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Solar Cell Based Automatic Garden Watering Control System

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ABSTRACT

Watering Gardens Using Solar Cells. Supervised by Zahir Zainuddin and Adriani. Solar cell is a device composed of semiconductor material that can convert sunlight into electric power directly. Often also used the term photovoltaic or photovoltaic. In this design, automatic garden watering using a solar cell requires timer equipment, BCU, rain sensor, relay, battery/battery and inverter. The purpose of this design is to determine the performance of the plant watering design using a solar cell as a voltage source and to determine the rain sensor and control system in watering plants optimally, so that later it can be applied to further designs and the community. The results of the garden watering test using a solar cell without a load on December 31, 2017 produced a voltage of up to 18 volts with a current of 1.5 amperes and on December 14, 2017 it produced a voltage of up to 17.5 volts with a current of 1.4 amperes. Meanwhile, when given a load, the voltage released by the battery is 11.5 V and produces a current of 5.73 A and the voltage issued by the inverter is 214 V and produces a current of 1.05 A. issued by the battery is 11.80 V with a current of 7.80 A and the voltage issued by the inverter is 221 V and the current issued is 0.81A. 5 volts with a current of 1.4 amperes. Meanwhile, when given a load, the voltage released by the battery is 11.5 V and produces a current of 5.73 A and the voltage issued by the inverter is 214 V and produces a current of 1.05 A. issued by the battery is 11.80 V with a current of 7.80 A and the voltage issued by the inverter is 221 V and the current issued is 0.81A. 5 volts with a current of 1.4 amperes. Meanwhile, when given a load, the voltage released by the battery is 11.5 V and produces a current of 5.73 A and the voltage issued by the inverter is 214 V and produces a current of 1.05 A. issued by the battery is 11.80 V with a current of 7.80 A and the voltage issued by the inverter is 221 V and the current issued is 0.81A.

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1. INTRODUCTION

The solar energy provided by God for mankind, especially in Indonesia as a country that has a tropical climate is very abundant (Saputra & Agus Supardi, 2015). In addition to being abundant and not used up, solar energy also does not cause pollution so that solar energy has the potential to be used as alternative energy (Junaidi, 2015). Solar energy cannot be used directly, to convert solar energy into electrical energy (Lubis et al., 2022). However, equipment such as solar cells is still needed to convert solar energy into electrical energy (Nurdiansyah et al., 2020).

So that solar energy has the potential to be used as a substitute for oil, coal, etc (Saputro, 2015). Utilization of solar heat as a source of electrical energy can also be an alternative solution in the need for electrical energy for watering the garden (Santoso & Sumarjo, 2020).

Energy is a primary need for human life in this modern era, especially in terms of electrical energy (Prianto, 2007). The availability of electrical energy is a must to support human activities(Yanto, 2020). Therefore, electrical energy has a great influence to facilitate human productivity (Komuna et al., 2021).

In addition, population growth continues to increase resulting in the need for electrical energy continues to grow (Basyiran, 2014). This is contrary to the availability of fossil energy, which has been the main fuel, which is dwindling (Rompas et al., 2018). Humans are very dependent on electricity generated by fossil energy. This happens in all fields, not least in terms of watering the garden (Mediastika, 2021).

Watering plants that we know is done manually by giving water to plants according to a schedule and using voltage from PLN (Effendi & Yusran, nd). Manual watering is considered inefficient, because it requires a lot of time, effort, finances in the form of money, and the plant owner cannot leave the plant for a long time. So in this case, with the development of the era, an automatic plant sprinkler was made using solar cells as a source of electrical energy.

2. RESEARCH METHOD

2.1 Tools and materials

This design and manufacture requires a number of tools and materials to assemble this tool so that it is created according to what you want (Sudono, 2000). The tools and materials used can be seen in table 3.1 and table 3.2.

Table 1. Tools Used

No	Alat	Sspecification	Jumlah	Satmoney	Keterangan
1	tang	Lancip, combination, and peel.	1	Buah	-
2	Palu	-	1	Buah	-
3	Obang	Plus and minus	1	Buah	-
4	Kpass lock	12	1	Buah	-
5	BorElectric	-	1	Buah	-
6	Mata Bor	10	1	Buah	-

Table 2. Materials Used

No.	Bahan	Sspecification	Jumlah	Satmoney	Keterangan
1	Pasolar cell nel	50 WP	1	Buah	-
2	Aki/Battery	45 Ah	1	Buah	-
3	BCU	-	1	fruit	-
4	Inverter	-	1	Buah	-
5	Kayum bell	2x1.5 mm2	10	Cashewr	-
6	KaNYAF bell	1.5 mm2	5	Cashewr	-
7	Selenoid valve	-	1	Buah	-
8	Pompa water	125 W	1	Buah	-

2.2 Research Stages

The stages carried out in the study of the length of plant sprinklers using solar cells, namely: (1) Preliminary study, Conducting guidance with the supervisor on the title and topic of discussion which is directed to be able to design plant sprinklers using solar cells. (2) Library data, Collecting data by reading and studying various literatures, writings, and lecture materials obtained during lectures in order to obtain a theoretical basis related to the material being discussed in writing this final project (Gainau, 2021). (3) Field research (field research), research conducted directly on the object of research, namely the analysis of the performance of solar cells in watering plants (Amuddin & Suwardji, 2018). (4) Design Phase, In designing the final project tool entitled "Plant Watering Using Solar Cells"

3. RESULTS AND DISCUSSIONS

The results of the design of the tool that has been designed as expected is to work as the main source of automatic garden watering control by converting solar heat into electrical energy and spitting out circular water with a diameter of 2.2 meters. The explanation is as follows.

3.1. Tool Design

To design an automatic plant watering device using a solar cell requires tools such as a Solar Cell, BCU (battery control unit), Aki, Inverter 12 VDC to 220 VAC 500 Watt, Timer TB-888, Relay 12 VDC, Rain Sensor, and Water Pump.

Figure 1. Physical Tool Circuit

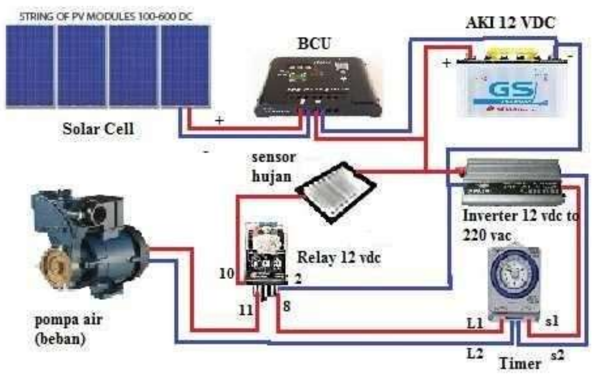

Figure 2. Series of Plant Watering Using Solar Cell

In figure 4.2. Watering plants using a solar cell as a power generator with solar power as a substitute for the PLN voltage which is connected to the power panel where there is a BCU and battery. Because the load required is 220 VAC, an inverter is used to increase the voltage from 12 VDC to 220 VAC. The plant watering control system uses a TB-888 timer where the system operates every 3 hours the timer from S1 and L1 changes from NO to NC for fifteen minutes. When the fifteen minutes are over, the legs S1 and L1 from the timer that were NO to NC return to NC to NO.

The rain sensor functions for relay operation. Where pin 1 of the rain sensor is connected to the battery phase while pin 2 is connected to pin 10 of the relay while the neutral on the battery is connected directly to the relay. The relay here functions when the circuit breaker from the inverter and timer. When it rains, the rain sensor sends the phase current to the relay so that on legs 8 and 11 of the NC it becomes NO which makes the load current cut off and stops the timer operation.

3.2. Tool Test Results

In designing a garden watering device using solar cells, we divided the test results into two, namely the no-load test and the load-bearing test, the results are as follows:

3.2.1 No-load Test Results

PaOn 14 December 2017 and 31 December 2017 we carried out a no-load measurement on the solar cell output. This measurement was carried out at the Muhammadiyah Makassar University campus park at 10:00 to 15:00 local time. This test produces outputs such as table 1 and table 2. Table 1 Data for measuring the voltage and current output of solar cells on December 14, 2017.

Table 3. Solar Cell Output Voltage And Current Measurement Data December 14, 2017

Measurement time	Voltage (V)	Current (A)	Power (P)	Information
10.00	18	1.5	27	Bright
10.30	12	1.4	16.8	Cloudy
11.00	12	1.4	16.8	Cloudy
11.30	12	1	12	Cloudy
12.00	18	1.5	27	Bright
12.30	11	0.9	9.9	Cloudy
13.00	18	1.5	27	Bright
13.30	18	1.5	28.5	Bright
14.00	11	1	11	Overcast
14.30	15	1.1	16.5	Bright
15.00	13	1	13	Bright

Table 4. BCU Output Voltage And Current Measurement Data December 14, 2017

Measurement time	Voltage (V)	Current (A)	Power (P)	Information
10.00	11	0.5	5.5	Bright
10.30	12	0.6	7.2	Cloudy
11.00	12	0.6	7.2	Cloudy
11.30	12	1	12	Cloudy
12.00	12	1	12	Bright
12.30	11	0.9	9.9	Cloudy
13.00	12	0.9	10.8	Bright
13.30	12	1.4	16.8	Bright
14.00	11	1	11	Overcast
14.30	12	1.1	13.2	Bright
15.00	12	1	12	Bright

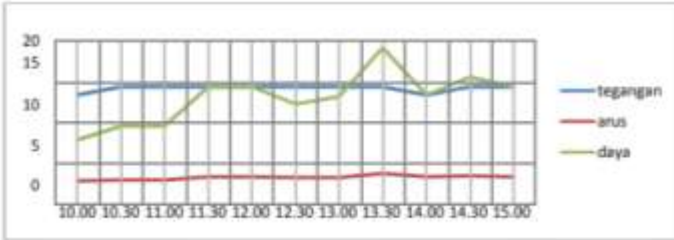

Figure 3. Graph Of Comparison Of Power, Current And Voltage Against Time

As seen in table 1 and table 2 can be illustrated by graphs. The voltage, current and power generated by solar cells are unstable. This is because the weather conditions at the time of measurement are changing so that the light received by the solar cells also varies. While table 3 and table 4 are the results of measurements on December 14, 2017.

Table 5. Solar cell output voltage and current measurement data December 14, 2017

Measurement time	Voltage (V)	Current (A)	Power (P)	Information
10.00	17	1.1	18.7	Bright
10.30	17.5	1.4	24.5	Bright
11.00	17.5	1.4	24.5	Bright
11.30	17.5	1.4	24.5	Bright
12.00	17.5	1.4	24.5	Bright
12.30	17.5	1.4	24.5	Bright
13.00	17.5	1.4	24.5	Bright
13.30	17.5	1.3	22.75	Bright
14.00	17	1.2	20.4	Cloudy
14.30	17	1.2	20.4	Cloudy
15.00	11	0.5	5.5	Cloudy

Table 6. BCU Output Voltage And Current Measurement Data December 14, 2017

Measurement time	Voltage (V)	Current (A)	Power (P)	Information
10.00	15.5	0.5	7.75	Bright
10.30	16	0.8	12.8	Bright
11.00	16	0.8	12.8	Bright
11.30	16	0.8	12.8	Bright
12.00	16	0.8	12.8	Bright
12.30	16	0.8	12.8	Bright
13.00	16	0.7	11.2	Bright
13.30	15.5	0.7	10.8	Bright
14.00	15	0.7	10.5	Cloudy
14.30	15	0.7	10.5	Cloudy
15.00	11	0.5	6.5	Cloudy

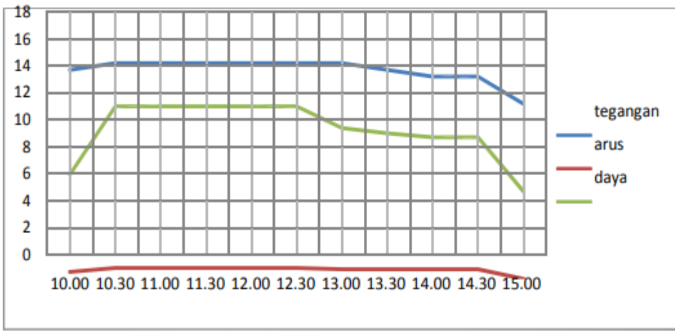

Figure 4. Graph Of Comparison Of Power, Current And Voltage Against Time

It is concluded that in the picture above, the voltage is said to be high from 10.00 to 13.00.

3.2.1 No-load Test Results

After carrying out the no-load test, a test was also carried out using a load to determine the duration of operating the load using a battery using a 125 watt water pump as a load.

Table 7. Load Test Results

Menits to-	Keterangan
10	light upa
20	light upa
30	light upa
40	light upa
50	light upa
60	Dead

As in Table 5 above, it can be seen that the load, in this case the water pump, can operate for 60 minutes, at the beginning of operation the voltage issued by the battery is 11.5 V and produces a current of 5.73 A and the voltage issued by the inverter is 214 V and issued a current of 1.05 A. While in the middle of the operation, measurements were also carried out, the voltage released by the battery was 11.80 V with a current of 7.80 A and the voltage released by the inverter was 221 V and the current issued was 0.81A.

3.3. Discussion

After testing the tool and measuring the voltage of the solar cell without a load and using the BCU output for two days, the voltage increase is directly proportional to the current and power because there is no load that can inhibit the increase in current so that the increase in radiation received by the solar cell will affect the current increase. and voltage so that the power goes up.

The rise and fall of voltage and power in solar cell measurements is determined by weather conditions at the time of measurement, cloudy, cloudy, and hot. In other words, the intensity of radiation affects the input power of the solar cell. The input power from this solar cell will affect the efficiency generated by the solar cell. As in the equation below:

3.3.1 Solar Cell Input Power (P input)

Input = G x A (1)
Is known:
G = 1366 W/m2
A = (4x102) (6x102) = 0.24 m2
Solution
Input = G x A
= 1366 W/m2 x 0.24 m2
= 327, 84 Watt

3.3.2 Solar Cell Output Power

Solar Cell Output Power
Output = V x I (2)
Is known:
V output = 14.45 Volt
I Output =1.25 Ampere
Solution:
Output = V x I
= 14.45 Volts x 1.25 Ampere
= 18.06 Watts

3.3.3 Solar Cell Efficiency

Solar Cell Efficiency
= 100%
Is known:
P_O/P_In x (3)
P input = 327.84 Watt
P output = 18.06 Watt
Solution:
=P_O/P_In x 100 %
=(1.0 W)/(3.8 W) x 100 %
= 5.5
From the equations above, it can be seen that there is a relationship between the area of the solar cell panel with the output and input power generated. For irradiation, it is obtained from the data of the average value of solar radiation that reaches the earth with a value of 1336 W/m2.

3.3.4 Power and Battery Relationship

Because the battery used in this design is a 45 Ah 12 Volt battery, the power stored in the battery is obtained by:
Battery Power = 12 Volts x 45 Ah
= 540 Whour
From these calculations, the stored power is 540 Whour.

3.3.5 Advantages and Disadvantages of Tools

Everything in this world is definitely not perfect, just as the tools we design must have flaws, both technically and in design. But in addition to having disadvantages, this tool also has advantages. The advantages and disadvantages of this solar cell-based garden watering that we designed are as follows: (1) Advantages of the Tool: (1) The energy used is the sun which will never run out and is freely available. (2) No longer dependent on PLN sources because it uses the sun as the main source. (1) Lack of Tools, This tool is still classified as a high-value tool because it uses high-value materials.

4. CONCLUSION

Based on the results of the design that has been carried out on a solar cell-based garden watering device, it can be concluded that: (1) Solar cell-based watering plants when the load produces a voltage of up to 11.5 V and a current of 5.73 with an inverter output voltage of 214 V and a current of 214 V. 1.05 A. (2) Timer controls the water pump in watering plants, every 6 hours the water pump waters the garden for 15 minutes and the rain sensor functions to cut off the load flow so that watering does not occur when it rains. (3) The design of this tool can ease the work of the community in watering plants.

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