Design of Solar Cell Potential Devices in Real Time based on the Internet of Things (IoT)

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Abstract: Renewable energy sources, ranging from hydro power, wind power (wind), solar power, sea water wave power and others. The potential for renewable energy sources in Madura is very high, but not all places have the potential to be used as electricity generation. Before a place is used as a power plant with renewable energy sources, it is necessary to know the potential characteristics of an area that will become the reference for the generator. Solar power plants are influenced by several factors such as light intensity, temperature and several other factors. In this problem what will be proven is the effect of temperature and light intensity on the voltage generated by the solar cell. The temperature and light intensity are known using sensors. Data from sensor readings is managed in the form of an information system that collects in one server. Tools that have been designed are ergonomically designed, both in terms of material selection, easy to assemble and assemble, space efficiency, comfort and safety. The data that has been obtained from the test results in this study show that the higher the temperature received by the solar cell, the lower the resulting voltage. This condition is inversely proportional to the light intensity, the higher the light intensity, the higher the voltage generated by the solar cell. This research has shown that the temperature received by the solar cell is not the basis for the higher the resulting voltage, but the light intensity that becomes the input of the resulting light voltage.

1 INTRODUCTION

Energy sources in Indonesia are mostly non-renewable energy sources that come from fossil energy, because their availability cannot be regenerated. Oil reserves in 2013 were 3.7 trillion barrels, producing or drilling 882 thousand barrels per day. Renewable energy is an alternative energy source to meet energy needs, the potential for new renewable energy is very significant. Indonesia has renewable energy potential in the form of 75,091 MW of geothermal energy, 29,164 MW of micro hydro, 480 KWH / M2 / day of solar power, 49,810 MW of biomass.

Renewable energy has a very important role in meeting energy needs considering that the source is very abundant. This is because the use of fuel for conventional power plants in the long term will deplete the depletion of oil, gas and coal resources and can also cause environmental pollution. One of the efforts that has been developed is the Solar Power Plant (PLTS).

PLTS or better known as solar cells (photovoltaic cells) will be more attractive because they can be used for various relevant purposes and in various places such as offices, factories, housing, and others. In Indonesia, which is a tropical area, has a very large potential for solar energy with an average daily insolation of 4.5-4.8 KWh / m² / day. However, the electrical energy produced by solar cells is greatly influenced by the intensity of sunlight received by the system. So that the utilization of electric energy can be used optimally, it is necessary to have a hybrid system with PLN electricity nets.

During a clear day, solar radiation can reach 1000 watts per square meter. If a semiconductor device covering an area of one square meter has an efficiency of 10%, then this solar cell module is able to provide electric power of 100 watts. Commercial solar cell modules have efficiencies ranging from 5% to 15% depending on the constituent materials. Crystalline silicon type is a type of solar cell device that has high efficiency even though the manufacturing cost is relatively more expensive than other types of solar

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cells. The most important problem for realizing solar cells as an alternative energy source is the efficiency of solar cell devices and the cost of manufacture. Efficiency is defined as the ratio between the electric power generated by the solar cell device compared to the amount of light energy received from the sun's rays. Solar power plants (PLTS) actually depend on the efficiency of energy conversion and the concentration of sunlight received by these cells (Awang Riyadi, 2008).

A solar cell in producing electrical energy (energy from sunlight into photons) does not depend on the size of the silicon field, and will constantly produce energy in the range of ± 0.5 volts maximum 600 mV at 2A, with the power of solar solar radiation 1000 W / m2 = "1 Sun ”will produce electric current (I) of about 30 mA / cm2 per solar cell. The factor of the first operation, in order to obtain the maximum value, depends on the ambient air temperature, solar cells can operate optimally if the cell temperature remains normal (at 25ºC), the increase in temperature is higher than the normal temperature in the cell which will lower the voltage value (Voc). Each 10 Celsius (from 25ºC) increase in the temperature of the Solar Cell will decrease approximately 0.4% in the total power generated or will decrease twice (2x) for the increase in Cell temperature per 10ºC. (Source: Solar Electricity, Lorenzo Eduardo.)

Both solar radiation, solar radiation on earth and various locations vary, and very much depends on the state of the solar spectrum to the earth. The three solar insolation of the sun will have a lot of effect on current (I) a little on the voltage. Wind speed blowing, wind speed around the location of the solar cell array can help cool the surface temperature of the solar cell array glass.

The four conditions of the earth's atmosphere, the state of the earth's atmosphere is cloudy, cloudy, the types of airborne dust particles, smoke, air vapor (Rh), fog and pollution determine the maximum electric current results from a row of solar cells. The five orientation of the panel or array of solar cells. The optimum orientation of the solar cell series (array) towards the sun is important so that the panel / row of solar cells can produce maximum energy. Apart from the orientation direction, the tilt angle of the panel / row of solar cells also greatly affects the maximum energy yield. The six positions of the solar cell (array) to the sun (tilt angle), Maintaining sunlight falling onto a surface of the solar cell panels perpendicularly will get a maximum energy of ± 1000 W / m2 or 1 kW / m2.

The mistake that has become common in society is that if an area is very hot, the potential for solar power generation is very potential, this wrong assumption is the basis for this research, another goal is to create a solar power information system tool in real time, so that the output of this research becomes concrete data sources for the realization of the energy sector, particularly renewable energy.

2 METHODS

This research was conducted at the Industrial Engineering Laboratory. The designed frame is analyzed according to the ergonomic method of a device. The system to be implanted in the device is carried out at the Mechatronics Engineering Laboratory by carrying out several activities such as sensor installation, sensor testing and method testing of the system. As shown in Figure 1.

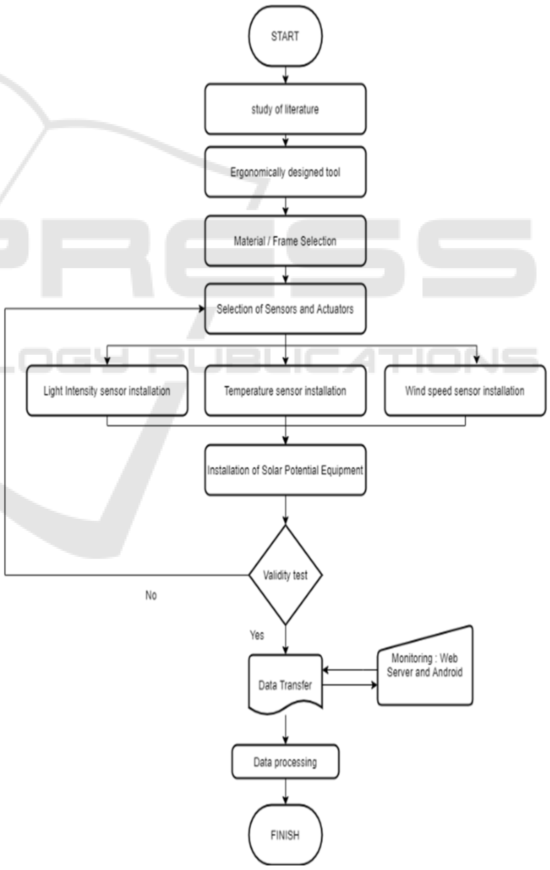

Figure 1: Research flow diagram.

The flow chart above shows the research stages and the system on the tool. The tool design will be ergonomically designed, easy to assemble and install, and pay attention to the comfort and safety factors, the potential tool models to be made are presented in Figure 2.

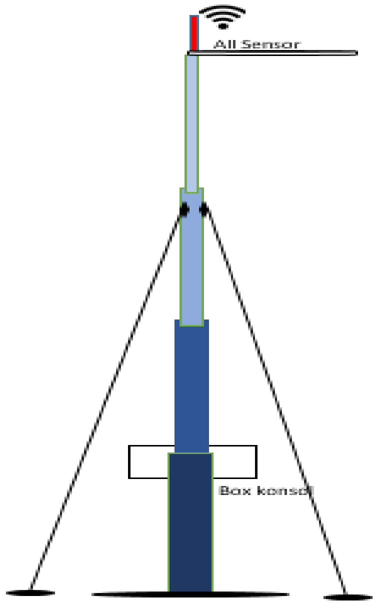

Figure 2: The tool model to be made.

As input power will use a battery that is connected in series, battery charging is done every week, or according to the capabilities of the battery.

Research uses various types of sensors, some of these sensors include:

a. Temperature Sensor
   The function of the temperature sensor is to analyze the heat of the surrounding air, because if it is too hot it will reduce the solar cell's ability to produce voltage and current.
b. Wind speed sensor
   The wind speed sensor (anemometer) is used to obtain real time wind speed data, this data is useful as a cooling calculation in the solar cell area.
c. Lux meter sensor
   Lux meter sensor, is used to obtain real time light intensity data, which is used as input to the solar cell.

In general, the flow chart of the work tool system and description will be described in detail as Figure 3.

Information:

1. Data from several sensors, in several places (areas) will be sent via the internet, and will appear on the web server and android, users can monitor in real time. System maintenance can be done manually if reading data is problematic.
2. The web server or Android is the interface for the data sent by all sensors.
3. Forecasting data from solar cell tools will be done manually every month, after the data obtained has passed the normalization process and the data is accurate.
4. Data analysis, the resulting data are:
   a. Light intensity data (lux meter) is used for solar cells to absorb energy, for how many hours the energy is absorbed
   b. The temperature data, which is used to determine the heat absorbed by the solar cell, is related to the voltage drop.
   c. Wind speed data, used for cooling calculations on solar cells due to ambient air temperature, is used to overcome voltage drop.

The conclusion is that it is feasible or not feasible for the area to use solar cell power plants, it is possible to use other types of new renewable energy sources (wind / wind, micro hydro, sea waves, etc.).

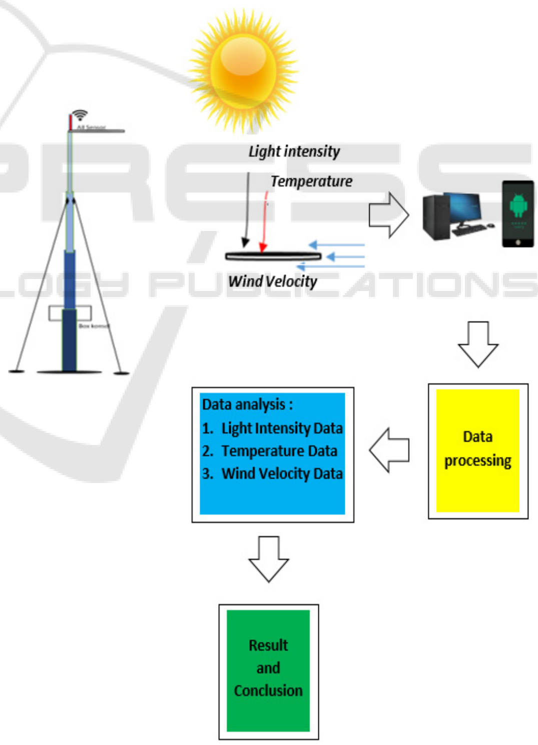

Figure 3: System Flowchart.

3 RESULT

The design of a solar energy potential tool uses several sensors and actuators, the sensors used are:

a. Lux meter sensor, is used to detect the intensity of sunlight captured by solar panels. The solar panels used are poly solar panels with an output voltage of 10 WP (watt peak).
b. Anemometer sensor, is a sensor to detect wind speed, in this research group's research, that wind speed will be used as a cooling medium in solar panels, the form of cooling media will be used by students in the proposal in the final project that will be submitted.
c. Temperature and humidity sensors are sensors used to determine the temperature and humidity of the air around the solar panel.

On the pole, there are several sensors and actuators, namely a 10 WP solar panel, a console box containing a microcontroller and a wifi module because data in the form of land temperature, air humidity, light intensity, and wind speed will be transferred to the web and monitor the web server will be used, so that monitoring can be carried out continuously and can be accessed via Android, console box and several sensors installed on the pole as in Figure 4.

Figure 4: Console Box and some sensors on the solar cell pole.

Data on sensors can be accessed directly using an information system that has been built in the form of real-time and continuous sensor readings. The data from sensor readings are used as a reference or input to the system using the artificial neural network method. Input data is in the form of training data and test result data. Monitoring information system as in Figure 5.

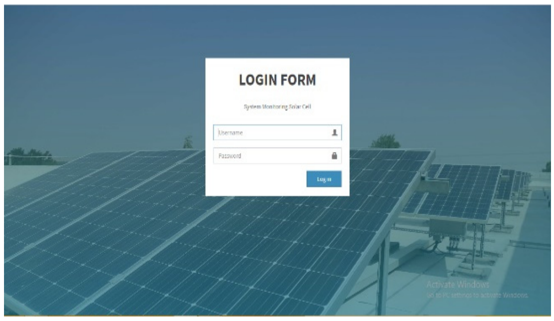

Figure 5: Initial appearance of the solar cell monitoring web.

Login is done to access sensor data via a web server. After logging in, it will go directly to the main view of the monitoring web, as in Figure 6.

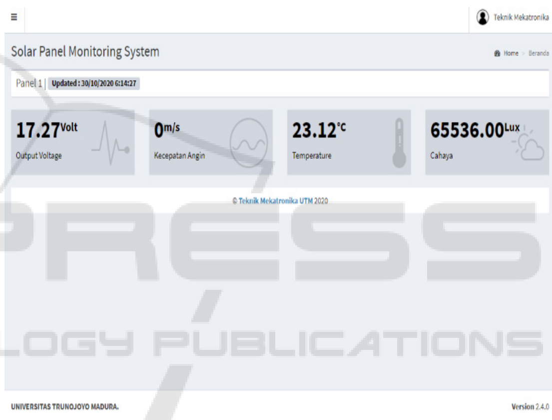

Figure 6: The main display of the solar cell monitoring web.

This research was conducted to prove that the air temperature on the solar panel will cause a drop in voltage (voltage will drop). The test scenario is carried out in two ways. First the test is carried out with a basic indicator in the form of light intensity as shown in Figure 7. While the second test is carried out with a temperature indicator as shown in Figure 8.

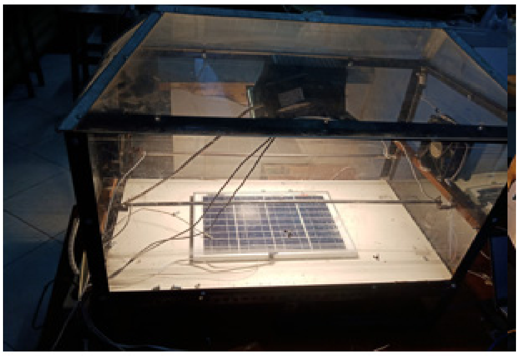

Figure 7: Solar cell testing with light intensity indicator.

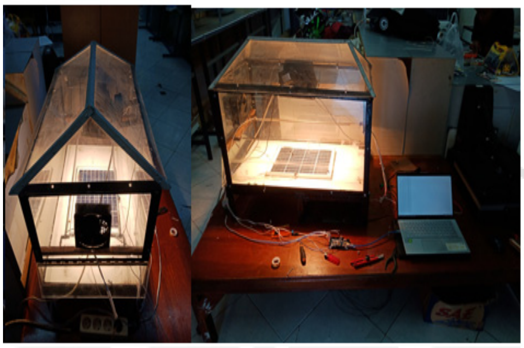

Figure 8: Testing solar cells with temperature indicators.

The test uses a spotlight as a light source (light intensity) and a heat source, because the heat generated by the spotlights can reach 50 °C, and the heater in the heating room, so the heat received by the solar panels is around 60-70°C. The test result data is used as a reference for forecasting for one year. From the above test shows that the greater the temperature received by the solar cell, the smaller the resulting voltage. In contrast to the light intensity received by the solar cell, the greater the value of light intensity received by the solar cell, the greater the resulting voltage. This condition is evidenced by the test data graph as shown in Figure 9 and Figure 10.

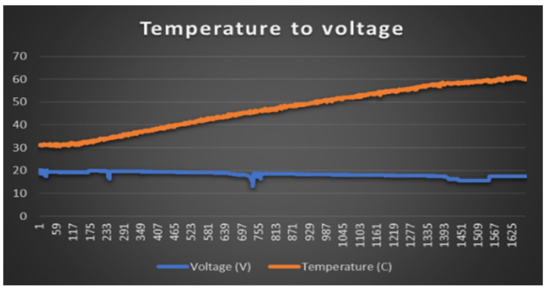

Figure 9: Graph of temperature test results against changes in voltage.

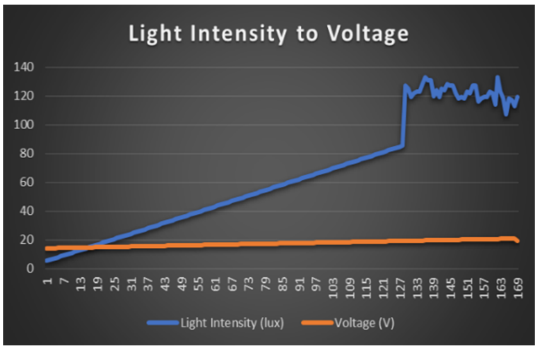

Figure 10: Graph of test results of light intensity against changes in voltage.

This research has been carried out in various places as a form of proof that each different place has a different resulting stress value. Other tests were carried out at sites with different characteristics of light intensity, temperature and wind speed. The following are the results of testing sensor data based on different places:

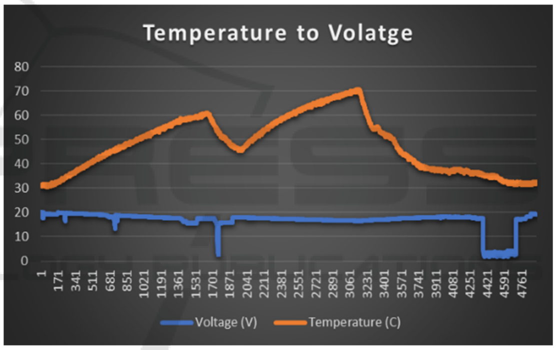

Figure 11: Graph of the results of testing the effect of temperature in different places.

Based on the graph in Figure 11, it is shown that the sensor reading conditions are not very stable due to several factors, including weather and other natural factors. But from this graph proves that the higher the temperature value, the smaller the resulting voltage refers to the test results in the graph in Figure 9.

In the same test in different places with different values of light intensity and having different characteristics. The test results are shown in Figure 12.

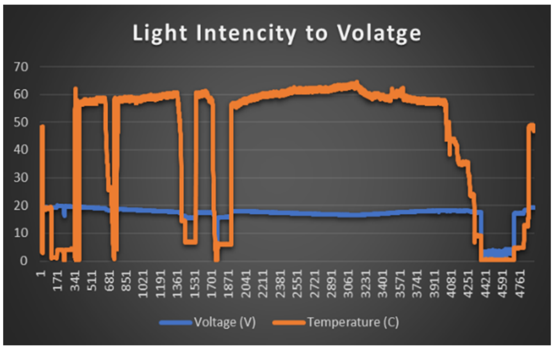

Figure 12: Graph of test results for light intensity in different places.

Figure 12 shows the test in the form of light intensity against the resulting voltage. In contrast to temperature, in this case the higher the light intensity received, the greater the resulting voltage, but the graph gets a poor sensor reading because the reading is unstable which affects the resulting voltage.

4 CONCLUSIONS

The conclusions from the results of this study are:

a. The sensors used in the system function well as input indicators.
b. The monitoring information system built has been able to accommodate data on a web server and display realtime sensor reading data.
c. The test result data shows that the greater the temperature received by the solar cell, the smaller the resulting voltage. Inversely proportional to the light intensity, the greater the light intensity received by the solar cell, the greater the resulting voltage.
d. The use of this type of sensor affects the readings and data processing results.
e. Sensor data must use a valid data acquisition system as the data base on the sensor for data analysis
f. The highest voltage produced by a solar cell with a light intensity of more than 4000 lux is 20 V.
g. The lowest voltage produced by a solar cell with the highest temperature is 9.87 V.The sensors used in the system function well as input indicators.

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