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Digital Anemometer and Solar Power Meter Analysis Measurements for Installation of Wind and Solar Hybrid Power Plants

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ABSTRACT

This paper presents an analysis of the results of wind speed measurements using Digital Anemometer Model AM-4203 and solar power measurements using Digital Solar Power Meter Model SPM-1116SD from a location which will be used as a site to install a hybrid system of wind and solar power plants. The wind speed measurement data taken in 3421 seconds are recorded and displayed in graphical form between wind speed (m/s) and time (s). Meanwhile, the solar power measurement data taken in 111 seconds are recorded and displayed in graphical form between solar powers (W/m2) to seconds (s). The lowest wind speed measurement result is 0 m/s for some time and the highest is 3 m/s for 2880 seconds, while for the average measurement result is 1 m/s. While the lowest solar power measurement results are 20 W/m2 for some time and the highest is 770 W/m2 at 14:14:43 (23 s), while for the average measurement is 360 W/m2. Referring to such measurement data, the potential for wind power generation is weak, so it is almost impossible to produce energy efficiently using wind power, as the wind speed must be greater than 4 m/s. While based on the measurement profile of solar power, from time to time can reach 770 W/m2 which has the potential to generate electricity. In addition, based on these two measurement results, they show a nonlinear random profile. Thus the installation of hybrid wind and solar power plants must have a nonlinear control system design.

Keywords:
Digital anemometer, solar power meter, measurement, installation, hybrid power plant

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1. Introduction

In Indonesia, the energy sector is a serious problem, as the rate of demand exceeds the growth of energy supply itself [1-3]. Fossil fuels as conventional fuels that have been the main use priority have long been imported to cope with the soaring demand from year to year so that national energy security is vulnerable to price fluctuations and supply. For that necessary serious steps in overcoming this problem such as maximizing the utilization of alternative energy that is increasing the role of

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renewable energy. The design of a hybrid system requires technical, economic, and environmental considerations. From the technical point of view, the number and type of generators used, energy storage, and converter, and load, optimal combination of system components, system performance, and control are the factors that need attention. From an economic point of view, it is necessary to take into account the initial costs, operational and maintenance costs, decommissioning fees, and so on.

While the environmental aspects that need to be included in the design considerations include greenhouse gas emissions that include the type, amount, and carbon content of fuel used. Designing through a computer program, such as the Homer program, is an option that can simplify, speed up, and be more cost-effective. The problems that occur in power generation utilize wind energy is the low speed of wind and the difficulty getting a motor that has a low rpm specification can produce high power, while for electric power that utilizes solar power is a solar panel that looks unattractive and expensive. Therefore, it is necessary to design a hybrid system that looks attractive, easy to install, and easy to move location and has a high enough power, where the operation can be run automatically. Program designing products such as Solidwork, Inventor, or Ansys [4-6], how experimental methods are run can be seen on [7-9], MQL drilling [10-12], sustainable cooling technique [13], and laser assisted micro milling application [14].

2. Methodology

Wind speed is wind distance or air movement per unit time and expressed in meters per second (m/s), kilometers per hour (km/h), and miles per hour (mil/h). The units of miles (nautical miles) per hour are also called knots; 1 knot = 1.85 km/h = 1.151 mil/h = 0.514 m/s or 1 m/s = 2237 miles/h = 1.944 knot. Wind velocity varies with the height of the soil surface, so the wind profile is known where the higher the surface the faster the movement of the wind. Wind is something that can never be guessed when it comes. When desired the wind could have no wind at all. On the contrary it can happen, when the wind is not desired, which came to hit just a strong wind that even caused disaster. Wind is the air that moves due to the rotation of the earth and the air difference around it. Wind is invisible, can only be felt. But the effects of this wind are visible. One example of the effect of this wind is when a tornado disaster struck an area.

This whirlwind can make some things become floating, not only light objects, heavy objects can float in case of a great tornado. Related to wind, there is a tool that can be used to measure wind speed. The tool is an anemometer. Although not visible to the eye, but the wind has speed. This anemometer is a tool that can measure it. Anemometers are widely used in the fields of meteorology and geophysics, and can be found in weather canters such as BMKG (Meteorological, Climatological, and Geophysical), volcano monitoring posts, as well as in meteorological and geophysical laboratories. With the use of an anemometer can be estimated weather on that day. This tool is also able to be used for a poor weather detector such as storms or hurricanes.

Basically, anemometer is a tool that serves to measure the speed of air or gas speed. To be able to determine the speed, the anemometer recognizes changes in some physical properties of the fluid or the fluid effect on the mechanical device is fed into the flow. The most common anemometer benefits can be found in cup anemometers. This type is the most commonly used tool because it is the simplest anemometer. It is divided into three metal cups generally three attachments at the horizontal end of the arm attached to the vertical axis. The capture in the wind cup resulted in them spinning. This action is in fact a shaft, which is connected to devices that provide wind speeds in miles per hour, km per hour, or knots. In a general type of anemometer cup, the shaft is attached to an electric generator. The total current generated by the generator varies with wind speed. Cup anemometers (used in weather stations) measure the velocity in perpendicular portion on the axis of the cup turn. If an anemometer cup is fixed with the axis perpendicular to the horizontal, it will measure only the components of the wind parallel to the ground.

On other anemometers, such as a propeller anemometer, are used with the tip parallel to the overall velocity vector. Prior to using an anemometer, it is important to determine how it should be positioned and what components of the overall measurement speed are representative. With the development of anemometer technology is growing so that has available Digital Anemometer which is a measurement tool that has the function to record the data wind speed with precise and accurate. With this tool wind speed measurement at a place or occupied territory. Digital Anemometer is very easy to use because the readings are very fast and easy to grasp. Digital anemometer is a tool used to measure wind speed. These measuring instruments are often used in weather forecast stations, meteorology and geophysics, ships and aircraft. Not only to measure wind speed, can this tool also measure the amount of wind pressure, weather prediction, and sea wave height. This gauge has a precision of up to 0.5 m/s. How to use an anemometer is very easy, because the wind speed figure will be displayed automatically on the speedometer just by holding the Anemometer vertically or putting it on top of the stand

Figure 1 shows the Digital Anemometer Model AM-4203. Measuring procedure is as follows [15-16]

i. Install the Probe Plug into the Sensor Input Socket.
ii. Power ON the meter by pressing the POWER Button.
iii. Select the desired temperature units by pressing the ℃/℉ Button.
iv. Select the desired air velocity measurement units by pressing the UNIT Button.
v. Data Hold: During the measurement, pushing the HOLD Button will freeze the measured value & the LCD will indicate D.H. indicator.
vi. Data Record (Maximum, Minimum reading)

Fig. 1. Digital Anemometer Model AM-4203

Solar power meter is a tool to test, measure the intensity of solar energy. This energy is the energy gained by converting solar thermal energy through other devices into energy sources in other forms. This technique of exploiting this dawn energy began to emerge in 1839, discovered by A.C. Becquerel, where he used silicon crystals to convert solar radiation, but until 1955, the method had not been widely developed. Over a period of more than a century, the most widely used energy sources are petroleum and coal. Over time will the need for energy resources are increasing, then the required alternative energy sources than the existing ones. Solar Power meter test equipment is an innovation in the test and measurement industry as a measuring tool for this solar power or solar cell device. In 1958 attempts to redevelop the way of harnessing solar energy resurfaced. Silicon cells used to convert solar energy into resources begin to be taken into account as a new method, because it can be used as a resource for space satellites, and alternatives that can be developed for other equipment.

Solar Power Meters or devices that test solar power, where these solar power sources convert from sunlight to electricity, either directly by using photovoltaic (PV), or directly using concentrated solar power (CSP) or concentrated solar power. Solar Power meters can be applied to various needs related to solar cell applications such as solar radiation level measurements, solar research, physics and laboratory applications, and many others.

Figure 2 shows the Digital Solar Power Meter Model SPM-1116SD. Measuring procedure is as follows [17-18]

i. Power on/off
ii. Unit selection
iii. Function selection
iv. Solar power measurement
v. Transmission measurement
vi. Solar power integration measurement
vii. Data Hold
viii. Data Record
ix. LCD Backlight ON/OFF

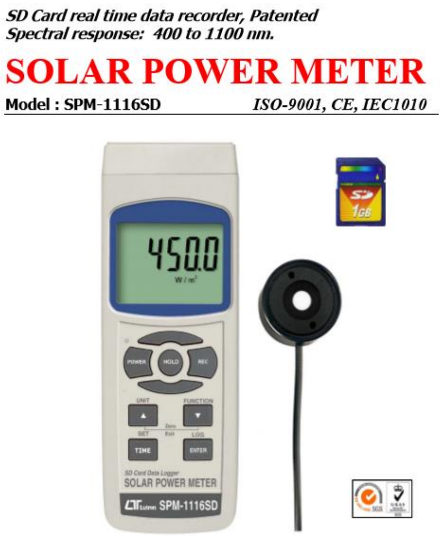

Fig. 2. Digital Solar Power Meter Model SPM-1116SD

3. Results

Figure 3 shows schematic and installation of the wind solar hybrid system. The left-hand image shows a schematic, and the right-hand image shows the built-in installation based on the schematic. The built-up installation is located on the campus of Telkom University, Bandung, Indonesia. Installation is mounted on the roof of the building 11 floors, approximately 35 meters from the ground.

The measurement of wind velocity (m/s) against time (s) using Digital Anemometer Model AM-4203 is shown in Figure 4. The data was taken in 3421 seconds, then recorded the results of wind speed measurement using the anemometer equipment. The highest measurement result is 3 m/s for 2880 seconds, while for the average measurement result is 1 m/s. Referring to such measurement data, the potential for wind power generation is weak, making it almost impossible to produce efficient power when using wind power. Potential electric power that can be generated through wind power, must be the wind density higher than 4 m/s.

Power Measurement (W/m2) of time using Digital Solar Power Meter Model SPM-1116SD is shown in Figure 5. From Figure 5, it can be seen that maximum solar power over time is achieved at 770 W/m2, and the solar power profile is also nonlinear random. The results of the measurements shown by the data have the potential to generate electric power.

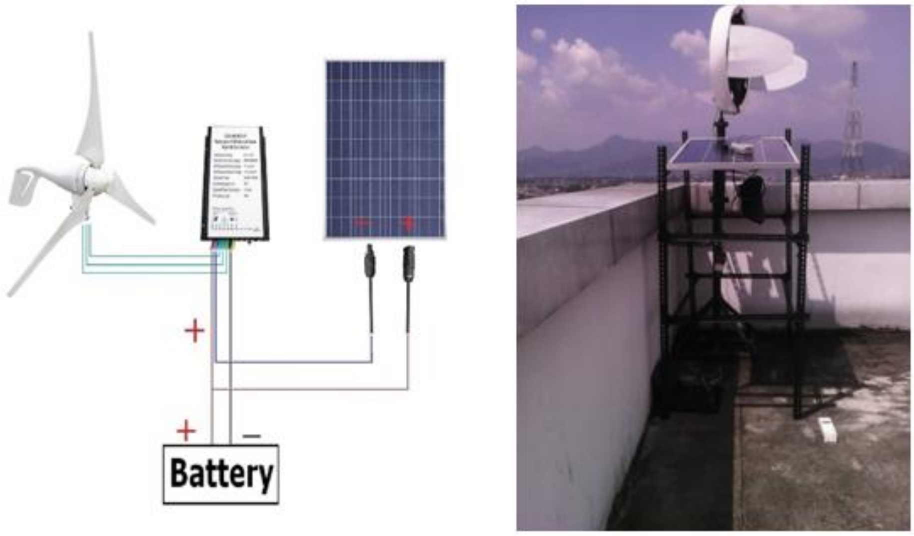

Fig. 3. Schematic and installation of the wind solar hybrid system

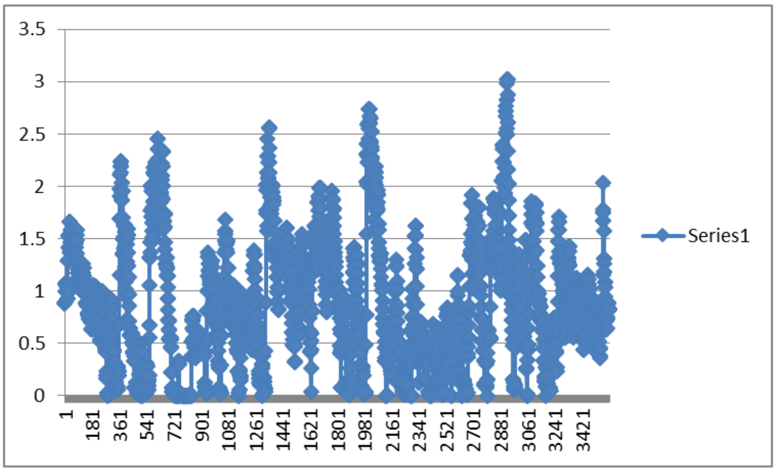

Fig. 4. Measurement Results Wind speed (m/s) against time (s) using Digital Anemometer Model AM-4203

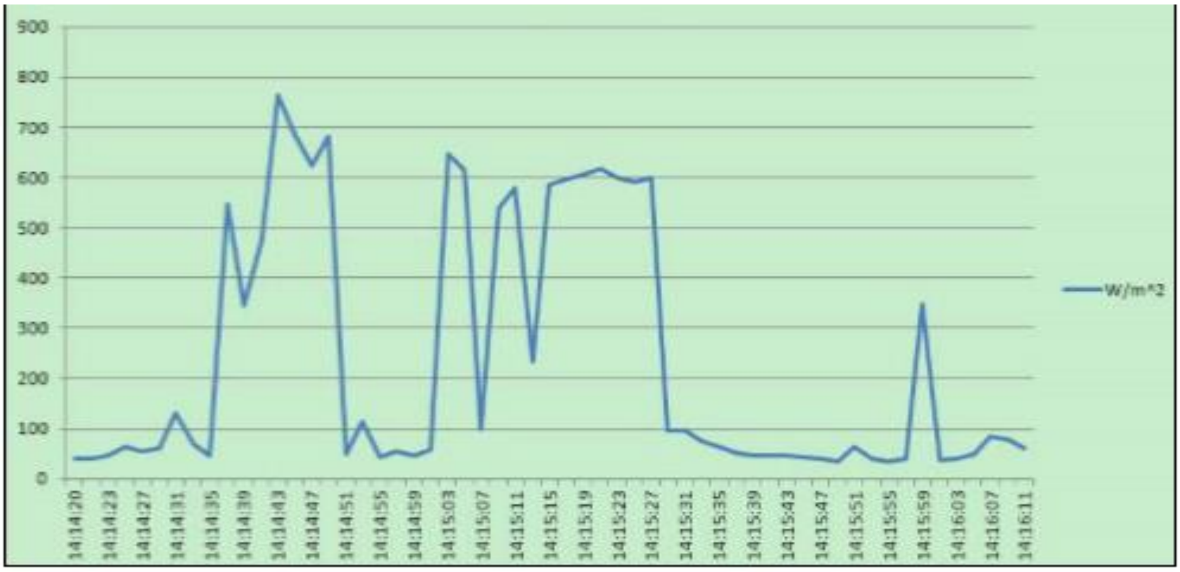

Fig. 5. Measurement results of solar power (W/m2) over time using Digital Solar Power Meter Model SPM-1116SD

4. Conclusions

In this paper we have presented wind speed measurement method using digital anemometer and solar power meter measurement using solar power meter. Based on both results measurements can be concluded that the profiles of both measurements are nonlinear random. To be able to control the process with a profile like this requires the design of nonlinear system control as well. Thus, the hybrid system that will be built later must require the design of a nonlinear control system.

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