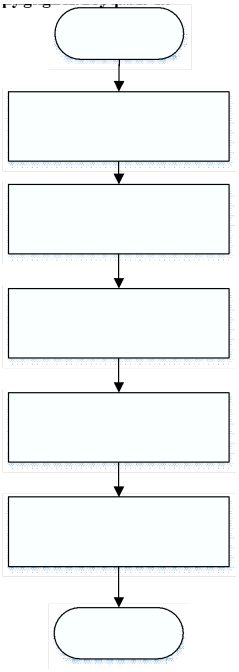
Cables used to connect solar panels to other components in a solar energy system, such as inverters, batteries, or home power grids. These cables are specifically

designed to handle the DC (direct current) electrical current generated by solar panels. The source of origin of the solar panel cable may vary. Solar Panel cables in figure 4 are manufactured specifically for renewable energy use. When choosing a solar panel cable, it is important to pay attention to its reliability, resistance to extreme weather, and ability to handle the electric current generated by the solar panel. Solar panel cables are typically designed to withstand UV rays, high temperatures, and other environmental conditions that may be encountered at the solar panel installation site.

Fig. 4. Solar Panel Cable

2.2.5 Power supply sequence scheme

The flow of power distribution from the PV to the load can be seen through Figure 5 below.



3. Result and Discussion

3.1. Installation Location

The solar PV installation project is located on Jl. Mitra Raya II No.F2, Parungmulya, Ciampel District, Karawang, West Java 41363 in Figure 6. The plan to install solar PV is carried out on a spandex roof with an area of 428m2 with a total number of solar panels of 1856 PV pieces with a capacity of 555wp per PV.

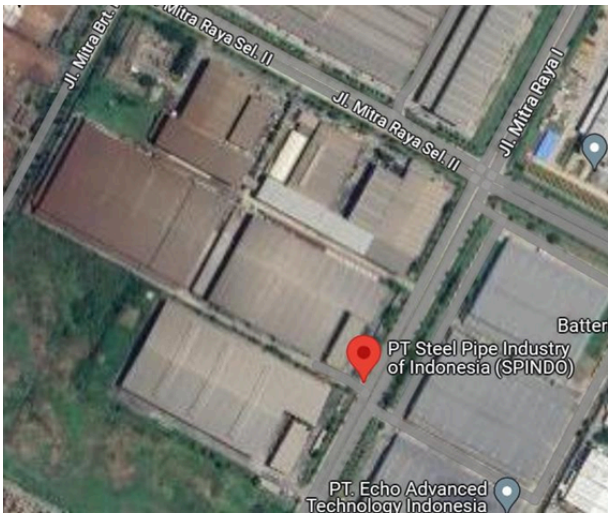


Fig 6. Map of the installation location

3.2. Sunlight Potential

Global Solar Atlas in figure 7 is a website commonly used by PT. RENUS GLOBAL INDONESIA to determine the level of solar radiation in an area as a reference for the installation of solar power plants because the website provides the necessary data for solar power plant installation planning. Solar energy in Karawang has great potential with a value of 1483.9 kWh/kWp per kilowatt which has the potential to be used as a solar power plant [8].

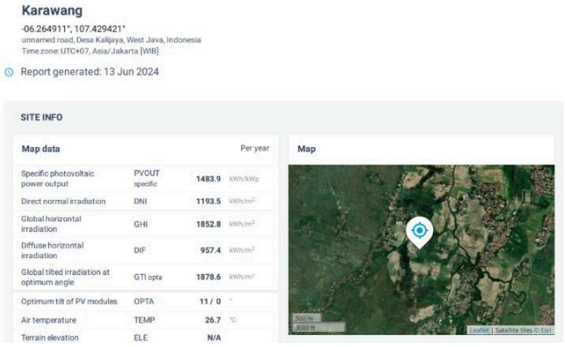


Fig 7. Data global solar atlas

3.3. Module Type Selection

The type of solar panel used in the PT. SPINDO is Monocrystalline Silicon and uses the Jinko brand with a capacity of 555wp per PV, using the jinko brand because the products of jinko are among the tier 1 Bloomberg. The type of solar cell component in figure 8 is the most widely used type because of the advantages it has. These solar cells are made of silicon that is sliced thinly using a machine. The slices can become thinner and also the characteristics are identical due to the use of this cutting machine.

Fig. 8. Monocrystalline Silicon Solar Panel

3.4. Roof Selection

The selection of the roof for the installation of solar panels is very vital because the majority of solar panel installations are carried out on the roof. The indication of the roof can be installed with PV by looking at the structure and materials used as a roof truss. Analyzing the type of roof truss is also very necessary for reference whether the building is strong to support the weight of solar panels and to determine how many solar panels can be installed on the roof in figure 9 as follows

Fig. 9. Roof Documentation

3.5. Permitted Solar PV Capacity

According to the regulations from PLN regarding the installation of solar PV, the capacity allowed to be installed is 15% of the total power installed at PT. SPINDO.
Allowable solar PV capacity = Installed power x 15%
1,050,000VA =
2,500,000VA + 4,500,000VA x 15%
So, the total capacity of solar power plants that can be installed is 1,050,000VA

3.6. Installed Solar PV Capacity

The capacity of the panels installed at PT. SPINDO is 1,030,080kWp, why is only 1,030,080 installed instead of 1,050,000 because it is in accordance with the demand for savings.

3.7. Number of PV Panels

The number of PV panels installed in Spindo can be calculated by dividing the installed solar PV capacity (kWp) by the power per PV panel (WP). It is known that the power per PV panel is 555 WP.

Number of PV panels = Installed solar PV capacity (kWp) / Power per PV panel (WP)
So, the number of PV panels installed in Spindo is:
Number of PV panels = 1,030,080 kWp / 555 WP = 1856 panels

3.8. Total Savings

The total savings from the number of installed solar PV capacity can be calculated by multiplying the total installed solar PV capacity by:
Installed solar PV capacity x solar panel absorption time efficiency = Energy Revenue/Day
1,030.08 x 3 hours = 185,414.4 kWp
185.414,4 kWp x 30hari = 5.562.432 kWp
5,562,432 kWp x Rp.1444 (basic electricity tariff) = Rp. 8,032,151,808/month

So, the total savings obtained by PT. SPINDO for one month is Rp. 8,032,151,808 which is equivalent to Eight Billion Thirty-Two Million One Hundred Fifty-One Thousand Eight Hundred and Eight Rupiah.

4. Conclusion

By using solar power plants, the systems not only save the cost of monthly electricity payments, but also reduce the amount of pollution and can reduce the use of fossil fuels as a power plant because solar panels themselves only use radiation from sunlight with the lifetime of solar panels which is approximately 50 years.

Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article (salin dan tempel kalimat ini ke naskah).

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