Design and Build of a Public Electric Vehicle Charging Station (SPKLU) Based on Solar Panel for Electric Vehicles Operating Poltektrans SDP Palembang

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Abstract. Solar panel-based Public Electric Vehicle Charging Stations (SPKLU) are an innovative solution to support the use of operational electric vehicles. With the increasing demand for environmentally friendly vehicles, the development of efficient and sustainable charging infrastructure has become increasingly important. This design utilizes solar energy as the main source, thereby reducing dependence on fossil energy and reducing carbon emissions. This study involves technical analysis in designing SPKLU equipped with solar panels, inverters, and energy storage systems. Strategic location and modular design are proposed to maximize space efficiency and user accessibility. In addition, system modeling was carried out to determine the optimal charging capacity, taking into account variations in user needs. The results of this research show that the implementation of solar panel-based SPKLU not only meets the need for charging electric vehicles but also supports sustainability and energy efficiency efforts. The daily electrical energy that can be produced is 5562.13 watts. Apart from that, the SPKLU system can charge electrical energy to operational electric vehicle batteries by maintaining a voltage above standard and charging from 37% to 100% in 210 minutes.
Keywords: Electric vehicles, Sustainability, Solar panels, SPKLU.

1 Introduction

Electrical energy is a primary need in every country after food and shelter because with electrical energy humans can fulfill their life needs. Every industry can operate well, and office centers and the government can carry out their activities. The need for electrical energy will continue to increase along with the increasing human population which continues to grow yearly. It is predicted that in 2050 the human population will reach around 10 billion compared to 2010 which was around 6.3 billion or an increase of around 37% [1].
The projection of the need for electrical energy based on the predicted increase in population will experience a significant increase, so today the development of technology to support the provision of electrical power continues to be echoed and developed very seriously with the main goal of meeting the need for electrical energy. Many countries are competing to create efficient and environmentally friendly electrical energy generation technology based on new and renewable energy because

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currently most power plants use fossil fuels which are not environmentally friendly and their availability is minimal.

New renewable energy sources that can be utilized for the process of generating electricity are already abundantly available in this world, these energy sources include water, wind, geothermal, solar, biomass, and ocean energy. Indonesia as a developing country is currently echoing the use of new renewable energy for the process of generating electricity. With an area of 2/3 of its territory being ocean and located in the equatorial region, Indonesia has the potential for renewable energy sources for the process of generating electricity such as water (75.091 GW), geothermal (29.544 GW), ocean energy (727 GW), solar (207.898 GW) and wind (60.647 GW) [2]. The potential for new renewable energy for generating very large electricity is not wasted by the Indonesian Government, especially for the needs of public transportation modes. The Indonesian Government has issued Presidential Regulation Number 55 of 2019 concerning the Acceleration of the Battery-Based Electric Motor Vehicle Program for Road Transportation. From the regulation, it can be seen that the use of electric vehicles, especially for official operational vehicles, is highly recommended by the government. The use of electric-based government operational vehicles should also be supported by the provision of clean electrical energy, where the electrical energy used by electric-based operational vehicles comes from clean energy, but in reality, they still use electrical energy from PLN, most of whose generators still use fossil fuels. The availability of clean electrical energy sources to recharge electric vehicles is still very limited, so this study will discuss the design and construction of a Public Electric Vehicle Charging Station (SPKLU) based on solar panels so that it will provide a source of clean electrical energy for operational vehicle needs with a case study of electric operational vehicles owned by the Palembang River, Lake and Crossing Transportation Polytechnic.

2 Research Methods

The research methodology that will be used in compiling this research is: first by identifying the problem and continued with a literature study from various studies that have been conducted previously, then the stage of collecting data on the load of electric operational vehicles is carried out and continued with the design and implementation of the SPKLU system to obtain results and conclusions. The stages of this research process are described in Figure 1.

3 Result and Discussion

The design carried out in this research is divided into two parts, namely the first is the design of the electrical system, the second is the design of the electrical energy output using the application.

a. Electrical System Design

Electrical system design is needed to ensure that the system can work well in terms of design and calculation. In addition, electrical design is needed to determine the specifications of each component so that it can function properly and be interconnected. Meanwhile, the design of the solar panel mount is needed to ensure that the size of the mount matches the size of the solar panel used in this study so that operations can run smoothly.

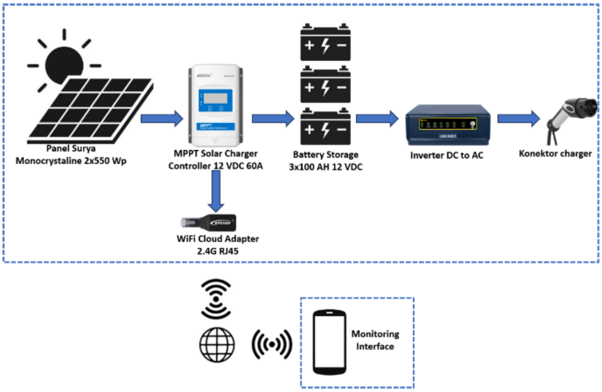

Figure 1 Research block diagram

The system designed in this study is as shown in Figure 1. In the block diagram, it can be explained that the solar panel to be used is a monocrystalline type with a capacity of 550 Wp. The solar panel functions as a generator of electrical energy that converts solar irradiation, then the electricity produced enters the MPPT charging controller with a capacity of 60A and a voltage of 12 VDC to engineer the voltage and current so that the electrical output matches the battery specifications as a place to store the electricity produced. The electrical output from the MPPT charging controller has a voltage of 12 VDC because the batteries are arranged in parallel. The battery capacity used is 100 Ah, 3 of which are arranged in parallel so that it has a total capacity of 300 Ah 12V.

b. Implementation

The first step of implementation in this study is to assemble and test each component before installing it on the solar panel roof frame. This is to ensure that all components can function as desired. In addition, testing activities on the work floor aim to minimize work if during the system test damage and malfunction of each component is found.

Figure 2 Component testing

In addition to testing each component, testing of the solar panel is also carried out to ensure that the solar panel can produce electricity according to specifications

Figure 3 Solar panel testing

After testing the components and solar panels, the next step is to make a cover for the electric fuel filling station for operational vehicle needs.

Figure 4 Construction of the cover and battery compartment

The next step is to install the solar panels on the roof frame and continue with the wiring and testing process. The installation of solar panels is carried out on the roof of the main building of the Palembang River, Lake and Ferry Transportation

Polytechnic. These solar panels are installed parallel and wired with a series circuit. The installation of solar panels arranged in series aims to keep the current value produced by the solar panels small, while the voltage value will be increased. This is useful for making the size of the cable used more efficient. The electrical energy produced by the solar panels arranged in series will produce a voltage of 84 Volts and have a current value of 13.06 Ampere.

Figure 5 Installation of solar panels and testing

c. Testing and Analysis

Measurements were carried out for 1 day starting at 07.00 - 18.00, from the results of the measurements it was found that the measured temperature was the range of the voltage produced was 26.47 - 87.81 Volts, while the current produced was 0.51 - 12.34 Ampere.

Table 1 Results of electrical energy output measurements

Time	Voltage (V)	Current(A)	Power (W)
06.00	26.47	0.71	18.88
07.00	79.76	3.55	283.54
08.00	75.83	6.91	524.05
09.00	75.04	9.5	712.93
10.00	75.71	10.9	825.41
11.00	73.99	12.34	913.41
12.00	79.53	10.24	814.75
13.00	85.93	6.58	565.42
14.00	77.26	4.48	346.8
15.00	87.81	2.6	228.83
16.00	86.23	1.74	150.46
17.00	82.94	1.6	133.35
18.00	85.46	0.51	44.3

The greatest electrical energy produced occurred at 11.00 with an electrical energy value of 913.41 Watts, while the lowest production occurred at 06.00

with an electrical production value of 18.88 Watts. In addition, from the measurement results it can be said that the output power will affect the voltage and current values. If the energy produced is low, the current that flows will also be low and vice versa. In the testing process, it was found that the current value produced by the solar panel experienced a very fluctuating value while the voltage value did not experience significant changes. This is because the value of the electrical power produced is influenced by the intensity of solar irradiation and the condition of the load or battery. If the solar irradiation condition is normal, the solar panel has the potential for large electrical energy to be produced. However, if the battery storage condition or load is full or the load is low, then the absorption of electrical energy produced by the solar panel will be low. This is what causes the relationship between solar irradiation and load conditions to greatly affect the electrical energy produced by the solar panel.

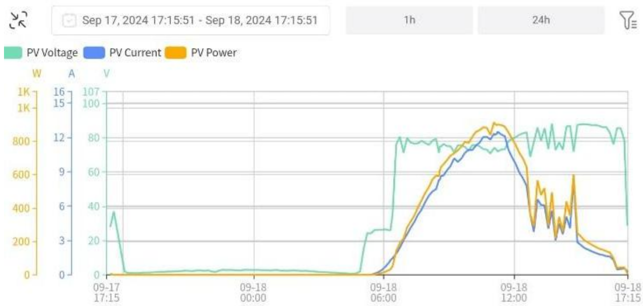

Figure 6. Daily Electrical Energy Production Graph

The electric motorbike owned by the Palembang River, Lake and Ferry Transportation Polytechnic as an operational vehicle has a total of 2 units. The electric motorbike has the Polytron brand type EV-Fox. The specifications of the electric motorbike used for the operational vehicle of the Palembang River, Lake and Ferry Transportation Polytechnic use the LifePO4 battery type with a battery storage capacity of 3.75 kWh with a battery voltage of 72 volts and 52Ah. When charging, the power required for charging is a maximum of 800 watts with an AC input voltage of 180-240 VAC and a maximum output voltage of 84 VDC.

Figure 7 Motor electric charging process

In the process of charging the battery of the electric motorbike used as an operational vehicle, the Palembang River, Lake and Ferry Transportation Polytechnic uses environmentally friendly energy produced by solar panels which are then stored in the battery. The electrical energy produced by the solar panels is in the form of DC voltage, the results of the electricity production will then be equalized by the charger controller so that it can match the battery voltage value of 12 VDC. During the process of charging the electric motor battery, the energy produced by the solar panel and the voltage value has been conditioned by the charger controller, then it will be converted into AC voltage by the inverter. This is because the electric motor charging system uses 220 Volt AC voltage.

Testing was carried out on several trials, in this research report it will be discussed only in one experimental condition. The test result data can be seen in table 2.

Table 2. Results of electric motor battery charging measurements

Time (Minute)	Battery SOC (%)	DC Voltage (Volt)	DC Current (Ampere)	AC Voltage (Volt)	AC Current (Ampere)
0	37	14,2	49,30	223	3,14
30	50	13,1	57,25	220	3,41
60	64	12,7	54,33	225	3,07
90	76	12,6	57,14	219	3,29
120	85	12,7	55,91	220	3,23
150	93	12,4	55,65	226	3,05
180	95	12,3	40,65	227	2,20
210	100	12,4	8,06	220	0,45

Based on the test results, the data is obtained in table 2. From the table, a discussion can be carried out to ensure that the SPKLU system can work properly and optimally. In table 2, it is known that the initial condition of the battery when charging electrical energy is 37%. The total time required to reach 100% of the electric motorcycle battery is 210 minutes. During the charging process, the AC and DC voltage data are very stable, but the current value that flows is quite large, so a larger conductor is needed. Based on the data in table 5.3. it can be said that the SPKLU system can operate properly, this can be proven by the increase in the electric motorcycle battery charge value. In addition, the voltage value which is still above the minimum average threshold proves that the SPKLU system can function properly.

4 Conclusion

The performance of the Public Electric Vehicle Charging Station (SPKLU) system based on solar panels for operational vehicles of the Palembang River, Lake and Ferry Transportation Polytechnic can produce 5562.13 watts of daily electricity. In addition, the SPKLU system can charge electric energy to operational electric vehicle batteries by maintaining voltage above standard and charging from 37% to 100% in 210 minutes.

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