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A Design Of Cellphone Charging Station System As Public Facility Using Off-Grid Solar Cell

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ABSTRACT
Solar Power Plant (PLTS) is a more environmentally friendly generator, because this generator requires sunlight to be able to produce electrical energy. This PLTS is OFF-GRID so an energy storage place such as a battery is needed. The battery is also used to distribute electrical energy to the load where the load used is charging smartphones. And requires a solar charger controller that functions to regulate the electrical energy produced by the solar panel. This study analyzes the design of a smartphone charging station system as a public facility. In this test, 3 tests were carried out, namely testing how long it takes the battery to charge using solar panels, how long it takes the battery to discharge using a load, namely charging a smartphone, and conducting real-time testing by charging and discharging the battery together. The battery used has a total capacity of 12V 60Ah. In the battery charger testing method with a 100 WP solar panel, it takes 4 days, for the discharger testing using a load, it takes 6 days, and real-time testing shows that the output current fluctuates because the output current is very dependent on the intensity of sunlight that occurs when the solar panel charges the battery.

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INTRODUCTION

In the digital era like now, many people who have smartphones to increase their activities, by 2024 smartphone users in Indonesia will reach 80% [1]. As time goes by, smartphones are increasingly available to all people. In addition, their compact size and small size can be used repeatedly by people who can recharge their smartphones even though they are not available [2]. However, not a few people remember to charge their smartphone batteries before traveling, so that when they are out of their smartphone batteries, they often look for a place to charge their smartphones, so a charging station is needed. Generally, charging stations use PLN electricity as their source of energy, but if they use PLN electricity, of course they will spend more money [2]. To reduce these costs, in this study, a Solar Power Plant (PLTS) was designed by utilizing solar energy [3]. The advantage of using renewable energy is that it does not cause pollution like other energy sources, so it is more environmentally friendly and the energy is very easy to use considering the geographical location of Indonesia which is very supportive for the availability of this energy [4].

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Renewable energy can be directly used by using solar panels or photovoltaic (PV) media. In this research, a system for using OFF-GRID solar panels for charging stations was created [5]. With the aim of implementing the Solar Power Plant (PLTS) using solar panels and electrical energy that is stored in the alkyd tank [6]. Thus, the alkyd tank analyzes the desalination of the Solar Power Plant (PLTS) system that is suitable for the alkyd tank to be used according to their needs, especially for charging smartphones [2].

Literature Review

Charging station

Charging Station is a public facility that can be used for public interest and is a necessity for all people[2]. There are 2 types of charging stations in Indonesia, the first is the electric control charging station, and the second is the smartphone charging station. This smartphone charging station is usually placed in city halls and other public facilities such as hospitals, airports, and shopping centers. Charging stations have a charging port so that charging can be done simultaneously without compromising on charging speed. In addition, they also have features that can be adjusted to the type of smartphone used [2]. Generally, charging stations that are used in general facilities have a small lock that can be locked to place their smartphones when charging [2]. However, there are also charging stations that have a gazebo shape so that the facilities that use these facilities can sit comfortably when charging

Solar Cell

A Solar Cell can also be called photovoltaic or a device that can convert magnetic energy into electrical energy [7]. Photovoltaic cells are made of special materials such as silicon. The metal in the cell recognizes the cell, while the function of the silicon is to absorb magnetic energy [8]. In general, the amount of electric current obtained depends on the energy of the magnetic that recognizes the solar cell [9]. The absorbed energy causes electrons to become loose and causes electrons to move more freely. Solar panels contain electrical media that cause electrons to move in a certain way [2]. This electron flow is an electric current, and by connecting metals in the altals in the PV wall, we can flow electricity out. There are 3 types of Solar Panels, namely: Monocrystalline is one of the most efficient types of solar panels compared to other types of solar panels [10].

This solar panel has an efficiency level of up to 20% so it can be used for large-scale electricity consumption. Polycrystalline is made from several silicon crystals that are melted into a square shape. However, the efficiency of polycrystalline is 16% smaller than monocrystalline, so this solar panel is more efficient. Thin Film has a size that is very thin compared to the other 2 types of solar panels, this causes Thin Film to have a lighter weight and have more flexible properties [11]. However, the efficiency level of this solar panel is quite low compared to other types of solar panels.

Solar Charge Controller (SCC)

The Solar Charge Controller is an electronic device used to control the flow of the mains current while charging the battery. The function of the Solar Charge Controller is to prevent overcharging of the mains current while charging the battery so that the battery charge will be overloaded [12]. If the battery charge is beyond capacity, the charge

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controller will disconnect the charge so that the battery is not overloaded with maximum battery conditions.

There are 2 types of Solar Charge Controller, namely: Pulse Width Modulation (PWM): PWM type Charge Controller is a charge controller that uses a 'wide' pulse in the electrical on and off, thus creating a sine wave electrical form. This type of Charge Controller is more suitable for use in systems with small capacities. Maximum Power Point Tracking (MPPT): MPPT type Charge Controller is a Charge Controller that can take the maximum value from solar panels (PV)[13]. MPPT Charge Controller internally stores the excess data generated by the solar panel into the battery. This Charge Controller is more suitable for use in systems with large batteries.

METHOD

This research was conducted with several steps, namely determining the basis, planning, research methods, and research procedures. In the research procedure, several testing steps were carried out to determine the working principle of the desalination system. The Landfill Station Charging System Common Faults Using Off-Grid Solar Cell. A more detailed explanation of the planning methodology is seen in this section.

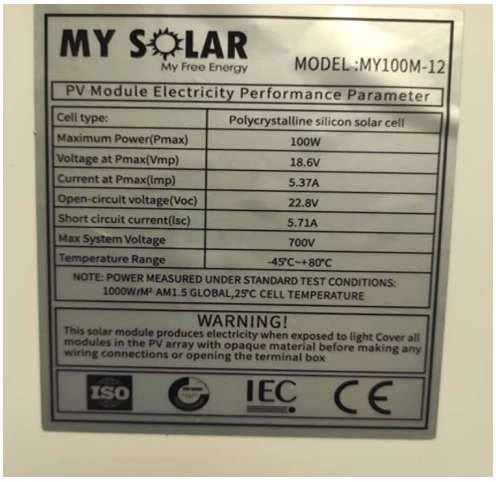

Figure 1. Nameplate of 100 wp polycrystalline Solar Panel

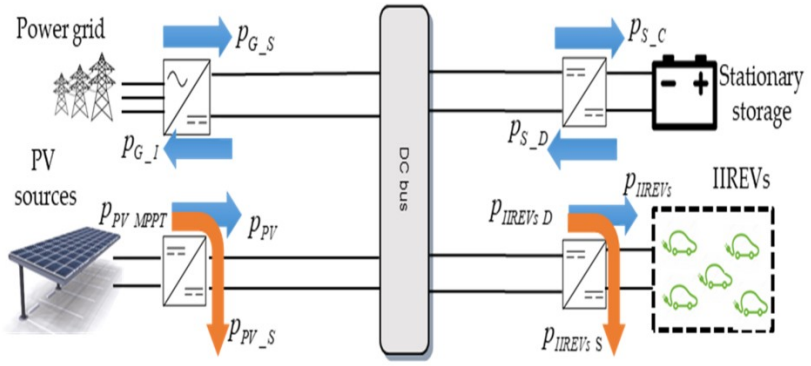

Figure 2. OFF-GRID System

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The OFF-GRID power generation system or also called stand-alone photovoltaic (PV) system is a power generation system that only relies on solar energy as the only main energy source by using a series of solar panels to produce electrical energy according to needs [14]. The OFF-GRID system is independent because this system is not connected to the main electricity grid system (PLN) so that the use of this system can reduce the costs that must be incurred to pay electricity bills from the main grid system. In addition, the OFF-GRID system usually uses additional batteries that function to store energy generated by solar panels, in addition the battery functions as a backup energy when the solar panels do not get enough sunlight such as at night or cloudy weather conditions and the sun is covered by clouds.

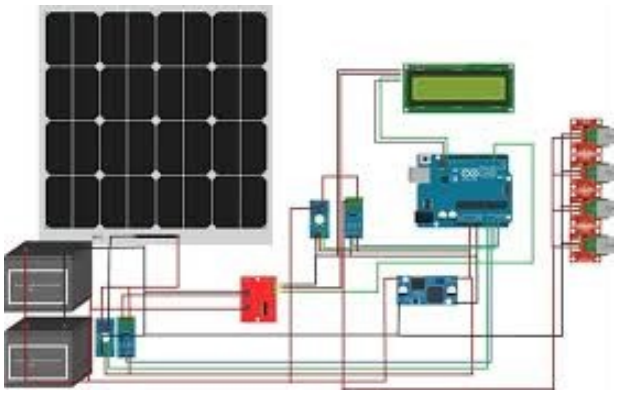

Figure 3. Smartphone Charging Station Circuit Design

The image above is a hardware design of a smartphone charging station. The main component of this smartphone charging station system uses a polycrystalline solar panel with a capacity of 100Wp. Because this study uses an OFF-GRID system, an additional battery is needed to store the electrical energy generated by the solar panel, the type of battery used is a accumulator battery because it is commonly used in OFF-GRID solar panel systems and the total capacity of the battery used is 12V 60Ah [15]. In addition, the battery functions as a voltage and current distributor so that it can be used for charging smartphones.

RESULT

Charging the Alkaline Battery in the charger utilizes Solar Panels as the primary source of electrical energy in the design of the charging station system. The duration required to charge the Battery depends on the Battery's capacity and the current flowing into it. According to the system design calculations, the Battery used has a capacity of 60Ah with an efficiency of 80%, while based on the specifications of the Solar Panel employed, it is capable of producing a maximum current of 5.37A.

This test is conducted to determine how long it takes for the battery to be fully charged using the Solar Panel as the main source of electrical energy. The test is conducted over several days until the battery is fully charged. The battery has been discharged before testing and shows the battery voltage when empty, which is 11.25V

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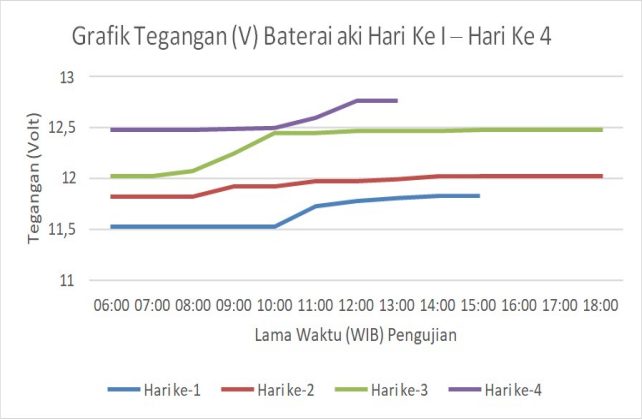

Figure 4. Battery Voltage Test Graph and Time Required for Charging from Day 1 to Day 4

After conducting the tests, the analysis results show that it took 4 days for the Alkaline battery to charge from empty to full, and during those 4 days, the battery voltage showed an increase. This differs from the estimated charging time for the Alkaline battery, which was calculated to take 13.96 hours or 14 hours and 36 minutes. The battery voltage when empty was 11.25V, and when fully charged, it showed 12.75V. However, during the testing, the system efficiency was not optimal, especially on the 1st and 4th days, where the data collection was not optimal until late afternoon due to weather conditions and the placement of the solar panel, which was not directly aligned with the sunlight.

This test was conducted to determine how long it takes for the Alkaline battery to return to an empty state using 4 smartphones as the charging load, assuming each smartphone was charged for 3 hours alternately, with Vout being 5V. The smartphones used had different battery capacities: iPhone 11 Plus with a battery capacity of 2900mAh, Xiaomi Redmi Note 10 with a battery capacity of 4500mAh, Vivo Y91 with a battery capacity of 4500mAh, and OPPO Reno 2 with a battery capacity of 4000mAh. The testing was carried out over several days until the Alkaline battery was depleted, with the previous test showing that the battery voltage when empty was 11.25V and when fully charged was 12.75V.

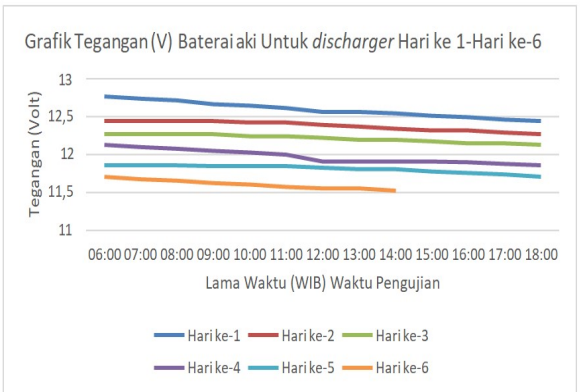

Figure 5: Graph of Alkaline Battery Voltage Testing and the Time Required for the Alkaline Battery to Discharge from Day 1 to Day 6

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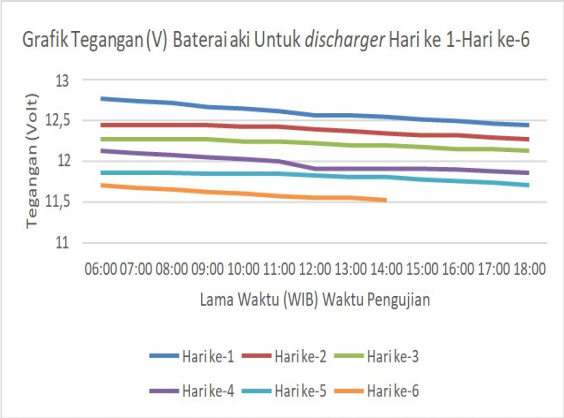
After conducting the tests, the analysis results show that it took 6 days for the battery to be fully discharged from its initial fully charged state, and during those 6 days, the battery voltage continuously showed a decrease. This differs from the estimated discharge time for the Alkaline battery, which was calculated to take 22.5 hours or 22 hours and 5 minutes. The battery voltage when fully charged was 12.75V, and when the battery was depleted, it showed 11.25V. However, the test took longer because the load was not used continuously but was instead used one at a time, with each test lasting 12 hours.

Real-Time Testing This test was conducted to determine the characteristics of the current output from the Alkaline battery during the charging process from the Solar Panel to the Alkaline battery simultaneously. This test was carried out over one week from Monday to Sunday and was conducted during the day, a time when solar radiation was available.



: 4. Tegangan Baterai Aki Pengujian Waktu yang di butuhkan Baterai Aki Untuk *dis-charge* H

Figure 6. Real-Time Output Current Testing Graph from Monday to Sunday

After conducting real-time testing from Monday to Sunday, it was found that the output current from the Alkaline battery experienced fluctuations. This is because the output current depends on the intensity of sunlight during the charging process from the Solar Panel to the Alkaline battery. This is different from the discharge process of the Alkaline battery, where the output current tends to be stable.

CONCLUSION

Based on the results of the Charging Station System Design Testing for Smartphones using an OFF-GRID Solar Panel, it can be concluded that: The time required to charge the Alkaline battery from empty to full using the Solar Panel as the main power source is 4 days. The time required to discharge the Alkaline battery from full to empty using a smartphone charging load is 6 days. The voltage of the Alkaline battery is considered empty at 11.25V and considered full at 12.75V. This research has limitations because the parameters used to determine whether the Alkaline battery is empty or full did not utilize a battery energy meter. The use of the Alkaline battery is quite effective because, even during cloudy weather or when the sun is covered by clouds, smartphone charging can still occur due to the electrical energy already stored in the Alkaline battery beforehand. The output current of

the Alkaline battery depends on the intensity of sunlight during the charging process from the Solar Panel to the Alkaline battery.

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