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THE UTILIZATION OF PHOTOVOLTAIC CELL FROM DISCARDED CALCULATORS AS AN IMPROVISED SOLAR POWER BANK

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ABSTRACT

The problem of energy storage and portable charging is addressed in this study with a green and affordable method. With the use of photovoltaic cells from discarded calculators, the study seeks to build a solar power bank. With the absorption of photons and the subsequent release of electrons, photovoltaic cells are devices that transform sunlight into electricity. They can power a variety of devices and are a clean, sustainable source of energy composed of materials like silicon. Proving its effectiveness, the efficiency rate of the power bank in charging a mobile device in various times was tested. The study proved that after 150 minutes, the device was charged from 0% to (100%). The research methodology involves the collection of discarded calculators, the dismantling of these calculators, and the extraction of their photovoltaic cells. The cells are then assembled and connected to maximize the energy output that can be used to charge batteries or portable devices. The study also examined the economic and environmental benefits of this approach. Utilizing a material such as the photovoltaic cell is a good way to reuse and recycle discarded materials or e-wastes. It was found that the cost of creating a solar power bank from discarded calculators is significantly lower than purchasing a new one. Furthermore, the ability to reuse discarded calculators reduces the amount of electronic waste and contributes to environmental sustainability. This study suggests that the use of discarded calculators as a source of photovoltaic cells has the potential to be implemented on a larger scale. In conclusion, this study demonstrates that photovoltaic cells from discarded calculators can be repurposed to create a solar power bank. This solution provides an environmentally friendly and cost-effective way of generating and storing electricity.

KEYWORDS: photovoltaic cells, discarded calculator, electronic waste, solar energy, powerbank, and sustainable environment.

I. INTRODUCTION

A part of human life is discarding certain objects that are not anymore necessary or beneficial to its being. Every day, at least 3.5 million tons of solid waste, including plastic, is generated worldwide (Leahy, 2018). Unfortunately, most of these items are supposed to be susceptible to being reused or upcycled. The term "upcycling" describes a number of techniques that enable "old" products to be altered and given a second life. According to brightly.eco (2021), upcycling benefits the environment by minimizing the extraction of natural resources, reducing landfill waste, and decreasing carbon emissions.

In solar-powered calculators, a photovoltaic (PV) cell, sometimes referred to as a solar cell, is typically present. Consumer devices like electronic toys, pocket calculators, and portable radios have all utilized solar cells. Such gadgets' solar cells may utilize both natural light from the sun and artificial light from sources like incandescent and fluorescent light. (Fonash, et al., 2023) Silicon, a semiconductor, is a component of the solar cell. As sunlight is shone on a solar cell, small photons that hit the silicon atoms help convert energy to free electrons. Due to the tightly bound nature of silicon atoms in their structure, these then work to create an imbalance with them. The n-type and p-type silicon elements are produced separately. An electric field is produced in the solar cell powering the calculator as the n-type becomes positively charged and the p-type becomes negatively charged. By providing a clean and renewable source of energy, photovoltaic cells reduce CO2 emissions and help to mitigate the effects of climate change by capturing solar energy and converting it into usable electricity.

Most calculators available nowadays are powered by photovoltaic cells. These cells usually measure 1×4 centimeters in size. They produce 1.5 volts of electricity, which is enough to power a calculator, but not sufficient for a power bank. In order for a mobile phone to be charged, a minimum of 4 solar cells must be utilized in the power bank, since most mobile phones require 5 volts to charge. In addition to the solar cells, the power bank must also contain a voltage boosting unit, which is the DC-DC boost converter circuit. A solar cell only converts solar energy to electrical energy. It is the direct current's (DC) function to utilize that electrical energy to charge the device. The DC-DC boost converter circuit helps in the conversion of a DC voltage into a larger DC voltage, enhancing the power bank's capacity for charging.

The researchers aim to use the photovoltaic cells in discarded calculators for power banks. By doing so, it reduces the carbon footprint that contributes to climate change and is a sustainable alternative to carbon emitting substances.

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RESEARCH QUESTIONS

The objective of this study was to create an improvised solar power bank out of photovoltaic cells from discarded calculators. Specifically, it sought answers to the following questions:

1. What is the energy output of the solar power bank out of photovoltaic cells from the discarded calculator?
2. What is the amount of time for the solar power bank to fully charge?
3. What is the efficacy rating the power bank in charging a mobile device at various time:

3.1. 30 mins;

3.2. 60 mins; and

3.3. 90 mins; and

3.4. 120 mins?

Hypothesis

H1: It is feasible to make a power bank powered by photovoltaic cells from discarded calculators.

II. METHODOLOGY

This study utilized the experimental design of research. Shrutika (2023) defined the experimental research design as a framework of protocols and procedures created to conduct experimental research with a scientific approach using two sets of variables. Herein, the first set of variables acts as a constant, used to measure the differences of the second set. In this study, the Photovoltaic Cell from Discarded Calculators are the independent variables and the Solar Power Bank is the dependent variable. Quantitative method was used to organize the experiment properly and to ensure that the right type of data is available to answer. It is necessary to use this method because it provides a high level of control over the variables that demonstrates an outcome and has an advantage in finding accuracy, consistency, and precision in its results.

The procedure shows the step-by-step process that shows and instructs how to make a solar power bank powered by photovoltaic cells from discarded calculators.

Ensuring the protection and maintaining safety

1. Wear personal protective equipment such as safety goggles, safety gloves, safety shoes, and a laboratory coat while performing the procedures below to avoid hazardous conditions.

Preparation

1. Check all the materials and equipment and make sure they are complete.
2. Know the proper way of handling the materials and equipment such as the soldering iron and the pliers.

Process of removing photovoltaic cells from discarded calculators
1. Unscrew the screws on the back panel of the calculator using the appropriate screwdriver.
2. Using a soldering iron, separate the photovoltaic cell from the wiring of the calculator.
3. Using pliers, gently lift the photovoltaic cell out of the calculator.

Process of making solar power bank powered by photovoltaic cells from discarded calculators

1. Solder modules with the soldering iron and iron wires following the wiring diagram. Place the battery's positive and negative terminals to the same pins on the battery holder. Connect the output of the charger to the input of the 5v DC-DC step up converter.
2. Place the battery in the battery holder.
3. Use hot glue to attach the 5v DC-DC converter and the charger to the power bank whilst minding the wiring done on the modules.
4. Solder the photovoltaic cells to the charger module following wiring indicated in the schematic diagram.
5. Using hot glue, attach the photovoltaic cells on the outer part of the power bank.

III. RESULTS

This section brings about the results and interpretation of data that were collected from the assembling and testing of the product.

1. Energy output of the Solar Power Bank out of the photovoltaic cells from the discarded calculators.

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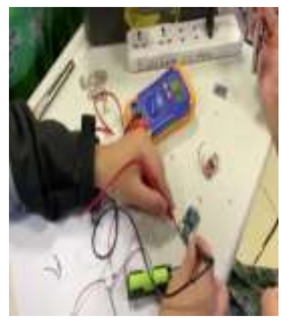
Table 1 Energy Output of the Solar Power Bank out of Photovoltaic Cells from the Discarded Calculator.

Trial No.	1	2	3
Image			
Data (Voltage)	1.84V	1.85V	1.86V
Average	**1.85V**		

The researchers tested the voltage of the connection of the solar power bank by using a multimeter. The multimeter is an instrument that measures the voltage of an object which, in this case, measures the voltage or energy output of the solar cells.

Table number 1 presents the different trials that the researchers performed in order to calculate and collect the data on how much voltage the solar cells can produce. Shown in the second column is the first trial that the researchers had with the solar cell. It reached 1.84V as seen on the multimeter. The third column displays the second trial that the researchers performed with 1.85V as its output. Finally, the fourth column presents the third and last trial with 1.86V.

Based on the findings that the researchers have gathered it produced a minimum of 1.84V and a maximum of 1.86V with an average of 1.85V. According to Flashbay (2023), the commercial power bank has an output of 3.7V compared to the solar power bank; it is half the energy output of the commercial power bank. Although, this presents that the solar power bank has a lower energy output and a slower charging performance it is acceptable considering it is utilizing a photovoltaic cell instead of an electric power.

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2. Amount of time for the power bank to fully charge

Table 2 Amount of Time for the Power Bank to Fully Charge

	Trial 1	**Trial 2**	**Trial 3**
Image	 	 	 
Time	15 hrs 44 min	17 hrs 24 min	19 hrs 18 mins
Average	17 hours and 48 minutes		

The researchers tested the time it takes to charge the solar power bank by leaving it directly under the sun from 6:00am to 11:00pm for 17 hours and 48 minutes until it is fully charged with an average temperature of 25°C. During the evening, artificial light was used as an alternative light source.

The controlled variable in the trial is the battery, it had to be fully discharged or at 0% at the beginning of the trial. This could be determined by the blue light that was shown on the 1A DC-DC Step up Module. Once the blue light was totally absent it showed that the battery had been fully discharged. After the solar power bank was placed under sunlight and the battery of the solar power bank was fully charged the blue light appeared.

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According to table 2, the data gathered by the researchers in measuring the amount of time for the solar power bank to fully charge it took 15 - 19 hours for it to charge. In the first trial, the solar power bank charged for 15 hours and 44 minutes. In the second trial 17 hours and 24 minutes is how much time it took to charge. Lastly the third trial, 19 hours and 18 minutes long for the solar power bank to charge.

According to Browning (2022), a solar power bank on average can fully charge in 25 - 50 hours using the sun's solar power. This also depends on the size of the power bank and the direct light from the sun. Kyle Browning stated that the solar power bank can charge up to 50 hours even with unobstructed sunlight. Also, Brian (2021), emphasized that with the use of solar power it may take 30 - 50 hours to charge the battery.

3. Efficacy rate of the solar power bank in charging a mobile device at various time.

Table 3 Efficacy Rate of the Solar Power Bank in Charging a Mobile Device in Various Time

Trial	Minutes	Image	Data
1	30 minutes		25% charged

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2	60 minutes		49% charged
3	90 minutes		73% charged
4	120 minutes		89% charged

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5	150 minutes		100% charged

Table 5 shows that the researchers tested the efficacy rate of the solar power bank by charging a mobile phone that is 0% charged and recording its battery percentage at set intervals after 30 minutes, 60 minutes, 90 minutes, and 120 minutes. In the first 30 minutes of charging, it was able to charge the phone by 25%. Within 60 minutes, the battery percentage reached 49%, which means it increased by 24% more. Within 90 minutes, the battery percentage reached 73% and increased by 24%. After 120 minutes, the battery percentage was at 89% meaning it increased by 16% more. Finally, after 150 minutes the battery percentage reached its maximum capacity (100%) which means that it increased by 11%.

According to Claire (2019), compared to the commercial products it takes at least 1.6 hours to charge the device using a commercial power bank. Meanwhile the product takes about 150 minutes or 2.5 hours. Therefore, the solar power bank was able to charge the mobile phone at an average of 20% but a minimum of 11% and a maximum of 25% for every 30 minutes.

IV. DISCUSSION

A solar power bank is a power bank that obtains energy from the sun and uses it to charge various electronic gadgets like cell phones and tablets. They are made of solar cells, or photovoltaic cells, that obtain energy from light and convert this energy into electrical energy. Since they are charged by exposure to light rather than requiring electricity, they are environmentally friendly. This helps lessen one's carbon footprint on the earth. In this study, the researchers used photovoltaic cells from calculators as the source of energy of the power bank.

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Aside from photovoltaic cells, the researchers used materials typically found in a power bank, such as a charger module, a DC-DC boost converter, as well as rechargeable batteries, and soldered these materials together to make a solar power bank. The charger module converts the low-power solar power bank into a USB rechargeable device.

The DC-DC converter temporarily stores the electrical energy to convert direct current (DC) from one voltage level to another. The rechargeable batteries then receive the upgraded electrical energy and store it until it is needed to charge a device. This study seeks to assess and evaluate the solar power bank in terms of its energy output, its charging time, and its efficacy rate.

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