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An Analysis Of Solar Energy Potential Based On Methods Weibull And Reyleigh Using Data From Weather Station

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Abstract

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Electrical energy is the primary need of the Indonesian people. Most of the electrical energy used comes from fossil energy such as fuel oil, gas, and coal. Fossil fuels themselves can cause environmental damage and include non-renewable energy, so it is necessary to study the potential for power plant development using alternative energy. This study discusses the analysis of the energy potential of natural resources, namely sunlight. Where the energy potential is carried out using 2 methods, namely the Weibull distribution and the Rayleigh distribution. The results showed that the Weibull distribution gave more accurate results than the Rayleigh distribution. It is known from the Mean square error value of the Weibull distribution that it was 6.4% in 2013 and 9.3% in 2014, and from the Rayleigh distribution, it was obtained 9% in 2013 and 18% in 2014.

Keywords: Energy, Weibull distribution, Rayleigh distribution, Power density, Mean square error PLTS, Campus Lighting, Energy Efficiency

1. Introduction

Indonesia has a population of 270.2 million people based on 2020 data from the Central Statistics Agency. A large number of people affects the consumption of electrical energy in Indonesia. This is because the demand for electrical energy in Indonesia is increasing from year to year so data from the Ministry of Energy and Mineral Resources (ESDM) shows that the installed capacity of national power plants until June 2020 reached 71 Giga Watt (GW). This figure increased by 1.3 GW when compared to the end of 2019, which was 69.7 GW. Data on the capacity of installed power plants throughout Indonesia as verified by ESDM can be seen in Table 1 below:

Table 1. Installed Power Generation Capacity

No.	Types of Power Generation	Capacity (MW)
1.	Power and Steam	35 220
2.	Gas and Steam	20 537
3.	Water	6 096
4.	Diesel	4 781
5.	Geothermal	2 131
6.	Other New Renewable Energy	2 200

The data obtained also noted that new and renewable energy (EBT) contributed 14.69% or 10,467 Mega Watts (MW) of the total installed capacity. The increasing role of new and renewable energy is one of the targets of the National Energy Policy (KEN), while the target in 2025 is to achieve an optimal energy mix where the role of new and renewable energy is 23% and will increase to 31% in 2050. According to ESDM data, with the current technology, the electric potential from renewable energy can reach 432 GW or 7-8 times the total installed generating capacity today.

The majority of existing and planned renewable energy power plants rely on hydro or geothermal power. Of the 7 GW of installed capacity, 66% are hydroelectric power plants (PLTA) and 27% are geothermal power plants (PLTP). Likewise, of the 29 GW planned additions in the RUPTL, 50% are in the form of hydropower and 26% are PLTP. (renewable energy status report). On the other hand, the planned construction of a Solar Power Plant (PLTS) is only 7% even though the potential is almost 50% of the potential of renewable energy in Indonesia. Based on solar radiation data collected from 18 locations in Indonesia, solar radiation in Indonesia can be classified as follows: for the western and eastern regions of Indonesia with a radiation distribution in the West Indonesia Region (KBI) of around 4, 5 kWh/m2/day with a monthly variation of about 10%; and in Eastern Indonesia (KTI) around 5.1 kWh/m2/day with a monthly variation of around 9%. (Data obtained through the official website of the ministry of energy and mineral resources whose article was uploaded on the website on May 3, 2010).

However, the application of new and renewable energy (EBT) needs to be prepared thoroughly because the investment costs required to utilize (EBT) are not small even though the energy produced will be free. Several things that need to be prepared before the installation of NRE utilization are data on the energy potential of an area. Data on the potential for solar energy for each region will be different depending on the topography of an area.

Therefore, this study aims to analyze the potential of solar energy in a location using data from the Weather Station Tool. The data obtained from this Weather Station tool is to test weather parameters such as air temperature, relative humidity, wind speed, wind direction, atmospheric pressure, and rainfall. The results of graphical AWS monitoring, between the components and functions of the automatic weather station, are a thermometer that functions to measure temperature (temperature), or changes in temperature, a wind meter to measure wind direction, an anemometer to measure wind speed, a hygrometer to measure humidity, a pyranometer to measure solar radiation. , rain gauge functions to measure rainfall, data logger to store measurement data, barometer functions to measure atmospheric pressure, and ceilometer to measure height in clouds. The data obtained will be analyzed using the Weibull and Rayleigh method to see the potential for solar energy in the area. The data were also tested using two methods, namely Weibull and Rayleigh to compare the two methods to see the accuracy and suitability of the data obtained in an area. Therefore, based on the description above, the author will conduct research on "Analysis of Solar Energy Potential Using the Weibull and Rayleigh Method Using Data from the Weather Station". The data were also tested using two methods, namely Weibull and Rayleigh to compare the two methods to see the accuracy and suitability of the data obtained in an area. Therefore, based on the description above, the author will conduct research on "Analysis of Solar Energy Potential Using the Weibull and Rayleigh Method Using Data from the Weather Station". The data were also tested using two methods, namely Weibull and Rayleigh to compare the two methods to see the accuracy and suitability of the data obtained in an area.

2. Methods

2.1 Solar Power Generation

Solar Power Plants (PLTS) are power generation equipment that converts solar power into electricity. PLTS is often also called Solar Cell, Solar Photovoltaic, or Solar Energy. PLTS utilizes sunlight to generate electricity. DC (direct current), which can be converted into AC (alternating current) electricity if needed. Therefore, even though it is cloudy, as long as there is light, PLTS can generate electricity.

2.2 How PLTS Works

The concept of a solar power plant is simple, which is to convert sunlight into electrical energy. Sunlight is a form of energy from natural resources. The sun's natural resources have been widely used to supply electrical power in communications satellites through solar cells. This solar cell can produce an unlimited amount of electrical energy directly taken from the sun, without any rotating parts, and does not require fuel. So that solar cell systems are often said to be clean and environmentally friendly. Compared with an electric generator, some parts rotate and require fuel to produce electricity. The sound is noisy, besides the gas produced can cause the effect of greenhouse gases (greenhouse gas) whose influence can damage the ecosystem of our planet earth.

The solar cell system that can be used on the earth's surface consists of a solar cell panel, a charge controller circuit, and a 12-volt battery with a maintenance fee. The solar cell panel is a module consisting of several solar cells connected in series and parallel depending on the size of the required capacity. The battery charging controller circuit in the solar cell system is an electronic circuit that regulates the battery charging process. This controller can adjust the battery voltage within 12 volts. If the voltage drops to 10.8 volts, it means the remaining voltage on the battery is 2.2 volts, then the controller will charge the battery with solar panels as its power source. Of course, the charging process will occur if it takes place when there is sunlight. If the voltage drop occurs at night, then the controller will cut off the supply of electrical energy.

After the charging process lasts for several hours, the battery voltage will increase when the battery voltage reaches 12 volts, then the controller will stop the battery charging process. Battery charging controller circuit, actually easy to assemble yourself. But, usually, this series of controllers is already available in the market. Indeed, the price of the controller is quite expensive if you buy it as your unit. Most solar cell systems are only sold in the form of complete packages, which is cheaper than assembling yourself. Usually, the solar panels are placed in a straight position facing the sun. Even though the earth moves around the sun, to be able to absorb the sun's rays optimally, it must always fall perpendicular to the surface of the solar panel.

The solar cell material itself consists of protective glass and transparent adhesive material that protects the solar cell material from environmental conditions then anti-reflection material to absorb more light and reduce the amount of reflected light, Ptype and N-type semiconductors (made from a mixture of silicon) to generates an electric field, an initial and a final line (of thin metal) to send electrons to an electrical apparatus. The workings of the solar cell itself are identical to the semiconductor diode device. When the light comes into contact with solar cells and is absorbed by a semiconducting material, electrons are released. If these electrons can travel to a semiconducting material in a different layer, there is a sigma change in the forces on the material. The repulsion between semiconducting materials, causes a magnetic field to flow. And causes electrons to be channeled into the starting and ending lines for use in electrical appliances.

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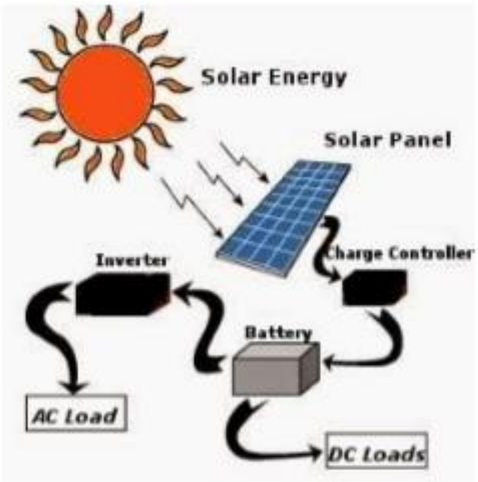
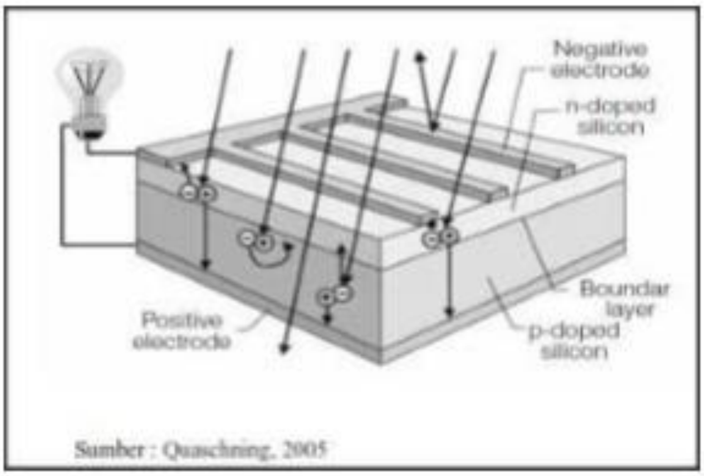


Figure 1. Installation System Using Solar Cell

2.3 Solar Cell

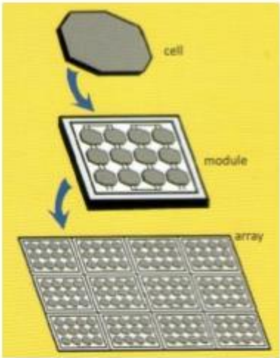
A solar cell is an electronic component that can convert short-wave light energy into electrical energy, this energy change is caused by a process called the photovoltaic effect. The photovoltaic effect itself is the release of positive and negative charges in solid materials through light. So indirectly the output in the form of current and voltage is influenced by the amount of light intensity. In solar cells there is a junction (junction) between two thin layers made of semiconductor materials, each known as a "P" (positive) semiconductor and an "N" (Negative) type semiconductor. P type silicon is a surface layer that is made very thin so that sunlight can penetrate directly to reach the junction.

The P part is given a ring-shaped nickel layer, as the positive output terminal. Below the P section there is an N type section which is plated with nickel as well as the negative output terminal. When light hits the surface of a solar cell, some of the photons from the light are absorbed by the semiconductor atoms to free electrons from their atomic bonds, thus becoming free electrons to move. The movement of electrons is what causes an electric current. (Quaschning, 2005)



Figures 2. Relationship of solar cells, solar panels (Quaschning, 2005)

Array is a combination of several solar cells called solar panels. A solar panel generally consists of 32-40 solar cells, depending on the size of the panel (Quaschning, 2005). The combination of these panels will form an "Array".



Figures 3. The arrangement of making solar panels, from solar cells, modules and panels (arrays)

This study uses a quantitative approach. A quantitative research method is a research method with a deductive approach that is derived from a general theory that is implemented or tested for special cases or called empirical tests. This study uses statistical means, such as correlation or regression, and t-test.

In this study, basic materials are needed in the form of data in calculating the correlation of weather data parameters with the suitability of new renewable energy generators. There are two research variables in this study, namely, the independent variable and the dependent variable. The independent variable in this study is the weather parameter which will be measured using a weather station. The dependent variable in this study is the suitability parameter of the type of solar and wind energy generation.

In data collection techniques, the data obtained will be processed and analyzed by researchers. The data that will be used by researchers are:

1. Weather parameter data obtained from the weather station
2. Data on the suitability of the types of solar and wind power plants

From the above data obtained from measurements and observations.

3. Results And Discussion.

Measurement of the electrical energy potential of the sun can be done with data including the area of the location, solar radiation, duration of radiation. Solar radiation data and old radiation can be obtained from BMKG local while the area of the location can be obtained from plans or measurements live.

Tables 2. Solar Radiation

Months	Radiasi (Kwh/m^2)
January	6.91
Februari	5.43
Maret	5.52
April	6.89
Mei	5.75
Juni	5.59
Juli	5.63
Agustus	6.49
September	7.16
Oktober	7.25

November	7.01
Desember	6.35

The potential of electrical energy from the sun has been known in the table above. Energy potential The electricity can only be used after The energy is absorbed by the solar panels. Application solar cell technology is through a system consisting of a solar panel and several other-equipment including batteries.

The amount of power written in solar module catalog is a standard condition test, i.e. radiation of 1000 w/m2 at a temperature module 25o C. The efficiency value shows how much power is capable of solar panels are generated from solar radiation received.

Tables 3. Efficiency of Solar Module

Modul	Voc (volt)	Ise (A)	FF	P (watt)	A(m2)	Eff
Sl250ce	59.9	5.25	0.76	250	1.68	0.141
Pv30/500	79.5	8.5	0.76	500	3.39	0.151
Sl180ce	44.71	5.1	0.76	180	1.27	0.135

The energy potential of the solar module is determined by two factors, namely the solar radiation factor and temperature module. For example, one unit PV30/500 solar module can collect the maximum electrical energy of 4,116 kWh of 9 hours of sunshine.

In this system the battery uses generator of the required DC power inverters. Because the battery capacity is measured In units of Ah, the unit of electrical energy of the solar cell must be converted into a form which contains the element amperage in it. Based on the general electrical equation P = I.V and with a charger voltage of 24 V to accommodate solar panel electrical energy for 9 hours.

4. Conclusion

After collecting data then calculate each energy the output of light intensity and potential wind to efficiency from modules and turbines wind, so we get the result:

a) The potential for electrical energy from the wind and a sun that can be used by wind turbines and solar cells on the ferry Sawu sea waters of 13.30 kWh per turbine and 2.62 kWh per sutya . module

b) Total use of electrical energy for lighting on ferries total for 1 trip or 16 hours of 177.89 kWh while on navigation equipment and communication is 76.18 kWh.

c) Application of solar modules and turbines the wind on the existing ferry can simulated with three scenarios which where is the max use with 4 pieces wind turbines and 56 units of solar modules can be produces a total power of 200.08 kWh of needs 196.82 kWh.

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