# Solar Powered Laptop and Phone Charger

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***Abstract—*** *With the rising global emphasis on renewable energy and sustainability, portable solar charging systems offer a practical solution for meeting energy demands in off-grid and outdoor environments. This project presents the design and implementation of a Solar Powered Laptop and Phone Charger aimed at delivering clean and reliable power for small electronic devices, particularly in remote or rural areas where access to electricity is limited. The project uses a 30W solar panel to harness solar energy, which is regulated and stored in a 12V, 7.2Ah lithium-ion battery. A PWM charge controller is implemented to ensure optimal energy transfer from the solar panel to the battery. The stored energy is then converted through DC-DC buck converters to provide two regulated outputs: 5V USB for charging mobile phones and 19V DC for powering laptops. The system is designed to be portable, cost-effective, and efficient, with applications in education, emergency services, camping, and remote areas.*

***Keywords— Off-grid Energy, Lithium-ion Battery, Charge Controller, Sustainable Technology.***

## I. INTRODUCTION

The rapid advancement in technology and the widespread adoption of portable electronic devices such as laptops, smartphones, tablets, and wearable gadgets have significantly increased the global demand for reliable and efficient charging solutions. These devices have become essential tools for communication, education, business, and entertainment, making uninterrupted power availability a critical requirement. However, conventional charging methods largely depend on grid electricity, which is not always reliable, especially in rural, remote, and off-grid regions. Frequent power outages, lack of infrastructure, and increasing energy demand further aggravate this issue.

In addition to reliability concerns, the environmental impact of conventional energy sources has become a major global challenge. Most electricity generation still relies on fossil fuels, which contribute to greenhouse gas emissions, climate change, and environmental degradation. As a result, there is a growing need to transition towards sustainable and renewable energy solutions.

Solar energy has emerged as one of the most promising renewable energy sources due to its abundance, accessibility, and eco-friendly nature. It offers a viable solution for decentralized power generation, particularly in areas where grid connectivity is limited or unavailable. Solar-powered charging systems can harness sunlight and convert it into electrical energy, providing a clean and sustainable alternative for powering portable devices.

This paper presents the design and implementation of a solar-powered charging system specifically developed for portable electronic devices. The proposed system incorporates a 30W photovoltaic solar panel, which captures solar energy and converts it into electrical power. To address the variability of solar energy due to changing weather conditions and time of day, a lithium-ion battery storage unit is integrated into the system. The system also includes a PWM charge controller and voltage regulation circuitry to provide stable output for different devices. Overall, the developed solar-powered charging system provides a practical, cost-effective, and environmentally friendly solution for device charging, especially beneficial for users in remote locations, during outdoor activities, emergency situations, and in areas with unreliable electricity supply.

## II. MATERIAL AND METHODS

The proposed system consists of a 30W photovoltaic solar panel, a PWM charge controller, a lithium-ion battery, and DC-DC voltage converters. The solar panel captures sunlight and converts it into electrical energy, which is then regulated and stored in the battery. This stored energy is later used to charge electronic devices.

### 2.1 System Architecture and Component Selection

The system follows a straightforward energy pathway: sunlight → PV panel → charge controller → lithium-ion battery → DC-DC converters → device output ports

| Component | Specification | Role in System |
|---|---|---|
| Solar Panel | 30W, Monocrystalline | Primary energy source |
| Charge Controller | PWM, 12V/10A, low-voltage disconnect | Battery protection and regulation |
| Lithium-ion Battery | 12V, 7.2Ah | Energy storage |
| Buck Converter | Input: 12-24V; Output: 5V / 2A USB | Mobile phone charging rail |
| Boost-Buck Converter | Input: 12-24V; Output: 19V / 3.5A | Laptop charging rail |
| Output Ports | 2× USB-A; 5× DC barrel jack | Device interface |

**Component Selection Justification:**

- **30W Monocrystalline Solar Panel:** Delivers sufficient daily energy under typical tropical solar irradiance (4–5 peak sun hours per day). Monocrystalline cells offer higher efficiency per unit area.
- **12V/7.2Ah Lithium-ion Battery:** Provides approximately 140 Wh of stored energy, enough to charge a 65Wh laptop battery around two times or a 15Wh smartphone battery more than eight times.
- **PWM Charge Controller:** Monitors battery state and adjusts charging current to prevent overcharge and deep discharge. Rated to 10A with low-voltage disconnect functionality.
- **DC-DC Converters:** Buck converter produces 5V USB rail (2A per port). Boost-buck converter (SEPIC-type) generates 19V laptop rail, maintaining regulation even when battery voltage sags below 19V.

### 2.2 Assembly Procedure

**Enclosure Preparation:** A rigid and compact enclosure was selected to safely house all components. Mounting supports and clamps were provided inside to securely fix components. Proper spacing was maintained for ventilation and heat dissipation.

**Solar Panel Connection:** The solar panel was connected to the charge controller using appropriate wires with correct polarity to ensure efficient energy transfer.

**Battery Connection:** The battery was connected to the charge controller using insulated wires with precautions to avoid short circuits.

**Converter Installation:** A buck converter was installed to step down voltage to 5V for mobile charging. A boost-buck converter was installed to provide constant 19V output for laptop charging.

**Wiring Arrangement:** All wiring was done in a neat and organized manner, kept as short as possible to reduce power losses, with proper insulation to prevent electrical hazards.

### 2.3 Output Section

**A. Mobile Charging (USB Output):** USB ports provided with regulated 5V output using the buck converter.

**B. Laptop Charging (5 Different Connectors):** Five different connectors were provided to support various laptop brands:

| Connector Type | Compatible Brands | Voltage |
|---|---|---|
| Round pin (4.5mm or 7.4mm) | HP | ~19V |
| Cylindrical pin with center pin | Dell | ~19V |
| Round or slim rectangular | Lenovo | ~20V |
| Standard 5.5mm barrel jack | Asus | ~19V |
| Universal connector | Multiple brands | 19-20V |

## III. RESULTS AND DISCUSSION

The developed solar-powered charging system was tested under sunlight conditions to evaluate its performance.

**Key Observations:**

| Parameter | Value |
|---|---|
| Solar Panel Rating | 30W |
| Battery Capacity | 12V, 7.2Ah (≈140 Wh) |
| Mobile Charging Output | 5V / 2A USB |
| Laptop Charging Output | 19V / 3.5A |
| Laptop Connectors | 5 types (HP, Dell, Lenovo, Asus, Universal) |

The system successfully generated and stored electrical energy, providing stable output voltages suitable for charging both mobile phones and laptops. The lithium-ion battery ensured continuous power supply even during low sunlight conditions. The PWM charge controller effectively protected the battery from overcharging and improved overall system reliability. The DC-DC converters provided consistent voltage regulation, ensuring safe and efficient device charging.

**Practical Applications:**

- Rural and remote areas with limited grid access
- Outdoor activities (camping, trekking)
- Emergency situations and disaster relief
- Educational institutions in off-grid locations

## IV. CONCLUSION

The solar-powered laptop and phone charger presented in this paper offers a practical and sustainable solution to charging problems in areas with limited access to electricity.

**Key Specifications:**

| Component | Specification |
|---|---|
| Solar Panel | 30W Monocrystalline |
| Battery | 12V, 7.2Ah Li-ion (≈140 Wh) |
| Mobile Output | 5V / 2A USB |
| Laptop Output | 19V / 3.5A (5 connector types) |

By utilizing solar energy, the system reduces reliance on conventional power sources and supports environmental conservation. The charger is portable, easy to operate, and cost-effective, making it suitable for rural areas, outdoor activities, and emergency situations. The proposed design demonstrates the effectiveness of renewable energy in meeting everyday power requirements and highlights the potential of solar technology for small-scale applications.

**Future Work:**

- Higher capacity solar panel for faster charging
- MPPT charge controller for improved efficiency
- Battery capacity indicator for user convenience
- Integration of multiple USB ports for simultaneous device charging

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## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper. This research was conducted independently without any financial support or commercial involvement that could influence the results or interpretation of the study.

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