Journal of Electrical Engineering and Computer Sciences P-ISSN: 2528-0260 E-ISSN: 2579-5392
Vol. 6, Issue 2, Desember 2021 p.1081-1086

DESIGN OF SOLAR POWER PLANT FOR ELECTRICITY SOURCE OF THE DRYING MACHINE

[1] UAIS SABILAH MUHAMMAD, [2] BAMBANG PURWAHYUDI

[1,2] Study Program of Electrical Engineering, University of Bhayangkara Surabaya

Jl. A. Yani 114, Surabaya, Indonesia

e-mail: bmp_pur@ubhara.ac.id

ABSTRACT

The increasing demand for electrical energy and the development of power generation technology have caused to the development of micro-scale industries increasing in Indonesia. The development of this micro-scale industries are expected to be able to utilize electrical energy from solar panels as the main source of electrical energy. In this paper, solar panels are used as a source of electrical energy in the drying machine. Utilization of solar panels aims to reduce production costs where solar energy is absorbed through solar panel as the main source of electrical energy for drying machine. In addition, the use of solar energy aims to make the drying machine continuously operate. This drying machine uses a heater of 700Watt and is operated during 4 hours. From the calculation results of the solar power plant system design are obtained the capacity battery of 300 Ah, the capacity solar cells of 10x100 Wp, the capacity inverter of 700 watt and the Solar Charger Controller (SCC) of 60 amperes.

Keywords: *micro-scale industry, solar energy, solar panels, solar charger controller*

1. INTRODUCTION

Recently, solar energy is a safe resource besides being free and unlimited. In Indonesia, the use of solar energy as a source of electrical energy has not been optimally utilized. The average intensity of solar radiation energy is 4.5 kWh/m2 per day [1]. In the energy field, one that can be utilized from the intensity of sunlight is to maximize the conversion of sunlight into electrical energy [2,3]. Solar energy sources can be used to supply electrical energy in micro-scale industrial equipments. In the field of micro-scale industry, one of the uses of solar panels is to help the drying process row materials from wet to dry such as pumpkin, cassava, banana, apple, potato and the others. By this way, they can be stored for a long time.

The source of electrical energy for the drying machine usually comes from The State Electricity Company (PLN). However, the electrical energy distributed by PLN is not always continuous, sometimes the electrical energy outage suddenly due to faults or maintenance of the electricity network, so that alternative energy is needed to reduce costs and avoid disturbances caused by PLN [4]. To overcome this problem, alternative sources of electrical energy are needed to ensure the drying machine continues to operate in the event of a power outage.

In this paper, a drying machine based on solar panels is developed to reduce operating costs for micro-scale industries and the use of solar energy as a source of electrical energy. So that, the drying machine can be continuously operate by utilizing an electrical energy source from solar energy.

2. RESEARCH METHODOLOGY

The solar power plant for the drying machine consists of solar panels or photovoltaic (PV), solar charge controller (SCC), inverter, battery and heater (load). The block diagram of the solar power plant can be seen in Figure 1.

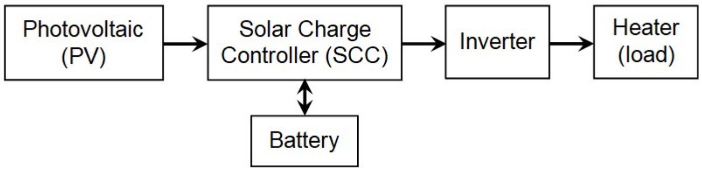

Figure 1. The block diagram of the solar power plant.

Meanwhile, the research methodology employed to design of solar power plant for electricity source of the drying machine is shown in Figure 2. Figure 2 show that design process of solar power plant should be followed some stages. That stages are calculate the energy load, calculate the capacity of photovoltaic (PV), calculate capacity of battery, calculate the capacity of inverter and the last stage is calculate of solar charger controller (SCC). These calculations are based on power load (watt) and operating time of load per day (hours).

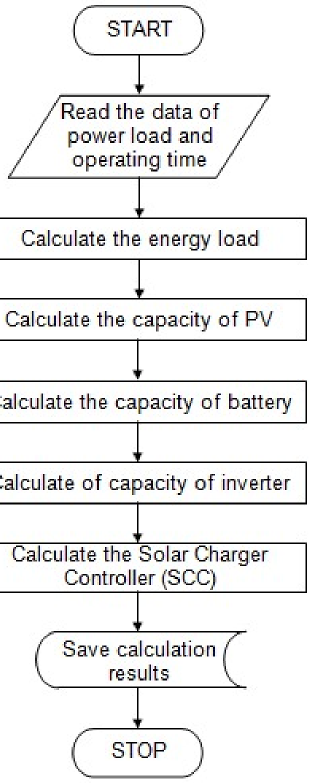

Figure 2. Research methodology for design of solar power plant.

2.1. Calculation of supplied electricical energy.

Supplied electrical energy can be obtained from power load (heater) and operating time of its per day. Calculation of supplied electrical energy can use equation (1) [5].

$$Wh = P \, x \, t \tag{1}$$

where *Wh*, *P* and *t* are respectively the supplied electrical energy (watt hour), power load (watt), operating time of load (hour).

2.2. Calculation of photovoltaic (PV) capacity.

Solar cells or photovoltaic (PV) is main components in solar power plant systems. This solar PV function is to convert solar radiation into electrical energy through a photoelectric process. The PV energy produced is direct current (DC). Currently, solar panels have various forms and types, each of which has its own ability. Several types of solar panels on the market are Mono-crystalline and Poly-crystalline. Figure 3 show types of solar panels [6].

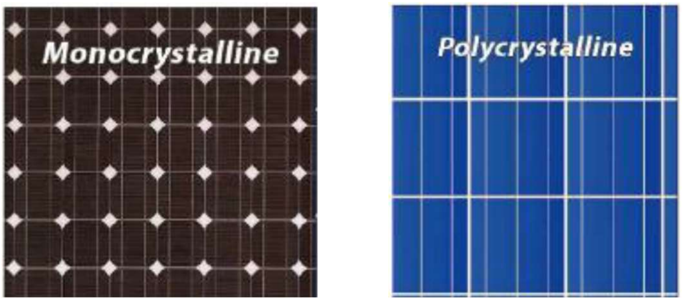

Figure 3. Types of solar panels

Capacity of PV (*Wp*) is determined by electrical energy (*Wh*) used load in one peroide time (hour) and solar radiation energy (kWh/m2). Some the other factors caused the PV capacity are temperature (^{0}C), connector cables, inverter, battery and solar charge controller (SCC). PV capacity can be calculated by Equation (2) [5,7].

$$Wp = \frac{Wh}{PSH\ x\ \eta} \quad (2)$$

where *Wp*, *Wh*, *PSH* and η are respectively the capacity of PV (watt peak), supplied electrical energy (watt hour), peak sun hour (hour per day) and efficiency of system (0.67-0.75). Duration of PSH is 3-4 hour per day.

2.3. Calculation of battery capacity.

A battery is an electrical-chemical device that stores energy and releases its energy in electricity. The battery in the solar power plant system is used as a component for storing direct current (DC) electrical energy generated by solar panels during the day, then supplying electricity to the load at night or during cloudy weather. There are many battery technologies available for the solar power plant systems such as lead-acid, lithium ion, Zinc water, Nickel cadmium and other types. Lead-acid batteries are the most widely used type of battery in the solar power plant systems because they last a long time, are safer, easier to use and have a relatively low cost per cycle. Figure 4. Show Lead Acid battery [6].

Figure 3. Types of solar panels

Calculation of battery capacity depend on supplied electrical energy and nominal voltage of battery. Equation (3) express the clculation of battery capacity [6,7,8].

$$AH = 1.25\ x \frac{Wh}{V_B} \quad (3)$$

where *AH*, *Wh* and V_B are respectively battery capacity (ampere hour), supplied electrical energy (watt hour), voltage of battery (volt).

2.4. Calculation of inverter capacity.

This inverter function is to convert DC voltage to AC voltage through a switching process. The capacity of inverter depends on the value of power load (watt) and inverter specifications on the market.

2.5. Calculation of solar charge controller capacity.

Solar charge controller (SCC) is a component used in the solar power plant system to regulate battery charging using solar panels to be more optimal. This device operates by adjusting the charging voltage and current based on the available power from the solar panels and the battery charging status or state of charge (SoC). Currently, the solar charge controller (SCC) which is widely used in the solar power plant systems has two main types. They are Pulse Width Modulation (PWM) and Maximum Power Point Tracker (MPPT). Figure 4 show types of SCC [6].

a. PWM type b. MPPT type

Figure 3. Types of the solar charge controller (SCC)

The capacity of solar charge controller (SCC) is determined from the maximum output current of photovoltaic (PV) and SCC specifications on the market.

3. RESULT AND ANALISIS

Design of solar power plant for the drying machine is based on power load (heater) and operating time of load. Table 1 shown the parameters of drying machine

Table 1. Parameters of the drying machine

Parameters	Values
Power of heater (watt)	700
Operating time of load (hours)	4
Peak sun hours PSH (hours per days)	4
Efficiency η	0.75
Voltage of battery (volt)	12

From parameters of drying machine in Table 1, supplied electrical energy, PV, battery, inverter and SCC can be determined.

3.1. Supplied electrical energy

Supplied electrical energy is calculated by using Equation (1). Then, the magnitude of supply electrical energy is

$$Wh = 700\ watt\ x\ 4\ hour = 2800\ wh$$

3.2. Capacity of photovoltaic (PV)

PV capacity is calculated by using Equation (2). So, the magnitude of PV capacity is

$$Wp = \frac{2800}{4\ x\ 0.75} = 933.33\ watt.peak$$

In the design, the solar power plant uses 10 solar panels with a capacity of 100 Wp.

3.3. Capacity of Battery.

The battery capacity can be calculated using Equation (3). Thus, the magnitude of battery capacity is

$$AH = 1.25\ x \frac{2800}{12} = 291.67\ ampere.hour$$

In the design, the battery capacity uses 300 AH for the solar power plant.

3.4. Capacity of Inverter and SCC

The capacity of inverter used in the solar power plant is 700 watt according with the magnitude of power heater (watt). While the SSC capacity is calculated from the photovoltaic (PV) output current.
Photovoltaic with a capacity of 100 Wp have the output current of 5.8 amperes [7]. So that, SCC capacity is 10 x 5,8 ampere = 58 ampere. In the research, the capacity of SCC used is 60 ampere.

4. CONCLUSION

Design of solar power plant for electricity source of the drying machine has been shown. The solar power plant for the drying machine consists of solar panels or photovoltaic (PV), solar charge controller (SCC), inverter, battery and heater (load). The design process of solar power plant should be followed some stages such as calculation of the energy load, calculation of the capacity of photovoltaic (PV), calculation of capacity of battery, calculation of the capacity of inverter and the last stage is calculation of solar charger controller (SCC). Calculation results of solar power plant design for the drying machine show that supplied electrical energy of 2.8 kWh, photovoltaic (PV) capacity of 10 x 100 Wp, battery capacity of 300AH, inverter capacity of 700 watt and SCC capacity of 60 ampere.

REFERENCES

[1] F. Habibi, Nur, S. Setiawidayat, and M. Mukhsim, “Alat Monitoring Pemakaian Energi Listrik Berbasis Android Menggunakan Modul PZEM-004T,” *Pros. Semin. Nas. Teknol. Elektro Terap. 2017*, vol. 01, no. 01, pp.157-162, 2017[Online].Available:https://prosiding.polinema.ac.id/sngbr/index.php/sntet/article/view/81/77.

[2] B. Purwahyudi, K. Kuspijani, and A. Ahmadi, “SCNN based electrical characteristics of solar photovoltaic cell model,” *Int. J. Electr. Comput. Eng.*, vol. 7, no. 6, pp. 3198–3206, 2017, doi: 10.11591/ijece.v7i6.pp3198-3206.

[3] V. V. Vingtsabta, A. Syakur, and A. Warsito, “Analisis Dan Perbandingan Jenis Kawat Kanthal a-1 Dan Hemat Energi,” *Transient2*, vol. 7, no. 4, pp. 846–852, 2020.

[4] S. SAODAH and S. UTAMI, “Perancangan Sistem Grid Tie Inverter pada Pembangkit Listrik Tenaga Surya,” *ELKOMIKA J. Tek. Energi Elektr. Tek. Telekomun. Tek. Elektron.*, vol. 7, no. 2, p. 339, 2019, doi: 10.26760/elkomika.v7i2.339.

[5] P. Gunoto and S. Sofyan, “Perancangan Pembangkit Listrik Tenaga Surya 100 Wp Untuk Penerangan Lampu di Ruang Selasar Fakultas Teknik Universitas Riau Kepulauan,” *Sigma Tek.*, vol. 3, no. 2, pp. 96–106, 2020, [Online]. Available: https://www.journal.unrika.ac.id/index.php/sigmateknika/article/download/2754/pdf.

[6] M. S. N. REGA, N. SINAGA, and J. WINDARTA, “Perencanaan PLTS Rooftop untuk Kawasan Pabrik Teh PT Pagilaran Batang,” *ELKOMIKA J. Tek. Energi Elektr. Tek. Telekomun. Tek. Elektron.*, vol. 9, no. 4, p. 888, 2021, doi: 10.26760/elkomika.v9i4.888.

[7] Markvart, T. Castaner, L. (Ed.). (2003). Practical Handbook of Photovoltaics Fundamentals and Applications. Netherlands: Elsevier Science Publishers.

[8] Y. D. Arfita, Antonov, S. Yuliananda, G. Sarya, and R. R. Hastijanti (2013). *Pemanfaatan energi surya sebagai suplai cadangan pada laboratorium elektro dasar di Institut Teknologi Padang*, Jurnal Teknik Elektro, Vol. 2, No. 3, pp. 20–28. [Online]. Available: https://ejournal.itp.ac.id/index.php/telektro/article/view/124