The Design of Solar Power Plants on Automatic Watering of Chili Plants

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Abstract -. Solar power plants are power plants that work without utilizing fossil energy in the form of solar power as an energy source. This research designed a solar power generation system used in an automatic watering system for chili plants. This study aims to test the effectiveness of using solar energy as an energy source to run an automatic watering system in chili farms The experimental method was carried out by designing and building a solar photovoltaic system connected to a water pump for watering chili plants. The results of this study show that the amount of power produced by solar panels depends on the intensity of solar radiation that hits the surface of solar panels. The solar panel is used at 50 Wp solar charge controllers, batteries automatic chili watering control systems, and water pumps. The maximum sunlight intensity of 1009.62 W/m2 can produce voltage connected to an average load of 12.74 volts and an average current of 1.24 Ampere and the power generated reaches 20.78 watts. Capable of operating an automatic chili sprinkler

Key Word - *Solar Photovoltaic, Solar Charge Controller, Battery*

1. INTRODUCTION

Indonesia is located on the equator, the sun shines all year round for 11-12 hours per day. Solar irradiation in Indonesia averages 4.73 – 5.77 kWh /m2/hour, with an irradiation duration of 11.8 hours to 12.4 hours per day, promising a potential solar power plant capacity of 207,898 MW[1]. This geographical condition makes it an abundant source of solar energy. Technology. It is estimated that the distribution of solar radiation for the Western Region is 4.5 kWh/m2/day and for the Eastern Region is 5.1 kWh/m2/day with variations ranging from 9-10%. Solar energy is one of the energy sources that can be renewed and converted into electrical energy using solar panels.

Solar energy is one of the potential alternative energy sources, and since the sun never goes away and can be used as a power plant, there is great prospect for development. The time of solar irradiation fluctuates starting from 6 a.m. to 6 p.m. or about 12 hours every day with sufficient intensity. To utilize solar energy as a source of electrical energy, a device is needed that can convert sunlight into electrical energy in the form of semiconductors called solar cells[2].

Chili agriculture is a sector that requires energy. Electrical and mechanical power is required in agriculture for a variety of activities, including land preparation, planting, irrigation, and harvesting. In addition, pumping and distributing water through irrigation systems requires the availability of consistent and reliable energy resources. The relationship between water and energy in the agricultural sector is crucial, and increased demand in one sector will have an impact on the other. The use of water pumps can increase access to sustainable and safe water resources for domestic and production purposes.

2. LITERATURE REVIEW

Chili farmers are often caught up in terms of watering because it is still manual, the location of the land is far from the house and the power grid or other needs result in irregular watering of chili peppers. This will result in the growth of chili plants will not be good due to a lack of mineral intake. Of course, this will hurt farmers where the harvest of chili will not be maximized, and consumers themselves will not get the desired quality of chili.

The use of solar energy in the agricultural sector is the right solution considering that agricultural land is generally far from the power grid and in open areas. In general, agricultural land gets abundant sunlight so that with solar

photovoltaic technology it can be converted into electricity as an energy source for various agricultural tools. The modular nature of solar PV makes it applicable as needed[3].

Solar charge controller applies Pulse Width Modulation (PWM) technology to regulate the battery charging function and current release from the battery to the load. 12-volt solar panels generally have an output voltage of 16 - 21 volts[4].

The battery is one of the components used in the solar cell system which is equipped with electrical energy reserve storage[5]. Batteries have the function of storing electrical energy generated by solar panels in the form of direct current energy. The energy stored in the battery functions as a backup, usually used when the solar panel does not consume electrical energy[1], for example at night or when the weather is cloudy, besides that the output voltage to the system tends to be more stable.

RTC (Real Time Clock) is a device that makes it possible to generate precise time because it is equipped with a time generator and a battery. RTC is an electronic clock that has a chip that can accurately calculate the time (from seconds to years) and maintain or store data of that time in real-time. Because the clock works in real-time, the data output is immediately stored or sent to other devices through the interface system.

The Arduino Uno is a microcontroller-based board on the ATmega 328. The board has 14 digital inputs/output pins (of which 6 pins can be used as PWM outputs)[6], and 6 analog reset inputs. These pins contain everything that is treated to support the microcontroller and only connect to the computer with a USB cable or a voltage source that can be obtained from an AC-DC adapter or battery to use it[7].

3. METHOD

The research was carried out by designing a solar power plant that is used to provide energy sources to chili sprinklers based on the desired time using solar panels, solar charge controllers, batteries automatic chili watering control systems, and water pumps, which This research uses a 50 WP solar panel[8], a Solar Charge Controller with a rated voltage of 12/24 volts and a rated current of 10 Amps, a battery with a capacity of 7.5 AH, to meet the needs of Arduino of 12 volts[9], RTC (real-time clock) of 5 volts, a water pump requires a voltage of 12 volts dc and a current of 3 Ampere, the research diagram block is shown in Figure 1.
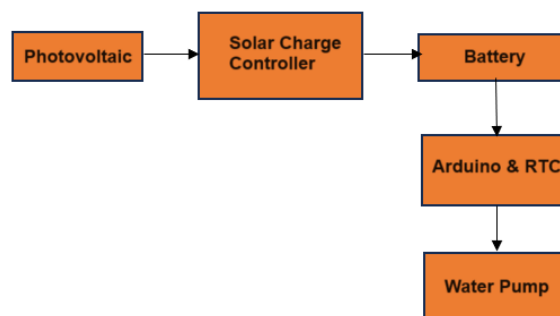

Figure 1. Research Diagram Block

Figure 1. shows Solar panels function to absorb solar radiation and convert it into electrical energy[10][11]. Furthermore, the amount of electrical energy produced by the solar panel will be forwarded to the solar charge controller[12]. The Solar Charge Controller regulates or controls the direct current charged to the battery and the current taken from the battery to the load. The Solar Charge Controller will also set the limit of overcharging if the battery is full and overvoltage from the solar panel. The electrical energy generated by the solar panel will then be stored in the battery (battery) which will later be used to supply energy to operate the Arduino Uno and DC Water Pump[13].

4. RESULTS AND DISCUSSION

This research aims to produce an environmentally friendly chili sprinkler and use renewable energy sources. The designed tool is expected to be able to maintain the continuity of watering water based on the specified time minimize labor costs in the chili watering process and reduce the level of worker fatigue. To achieve this goal, a chili sprinkler is designed using a solar power plant of 50 Wp. Figure 2. Showing the results of the design of the tool

Figure 2. overall solar PV

Figure 2. Showing the design of a solar power plant that has been used as an energy source for chili sprinklers to provide an energy source for Arduino, RTC, DC motors, and water pumps, the voltage source needed for equipment is 12 volts DC and 5 volts DC[14][15].

The results of the test of the use of solar power plants in automatic plant sprinklers, when not loaded, can be seen in Figure 3.
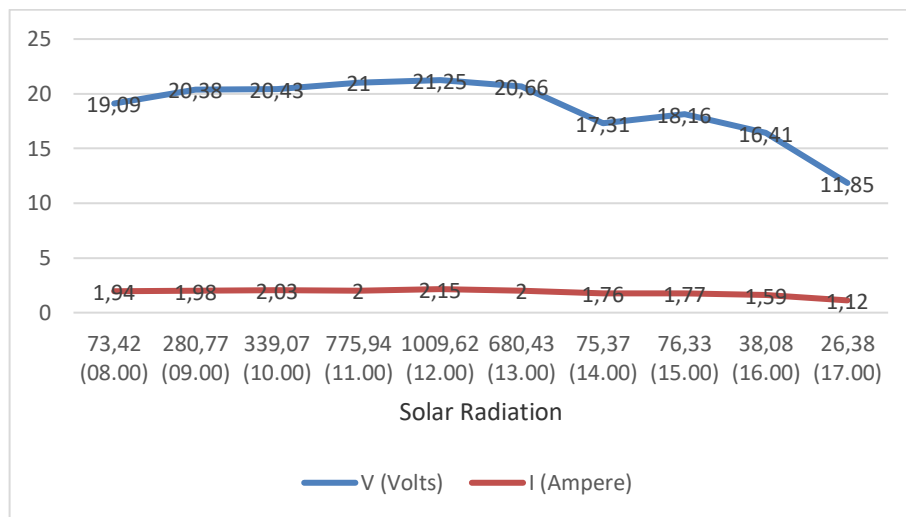

Figure 3. Measurement Chart of No-Load Solar Panels

Figure 3. shows the results of the measurement of the no-load Solar Panel can be seen, and the maximum voltage obtained at 12.00 PM is 21.25 volts and the maximum current is 2.05 Ampere with a light intensity of 1009.62 W/m^2. The minimum voltage from solar panel measurements occurs at 05.00 PM of 11.85 volts and a minimum current of 1.12 Ampere with a light intensity of 26.38 W/m^2. The average voltage and current magnitude of the no-load test results were 18.65 volts and 1.83 Ampere. Average power magnitude 34.13 Watts

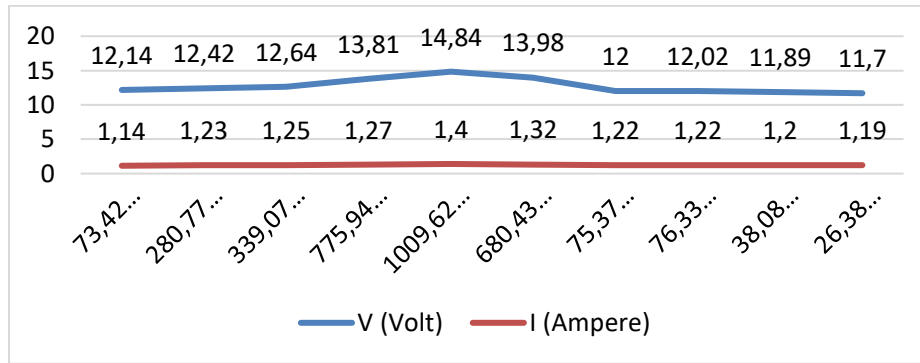Testing when the automatic sprinkler is working can be seen in Figure 4.

Figure 4. Solar module test chart under load

Figure 4 shows the results of the Solar Panel test when under load, the maximum voltage of the solar panel is obtained at 12.00 PM of 14.84 volts, and the maximum current is 1.4 Ampere with a light intensity of 1009.62 W/m2. The minimum voltage from the measurement of this solar panel at 05.00 PM is 11.7 volts, and the minimum current is 1.19 Ampere with a light intensity of 26.38 W/m2. The average voltage of the test result is 12.74 volts, and the average current of the test result is 1.24 Ampere. The average power magnitude when loaded is 15.80 Watts and can provide voltage supply to the automatic chili plant sprinkler. Time required to charge the battery

$$\text{Battery charging time (hour)} = \frac{Battery\ capacity(Ah)}{charging\ current\ (A)}$$
$$\text{Battery charging time (hour)} = \frac{7.5(Ah)}{1.24\ (A)}$$
$$\text{Battery charging time (hour)} = 6\ \text{Hour}$$

The average current that comes out of the SCC is 1.24 Ampere when loaded, it takes 6 hours to fully charge the battery. The battery is capable of being the voltage source needed by an automatic chili watering device when there is no solar radiation.

5. CONCLUSION

The design of a 50 Wp solar power plant in this automatic chili plant watering system can work well, characterized by the solar power plant being able to supply the energy needed by the pump when under load, the average voltage obtained is 12.74 volts, and the average current is 1.24 Ampere and the system can operate to water chili plants according to the set time

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