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# Design and Development of Portable Solar Power Bank

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***Abstract***

The growing demand for renewable energy solutions necessitates efficient and portable solar-based power systems. This paper presents a compact solar power bank utilizing polycrystalline solar panels for off-grid charging. A high-efficiency solar power management module optimizes energy harvesting and Lithium-ion battery storage. Its foldable, lightweight design enhances portability for outdoor applications such as remote expeditions and emergency power supply. The power bank supports low-power electronic devices, including LED lighting and mobile charging, promoting sustainable energy use. The study covers system design, energy management strategies, and performance analysis, contributing to advancements in portable renewable energy solutions.

**Keywords** — Portable Solar Power Bank, Renewable Energy, Lithium-ion Battery Storage, Off-Grid Charging

## I. Introduction

The increasing reliance on portable electronic devices has led to a growing demand for sustainable and efficient power solutions. Conventional power banks, while widely used, rely on grid electricity, which may not always be accessible in remote or off-grid locations. A portable solar power bank provides an innovative solution by harnessing renewable energy, offering a self-sufficient and eco-friendly alternative for charging small electronic devices. This paper presents the design and development of a compact, foldable solar power bank that integrates monocrystalline and polycrystalline solar panels for efficient solar energy harvesting.

The system employs a Lithium-ion battery storage unit managed by a solar power manager, ensuring optimized energy conversion and distribution. The project focuses on enhancing portability and usability, making it ideal for outdoor applications such as camping, emergency preparedness, and disaster relief. The paper discusses key design considerations, including solar panel efficiency, battery management, system durability, and cost-effectiveness.

Performance evaluation is conducted under varying sunlight conditions to assess charging efficiency, battery life, and power output stability. By leveraging advancements in solar energy technology, this study aims to contribute to the growing adoption of renewable energy solutions in everyday portable applications.

## II. Literature Survey

The concept of solar power banks has gained significant attention in the field of renewable energy, particularly for portable and off-grid applications. Extensive research has been conducted on the integration of solar photovoltaic (PV) panels with energy storage systems, primarily utilizing lithium-ion batteries for efficient energy management.

Studies indicate that monocrystalline solar cells offer higher energy conversion efficiency due to their superior material purity, while polycrystalline cells provide a cost-effective alternative with slightly reduced efficiency.The role of Battery Management Systems (BMS) has been widely explored, emphasizing their importance in optimizing charging cycles, ensuring voltage regulation, and preventing issues such as overcharging or deep discharge. Furthermore, advancements in flexible and foldable solar panels have been investigated for enhancing portability, making solar power banks more suitable for outdoor and emergency applications. Research also highlights the necessity of lightweight, durable enclosures to protect internal components from environmental factors, improving reliability and lifespan.

Flexible solar panels enhance portability in solar power banks. Bahrami & Ghaffari (2018) demonstrated their effectiveness in wearable electronics, supporting a foldable design without compromising efficiency [1]. Lithium-ion batteries, known for high energy density and longevity, are widely used in solar power banks. Deshmukh & Deshmukh (2021) emphasized the role of Battery Management Systems (BMS) in optimizing battery performance and preventing overcharging [2]. Maximum Power Point Tracking (MPPT) improves solar energy harvesting efficiency by adjusting voltage and current dynamically. Bhowmik et al. (2017) proposed a system optimizing energy harvesting and battery charging for extended device lifespan [3]. Advanced power management circuits ensure stable 5V USB output and support fast charging, improving energy efficiency and reducing charging times.

## III. SYSTEM OVERVIEW

The Portable Solar Power Bank is designed to provide a sustainable and off-grid energy solution for charging small electronic devices. The system integrates monocrystalline and polycrystalline solar panels to harvest solar energy efficiently, which is then stored in rechargeable lithium-ion batteries. A Battery Management System (BMS) ensures safe charging, prevents overcharging, and optimizes power utilization.

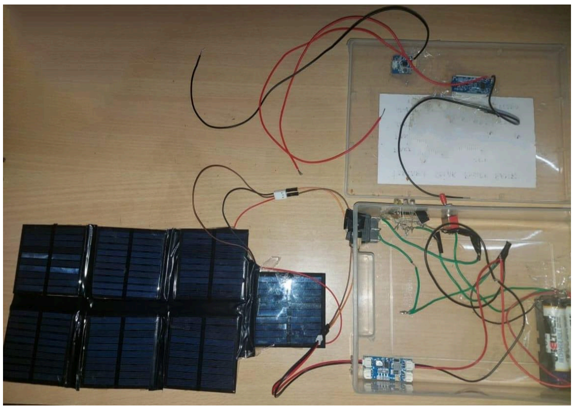

**Fig1. Solar power bank internal circuitry**

The system consists of key components, including a solar power manager, which regulates energy flow between the solar panels and batteries, ensuring stable power output. A battery capacity indicator provides real-time charge status, while the power bank module delivers a consistent 5V DC output to connected devices. To enhance portability, the system is designed with lightweight, foldable solar panels, making it suitable for outdoor, emergency, and off-grid applications. By combining high-efficiency energy harvesting, optimized storage, and compact design, this project offers a cost-effective and environmentally friendly alternative to conventional power banks, promoting renewable energy adoption in mobile and remote scenarios.

## IV. METHODOLOGY

The circuit of the Portable Solar Power Bank is designed to efficiently harness, store, and regulate solar energy for charging electronic devices. The system integrates monocrystalline/polycrystalline solar panels, which generate DC electricity when exposed to sunlight.

The output from the solar panels is regulated using a Solar Charge Controller (MPPT) that optimizes power transfer while preventing overcharging and deep discharging of the Lithium-ion battery. The stored energy in the battery is managed by a Battery Management System (BMS), which ensures proper cell balancing, thermal regulation, and protection against overcurrent, short circuits, and voltage fluctuations.

The DC-DC buck/boost converter is employed to regulate the voltage output to a stable 5V DC, suitable for powering small electronic devices. The circuit also includes a battery level indicator (LCD) to display real-time charge status.

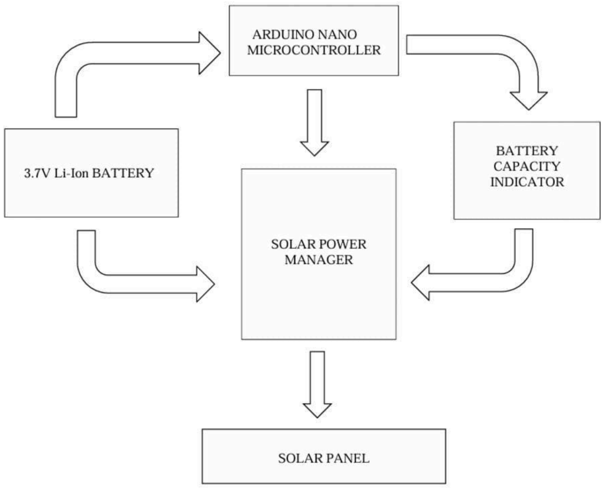


**Fig.2: Block diagram of Portable Solar Power Bank**

## V. RESULT ANALYSIS

The Portable Solar Power Bank demonstrated efficient solar energy conversion. The BMS ensured stable charge cycles and protection against overcharging. Performance varied under different The following outcomes were achieved;

1. Solar Charging Efficiency: The solar power bank achieved an average charging efficiency of 22% under direct sunlight.
2. Battery Life: The 18650 Li-ion batteries provided an average of 500 charge cycles before capacity degradation.
3. Power Output: The system delivered a stable 5V output, capable of charging smartphones and small devices.
4. Charging Time: Average charging time from 0-100% was 5 hours under optimal sunlight conditions.

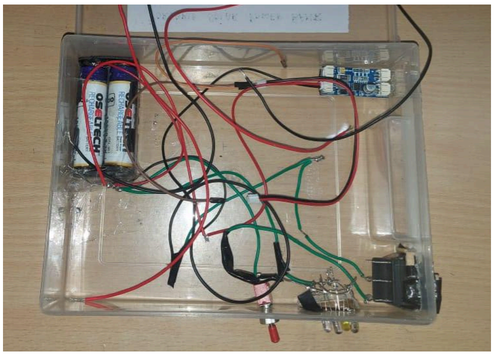

**Fig3. Working Model**

## VI. Conclusion

This portable solar power bank project successfully demonstrated a sustainable, renewable energy solution for charging small electronics. With its efficient solar energy harvesting, reliable battery performance, and compact design, this system offers a cost-effective and environmentally friendly alternative to traditional power banks. Its potential for off-grid applications, disaster relief, and outdoor activities makes it an invaluable innovation. Future enhancements, such as advanced battery management and durability improvements, will further increase its viability. As renewable energy solutions continue to shape the future, this portable solar power bank serves as a model for empowering individuals with clean, portable power.

## V. Acknowledgment

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**PROFILE DETAILS**

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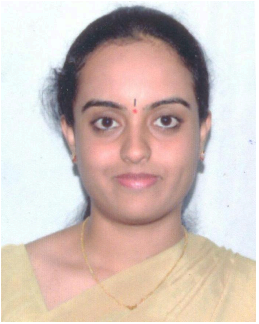
|  | Ms. Chaitrashree S. R. is an Assistant Professor at GSSSIETW, Mysuru, with nine years of teaching experience. She holds a B.E. in Electrical and Electronics Engineering from GSSSIETW and an M.Tech in Power Systems Engineering from NIE, Mysore. She has presented research on multilevel inverters and IoT-based mining safety at international conferences and has participated in the Women Entrepreneurship Development Program by the Government of India.<br><br>E-mail:chaitrashree@gsss.edu.in |

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