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# HAD HARGREAVES METHOD FOR EFFECTIVENESS POWER IN PHOTOVOLTAIC MODULE

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**ABSTRACT**

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Universitas Pembangunan Panca Budi is one of the best locations for solar radiation data collection and it is easy to conduct continuous research on solar cell power plants so that they can develop something in the photovoltaic module. This study discusses a photovoltaic analysis research using the Hargreaves model in terms of predicting the solar radiation that will be obtained and getting the value of effectiveness and efficiency. This study was conducted in a 2022 study in Medan, North Sumatra.

Keywords: Solar radiation, air temperature, Hargreaves rule

## 1. INTRODUCTION.

Many things have to be done in renewable energy generation where various ways have been done to reduce the number of fossils already getting smaller on earth caused by excessive use of energy resulting from the use of technology that is not environmentally friendly.(Khairunnisa et al., 2017). Matahari is the energy sector is one of the most important sectors in Indonesia because it is the basis for all other developments. There are many challenges related to energy and one of the issues of concern is the development and use of solar power. This is necessary for them to form collectors for solar heaters and other photovoltaic equipment that relies on solar power. Over the past few years, interest in modeling solar radiation data has increased widely(Aryza, 2018).

The concept of research has been carried out with several methods which to make it easier in terms of research to be able to predict solar radiation involving several internal factors such as in the case of closed clouds, the number of rexes, the percentage of certain cloud types, aspiration, humidity, number of days with dust or smoke. , air temperature, rain, latitude, and altitude(Sitepu et al., 2019).

Due to concerns about energy security and climate change, Indonesia plans to increase its share of renewable energy utilization, which is very suitable for development in rural areas and remote areas. The current National Energy Policy has set a long-term energy development target, increasing the role of new and renewable energy to 25% of primary energy consumption by 2025(Nugroho & Facts, 2014).

This ambitious goal was promoted as “Vision 25/25. ”(Lubis et al., 2015). In the concept of renewable energy, one must know the design or design of alternative energy tools that will be converted from conventional energy into renewable energy. This design requires valid information, every detail of the energy needed as a whole is used and converted into renewable energy so that it can be applied to provide alternative energy that can be used and utilized in everyday life as well as ease of use.(Heryani & Nugroho, 2015).

Solar energy is the most important source to be able to ensure the photovoltaic output of the system, therefore, the best way to get solar radiation data for a particular place is to measure it at a specific site continuously and precisely over a long period. Various models have been explored to forecast solar radiation from other available meteorological data(Soeranto, 2003).

This research requires maximum and minimum air temperature every day as input data. Weather at Universitas Pembangunan Pancabudi is used in testing the methods and data carried out in the electrical engineering lab(Khairunnisa et al., 2017). As we know, where electricity sourced from

solar energy is currently still largely undeveloped, even though we have considerable potential. Therefore, the development of Solar Power Plants (PLTS) with solar panels placed in a fixed position on the holder (static), this technique of installing solar panels has a disadvantage, namely when the sun moves back to the Solar Photovoltaic (SPV) panel, the energy produced by the SPV panel will decrease(Svpwm, nd). Causes the position of the solar panel is not in the right position concerning the direction of the sun's rays. Because it is based on the rotation of the earth, the sun's position is not always the same every time.

As a result, solar panels are not able to absorb solar energy optimally because the sun's position changes every time based on these problems to get maximum efficiency, the solar panels must follow the movement of the sun so that there is no angle of deviation between the sun and the solar panel or sunlight falls perpendicular to the sun. solar panels. In this study, the PLTS made allows the solar cell to follow the movement of the sun's direction by using the Tracking dual axis technology method. The solar tracking system, by utilizing two axes of movement, is a sun position tracking system that allows solar panels to follow the sun's position in all directions at any time.

## 2. LITERATURE REVIEW

### 2.1.Solar Panel

A solar cell is a device or component that can convert sunlight energy into electrical energy using the principle of the photovoltaic effect. What is meant by the Photovoltaic effect is a phenomenon where an electric voltage arises due to the connection or contact of two electrodes connected to a solid or liquid system when receiving light energy. Therefore, the solar cell or solar cell is also called photovoltaic by Hendri Becquerel, 1839.

A solar cell is an active element that converts sunlight into electrical energy. Solar cells generally have a minimum thickness of 0.3 mm, and are made of slices of semiconductor material with positive and negative poles. The basic principle of making solar cells is to utilize the photovoltaic effect, which is an effect that can convert sunlight directly into electrical energy. This principle was first discovered by Becquerel, a French physicist in 1839. When a metal is exposed to light in the form of photons with a certain frequency, the kinetic energy of the photons will shoot to the metal atoms. The irradiated metal atom will lose its electrons.

It is these free electrons that carry a certain amount of current. Solar cells are semiconductors in which solar radiation is directly converted into electrical energy. The material that is often used to make solar cells is crystalline silicon. At this time silicon is a material that is widely used for the manufacture of solar cells. To be used as a solar cell material, silicon is purified to a high degree. Atoms are the particles that make up an element. Atoms consist of a nucleus with a positive charge called protons and neutrons which are neutrally charged. The nucleus is surrounded by several negatively charged electrons. A silicon atom consists of a nucleus that contains 14 protons and is surrounded by 14 electrons that circulate in certain orbits. The maximum number of electrons in each orbit follows a $2n^2$ pattern, where n is the path number of the atom (Mallvino, 1986). When silicon atoms combine to form a solid, they form a regular pattern called a crystal. Each silicon atom has 4 valence electrons and has 4 neighboring atoms.

### 2.2. Position of the Sun.

Position of the Sun The position of the Sun is determined using the Horizontal coordinate system. In this system, the coordinate center is the position of the observer (longitude and latitude) on the earth's surface (Nugraha, 2017). The coordinates of the earth that determine the position of the sun are the azimuth angle, the altitude/elevation angle, and the zenith angle. The three angles are influenced by calculations based on the angle of declination, hour angle, and latitude position on earth. The declination angle (δ) is the angle between the line connecting the center of the sun and the earth and the projection on the equator. The value of this angle is in the range -23.45O – 23.45O. Meanwhile, Hour angle (ω) is the angle between the local meridian and the position of the sun in one hour. The hourly value of the hour angle is 15O.

Conversion efficiency is the ratio between the power that can be obtained by a solar cell with the

power received from the sun. The energy density of sunlight reaching the outer part of the earth's atmosphere is about 136 mW/cm² but after passing through the atmosphere some of it is dissipated, while the density of solar energy that reaches the earth's surface on a clear day is about 100 mW/cm² (Kadir, 2010). 1995). The influence of the surface area of the solar cell on the power The area of the solar cell affects the power generated by the solar cell in this case the relationship is linear. For example, a solar cell with a cross-sectional area of 100 cm will have twice the power as a solar cell with an area of 50 cm (Karmon Sigalingging, 1994).

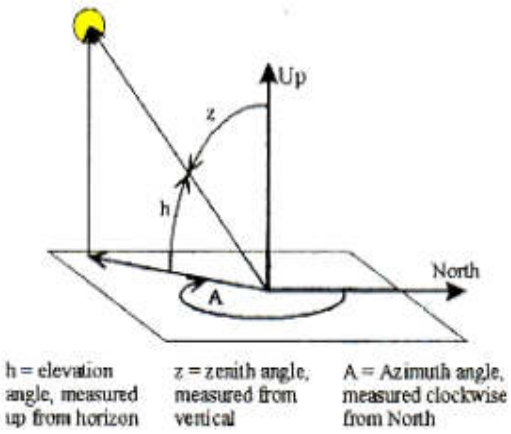


Figure1.Azimut coordinate system.

The position of the sun requires several equations. The equation used to find the sun's position is the sun's zenith angle, sun's azimuth, declination

## 3. METHODS

This research was conducted using a combination of qualitative and quantitative methods obtained from direct research at the Development University of Pancabudi during the day where the weather has the same temperature in the environment of 23-36 ° C throughout the year. During February-April, the weather is generally dry and warm.

Humidity is consistently high in the lowlands between 82% and 86% a year. The average rainfall a year is 2062-2543 mm and the wettest month is from September to December.

Data collection on the position of the sun is carried out based on the position of a place such as the position of latitude and longitude as well as the date and time of the research location. In this mobile passive solar tracking system, data retrieval is carried out on a mobile basis so that when the location and time change, the resulting azimuth and altitude values also change. The latitude and longitude position data will later be used to determine the azimuth and altitude values as input for the solar panel system. The route for data collection of the sun's position is carried out by taking several points on the Pancabudi Development University Campus, building m to building f.

The data used in this study were obtained from direct testing at the Universitas Pembangunan Panca Budi Medan, North Sumatra where the temperature was relatively uniform in an environment of 23-36 ° C throughout the year.

Where during February-April, the weather is generally dry and warm. Humidity is consistently high in the lowlands between 82% and 86% a year. In this case the average rainfall a year is 2062-2543 mm and the wettest month is from September to December. Where this research is predicted to capture daily solar radiation, maximum and minimum temperatures.

The estimated daily value of solar radiation (Rsest) compared to the measured value (Rsmea). To be able to assess the accuracy of the forecast for daily radiation estimation, four performance indicators have been used, namely, residual mass multiplier (CRM), lack of square root of quantity (RMSE), Nash-Sutcliffe equation (NSE) and percentage error(e) expressed as a percentage of min. The arithmetic of the measured solar irradiance is given as follows (Almorox, 2003).

## 4. RESULT AND DISCUSSION

This sunlight source (Rs) is carried out with the difference between the maximum and minimum air temperatures (Td). So that Rs is directly proportional to Td, if the value of Td increases, then the value of Rs will increase.

The weather temperature throughout 2018 recorded by the students of the Pancasila Development University is shown in Figure 1. So based on Figure 1, the lowest minimum temperature was 22.7 ° C on September 17 and the average minimum temperature was 26.5° C. Meanwhile, for the temperature maximum, the highest value was 37 °C on 20 March and the average value was 31.4 °C.

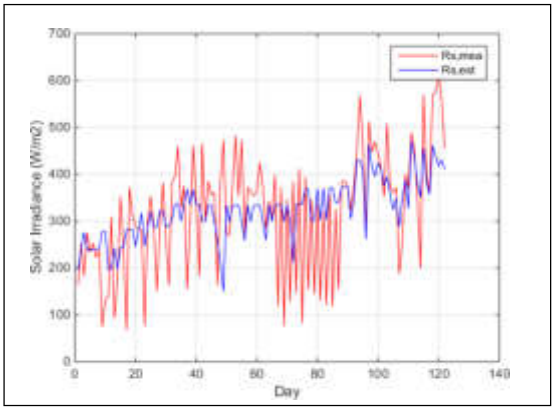


Figure 2. Temperature taken at the Universitas Pembangunan Panca Budi

In this case the sunshine for 2020 is calculated using the Hargreaves model in equation (1). Then the comparison of measured and predicted solar irradiance from the temperature measured daily is expressed by CRM, RMSE, $R^2$ and e,. The results show that the CRM value is 0.08, this indicates the tendency of the estimation model to predict the size of the sunshine. Meanwhile, the RMSE value is 5.37%, indicating that the percentage of error is small. The $R^2$ value is 0.96, closed to 1 indicating that it is approximately 96.61% of the total variation explained.

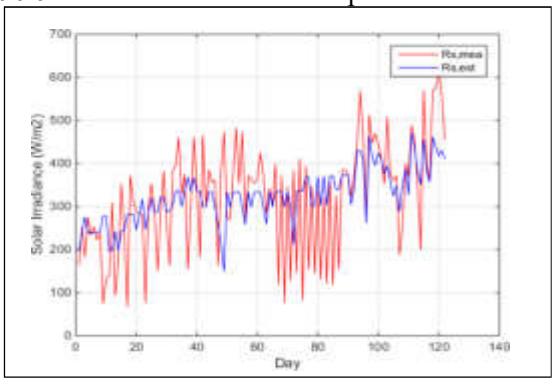


Figure 3. Recorded daily solar radiation all year round

## 5. CONCLUSION

From previous observations and research, we can conclude that the Hargreaves model method can be used in forecasting solar radiation in Medan, North Sumatra. Comparison of measured and predicted solar irradiance from daily temperatures measured using CRM, RMSE, R2 and e. Solar radiation minimum, maximum.

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