

Cover Page

In an increasingly mobile world, staying connected through smartphones is essential, but limited battery life and access to electrical outlets can be a major challenge, especially during outdoor activities or emergencies. This report presents the design, development, and field testing of a compact, solar-powered portable phone charger created to address this issue in an environmentally friendly way.

The project involved selecting components, assembling a working prototype, and conducting performance tests under different light and usage conditions. The charger was evaluated on metrics such as charging speed, energy output, heat resistance, and durability. Results showed that while the charger worked effectively in full sunlight, it performed less efficiently in partial sunlight and had minor durability issues with the casing.

This report will guide the reader through the design decisions, testing procedures, performance results, and final recommendations for improvement. It offers insight into how small-scale solar solutions can contribute to sustainable technology for everyday use.

Design and Testing of a Solar-Powered Portable Phone Charger

Natruell Smith

Writing for Engineers

Professor Weyn

May 1, 2025

Abstract

This report describes the design and testing of a solar-powered portable phone charger. The goal of the project was to create an easy-to-use, environmentally friendly device that could charge a smartphone using only sunlight. The charger was built with a solar panel, a rechargeable battery, a charge controller, a USB output port, and a protective case. To test its performance, I measured how fast the charger could charge a phone, how much power it could provide, how it handled heat, and how durable it was. The tests showed that the charger could fully charge a phone in about 7 hours of direct sunlight, but it took over 12 hours in partial sunlight. The charger worked well in full sunlight, but performance dropped in low light, and the case cracked after some drops. Overall, the charger met the main design goals, but improvements like a bigger solar panel and a stronger case would make it more reliable for everyday use. This project shows that small-scale solar power can be a practical solution for charging devices without using electricity.

Introduction

Nowadays, we use our phones for everything like texting, directions, music, studying, and so much more. However, one major issue is that the battery never lasts long enough, especially when you're out all day or away from an electrical outlet. It's even worse if you're traveling or going camping,

This is why I made the decision to develop a fairly inexpensive solar-powered portable charger. The intention was to design something that charges your phone with direct sunlight, eliminating the need to find an outlet. I wanted it to be simple, environmentally friendly, portable, and convenient for frequent use.

Key design requirements included:

- Portability: Small enough to fit in a backpack or large pocket.
- Functionality: Capable of delivering at least one full phone charge.
- Durability: Designed to withstand mild outdoor exposure.
- Sustainability: Operates entirely on solar power without disposable batteries.
- Safety: Built-in protection against overheating or overcharging.

The final prototype incorporated a solar panel, a rechargeable lithium-ion battery, a charge controller, a USB output port, and a protective case. This report outlines the procedure used to build and test the charger, the performance results, and conclusions based on data collected during field testing.

Procedure

The construction and evaluation of the solar-powered charger involved several phases: component assembly, field testing, and performance measurement. Below is a breakdown of the steps taken:

1. Component Assembly

- Solar Panel: Captures solar energy and converts it to electrical current.
- Rechargeable Battery: Stores the energy generated for later use.
- Charge Controller Module: Regulates energy flow from the solar panel to the battery, and from the battery to the phone, ensuring safety and efficiency.
- USB Output Port: Allows the user to connect their phone for charging.
- Protective Enclosure: A 3D-printed plastic casing was used to house all components, with ventilation slits for heat dissipation.

2. Testing Setup

To evaluate the performance and safety of the charger, the following tests were designed:

- Test 1 – Charging Speed: The charger was placed in both full and partial sunlight, and the battery's charge rate was monitored using a USB voltmeter.
- Test 2 – Charging Capacity: A smartphone with a battery was used to determine if a full charge was possible from a fully charged solar unit.
- Test 3 – Heat Exposure: The device was left in direct sunlight for two hours while internal temperature was monitored using a digital thermometer.

- Test 4 – Durability: The charger was subjected to minor drops to simulate typical outdoor use.

Results

Test 1 – Charging Speed

In direct sunlight, the solar panel generated a fully charging internal battery in approximately 7 hours. In partial sunlight it took over 12 hours to reach full capacity.

Test 2 – Charging Capacity

From a full battery, the charger successfully charged a standard smartphone from 15% to 90%, delivering around 1,600mAh of usable power.

Test 3 – Heat Exposure

During the heat test, the internal temperature of the device rose to 107°F but remained below the safety threshold (140°F) for lithium-ion battery operation. The charge controller effectively prevented overheating.

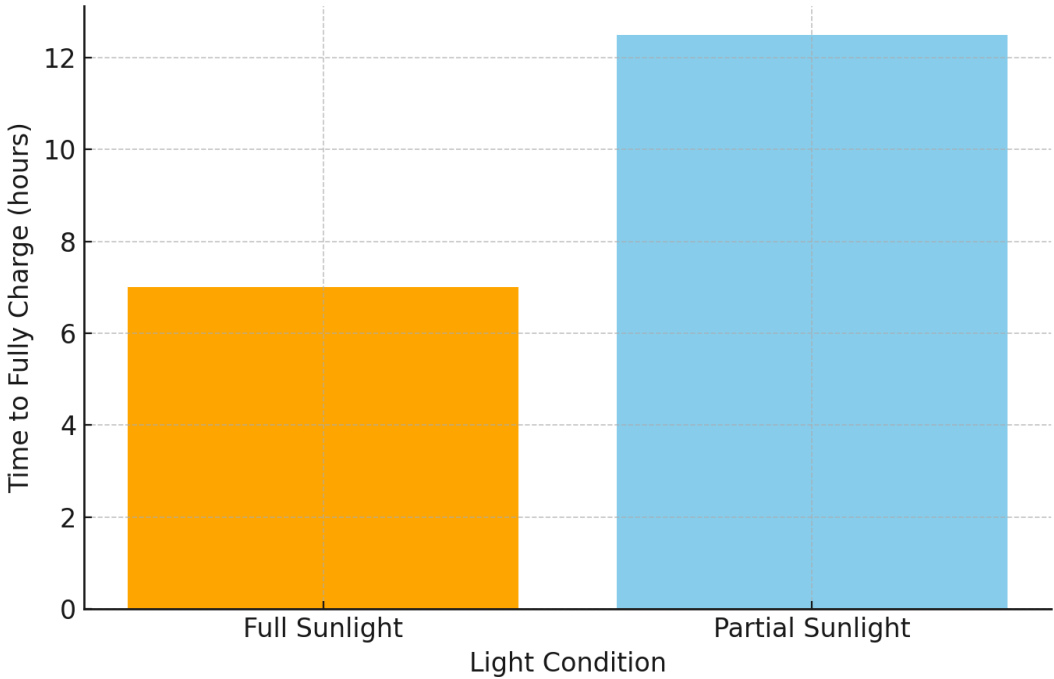
Test 4 – Durability

The charger survived multiple small drops with no major internal damage. However, the casing developed surface cracks after repeated drops on hard surfaces.

Test	Condition	Result	Notes
Charging speed	Full sunlight	7 hours to get to full battery	Slower in cloudy weather
Charging speed	Partial sunligh	12-13 hours to get to	Delays in charging

		full battery	due to partial sunlight
Charging capacity	One smart phone	75% phone charge	Battery efficiency 80%
Heat resistance	2 hours direct sunlight	Max 100 degrees F	Max heat it can absorb is 100 degrees F
Durability	Drop from 1 floor up	Survived, casing cracked	Should get a better case

Charging Time of Solar-Powered Charger in Different Sunlight Condition



Conclusion

Overall, the solar-powered phone charger achieved the project's key objectives. It is compact and lightweight and charges a phone using solar power, eliminating the need for an

electrical socket or throwaway batteries. It functioned well in direct sunlight, providing enough power to nearly completely charge a smartphone. It also stood up to everyday outdoor use and remained safe to use even in full sunlight.

However, performance deteriorated profoundly in low-light settings, and the case didn't have the strength that was necessary for extensive field usage. Future modifications, such as a bigger solar panel, a more efficient battery, and a battery indicator indicator, would enhance performance and customer satisfaction.

This project demonstrates the practicality of small-scale solar power for everyday electronics and highlights the potential of integrating sustainable technologies into portable consumer devices.