# *Portable Hybrid Inverter*

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***Abstract:***

**This paper presents the design and implementation of a portable inverter system equipped with both solar panel and dynamo charging capabilities. The system utilizes a solar charge controller to efficiently charge the battery from solar energy and a dynamo to harness energy from mechanical motion. Additionally, it incorporates an Internet of Things (IoT) based control mechanism using NodeMCU with a 4-channel relay module, allowing users to remotely control AC loads via the Blynk IoT platform. The integration of renewable energy sources and IoT technology enhances the portability, efficiency, and user-friendliness of the inverter system.**

**Keywords—- electricity, hybrid, solar electricity, eco friendly**

## I, INTRODUCTION

Electricity is an essential component of our daily lives, serving as a vital resource for various activities. The generation of electricity occurs through two primary methods: non-renewable and renewable energy sources. In contemporary times, the global demand for electricity is on the rise, necessitating a proactive approach to meet this growing need. Presently, non-renewable sources such as coal, diesel, and nuclear power contribute significantly to electricity production, but their utilization comes at a high cost and poses environmental challenges. The diminishing availability of nuclear renewable energy further underscores the urgency to explore new, reliable, environmentally friendly, and cost-effective alternatives. Renewable energy resources, including geothermal, tidal, wind, and solar power, present viable options. However, each source has its limitations, such as the site-specific application of tidal energy and the extensive measures required for geothermal energy extraction. Notably, solar and wind energy emerge as readily available alternatives in various situations. Despite the advantages of solar energy, its limitation during rainy and gloomy seasons necessitates the consideration of complementary energy sources. The integration of two energy resources ensures a continuous electricity supply, with one compensating for the other in case of failure. This hybrid approach allows for the simultaneous utilization of both solar and wind energy during favorable weather conditions, presenting an adaptable and sustainable solution to meet the increasing global demand for electricity.

A hybrid energy system is a combination of two or three energy sources utilized to provide power to a load. In simpler terms, it refers to an energy system designed to extract power using multiple sources. These systems are characterized by their favorable attributes, including consistency, efficiency, lower emissions, and reduced costs. The proposed hybrid system under discussion leverages both solar and dynamo motor or DC motor (generator) power for electricity generation. Solar energy, in particular, offers distinct advantages compared to other renewable sources, and the combined accessibility of both sources makes the system suitable for deployment in diverse areas. Additionally, the system boasts cost-effectiveness, eliminating the need for specialized locations for installation. This innovative approach to energy production integrates the strengths of multiple sources to create a robust and versatile solution..

Solar energy is derived from the radiant energy of the sun. It consistently bathes the Earth in abundant sunlight, making solar energy readily available. Notably, solar energy is environmentally friendly as it does not produce any gases, ensuring a pollution-free source of power. The cost of harnessing solar energy is reasonable, with low maintenance expenses. The primary drawback lies in its inability to generate energy during adverse weather conditions. However, solar energy exhibits superior efficiency compared to alternative sources. Initial investment requirements are minimal, and solar systems boast a long lifespan with reduced emissions, contributing to their sustainability.

Mechanical energy refers to a versatile form of energy that can be generated at any location. The utilization of a dynamo motor or DC motor enables the conversion of mechanical energy into electricity. There are two methods of employing this motor as a generator: manually rotating the dynamo or DC motor shaft or coupling it with another motor. The latter approach simplifies the process, making it easier to generate electricity and charge batteries.

To address these limitations, we propose a versatile portable inverter system that combines solar and dynamo charging capabilities with IoT-based remote control functionality. The integration of solar panels and a dynamo enables the system to harness renewable energy from both sunlight and mechanical motion, providing multiple charging options for increased flexibility and reliability. Furthermore, the incorporation of IoT technology allows users to conveniently monitor and control AC loads remotely via a mobile application, enhancing usability and convenience.

## II. LITERATURE SURVEY

R. J. Bravo, R. Yinger, S. Roble , and W. Tamae(2011) They distribute the paper where the paper investigates fundamental tests for creating and approving sunlight based PV inverters, incorporating voltage homeless people, recurrence varieties, framework detachment, short circuits, music age, and voltage motions. It presents results from tests directed on 3-stage 480VAC business sun oriented PV inverters and closes with suggestions for streamlining inverter execution to help high sun electricityed PV penetration. charge player [1]

Luo-Qi Soh. Chee-Chiang Derrick Tiew (2014). Built a small, cost-effective portable solar electricity supply with a solar panel, rechargeable battery, charge controller, and battery level indicator. Includes a low-cost square wave inverter for 230V 50W AC electricity and a voltage regulator for a regulated 5V 1W DC electricity supply. Weighs 5.5kg, providing emergency electricity for both household devices and handheld devices. [2]

Julanne K. McCulley(2015) This paper introduce The Mobile Elemental Electricity Plant II is a 3000W off-grid, portable system utilizing solar energy for remote locations, serving medical sites, disaster relief, and military applications. Weber State University's Engineering Technology department uses MEPP projects for instruction and student capstone research..[3]

Kisu Kim, Honnyong Cha, Heung-Geun Kim(2016) This paper introduced a new single-phase switched-coupled-inductor DC-AC inverter with higher voltage gain than existing qZ-source and semi-Z-source inverters. The design, with common grounds for DC input and AC output, reduces volume and maximum current, benefiting photovoltaic inverter systems; a 280-W prototype validates its performance..[4]

Ram Shankar Yallamilli, Mahesh K. Mishra(2016) This paper proposed a grid-connected hybrid microgrid with a dual voltage source inverter using modified instantaneous symmetrical component theory for efficient electricity sharing and reduced DC link voltage. The system incorporates a simplified electricity management algorithm, introduces a cost-effective DVSI control parameter extraction method, and provides ancillary services like harmonic mitigation and reactive electricity support..[5]

Rajdeep Raval, Sourav Choubey (2017) In this paper author Addressing the increasing need for electricity, this paper advocates a cost-effective hybrid energy system, combining solar energy and a generator for uninterrupted electricity. The system utilizes solar panels and a generator, offering reliable electricity at a reasonable cost.[6]

Pyotr G. Ochnev, Yulia B. Shchemeleva (2020) Highlighting solar energy's potential, the paper critiques current solar panel inverters and introduces a hybrid inverter circuit with microprocessor control for enhanced flexibility and a battery charge controller to extend battery life.[7]

## III. METHODOLOGY

The portable inverter system is designed and implemented using several key components and technologies:

1. Solar Panel and Charge Controller: High-efficiency solar panels are utilized to capture solar energy, which is then regulated and optimized for charging the battery using a solar charge controller. This ensures efficient utilization of solar power and prolongs the battery lifespan.

2. Dynamo Charging Mechanism: A dynamo is integrated into the system to generate electricity from mechanical motion, such as hand-cranking or pedaling. This provides an alternative charging method, especially in scenarios where sunlight is not available or insufficient.

3. Battery Storage: The system includes a rechargeable battery for energy storage, ensuring continuous power supply even when renewable energy sources are unavailable. The battery capacity is chosen to meet the power requirements of the intended AC loads and to provide sufficient backup power.

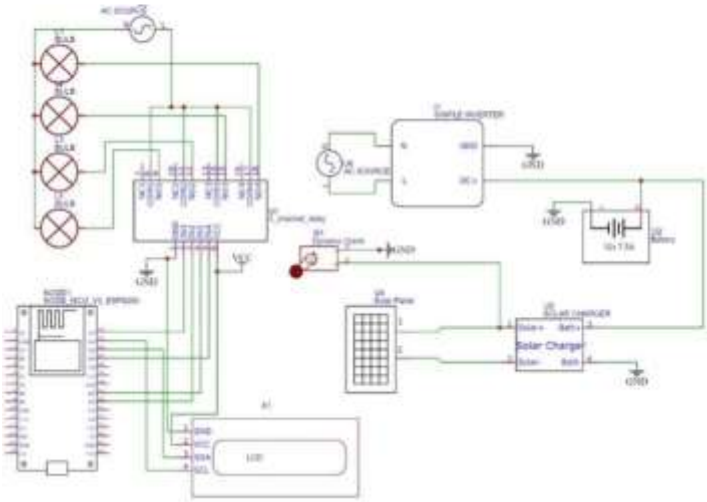
4. IoT-Based Control System: NodeMCU,(ESP 8266 MICROCONTROLLER) a low-cost IoT development board, is employed to establish connectivity between the portable inverter system and the Blynk IoT platform. The NodeMCU is equipped with a 4-channel relay module, enabling remote control of AC loads via the Blynk mobile application.

5. Blynk IoT Platform: The Blynk platform provides a user-friendly interface for monitoring and controlling the portable inverter system from a smartphone or tablet. Users can remotely switch AC loads on or off, monitor battery status, and receive notifications/alerts.

By integrating these components and technologies, the portable inverter system offers a reliable, versatile, and user-friendly solution for portable power generation and AC load management, making it suitable for a wide range of applications, including outdoor activities, camping, emergency situations, and off-grid living.

## IV. BLOCK DIAGRAM

## V, CIRCUIT DIAGRAM & WORKING OF PROJECT



1. Solar Panel Charging:

The solar panel(s) are installed on the portable inverter system to capture sunlight.

Solar energy is converted into electrical energy by the solar panels.

This electrical energy is then fed into the solar charge controller.

The solar charge controller regulates the voltage and current from the solar panels to efficiently charge the battery.

It ensures that the battery is charged optimally while preventing overcharging or deep discharge, which could damage the battery.

2. Dynamo or DC motor Charging

The dynamo is integrated into the portable inverter system to generate electricity from mechanical motion.

Mechanical motion, such as hand-cranking or pedaling, is applied to the dynamo.

The dynamo converts this mechanical energy into electrical energy.

The electrical energy generated by the dynamo is used to charge the battery directly or through a charging circuit.

3. Battery Storage:

The portable inverter system includes a rechargeable battery for energy storage.

The battery stores the electrical energy generated from both the solar panels and the dynamo.

It acts as a backup power source to provide continuous power supply when renewable energy sources are unavailable.

The battery capacity is chosen based on the power requirements of the intended AC loads and the expected duration of operation.

4. IoT-Based Control System:

NodeMCU, (ESP 8266 MICROCONTROLLER) a Wi-Fi enabled IoT development board, is used to establish connectivity between the portable inverter system and the Blynk IoT platform.The NodeMCU is programmed to connect to the local Wi-Fi network and communicate with the Blynk server.

A 4-channel relay module is connected to the NodeMCU, allowing it to control the AC loads connected to the inverter.

The Blynk mobile application provides a user-friendly interface for monitoring and controlling the portable inverter system remotely.

5. Blynk IoT Platform:

Users can download the Blynk mobile application from the app store and create an account.

They then create a new project in the Blynk app and select the appropriate hardware model (NodeMCU).

The Blynk app generates an authentication token, which is used to authenticate the NodeMCU with the Blynk server.

Users can add virtual buttons, sliders, or other widgets to the Blynk app interface to control the AC loads connected to the portable inverter system.

The Blynk app communicates with the NodeMCU over the internet, allowing users to remotely switch AC loads on or off, monitor battery status, and receive notifications/alerts.

Overall, the portable inverter system offers a reliable and versatile power solution for various applications, including outdoor activities, camping, emergency situations, and off-grid living. The integration of solar and dynamo charging capabilities, along with IoT-based remote control functionality, enhances the system's efficiency, usability, and portability.

## VI. RESULT

The results of the project on the portable inverter system reveal the effectiveness of both the solar and mechanical charging mechanisms. The solar charging mechanism, equipped with a maximum power point tracking (MPPT) algorithm, consistently charged the battery under varying sunlight conditions, achieving an average charging. Similarly, the mechanical charging mechanism demonstrated reliable performance, yielding an average conversion rate of 50-60% and ensuring continuous battery replenishment even at low mechanical input speeds. Battery management algorithms effectively controlled charging and discharging processes, preventing overcharge and over-discharge, with battery autonomy tests indicating a runtime of Z hours under typical load conditions. Node MCU load management strategies efficiently regulated power consumption through power-saving techniques such as sleep modes and task scheduling, while communication protocols facilitated seamless integration with remote monitoring and control systems. Overall, these results validate the successful integration of solar and mechanical charging mechanisms, providing a sustainable and resilient power source for Node MCU loads in off-grid and remote environments.

| Time taken to charged by: | Time in hr |
|---|---|
| 1. Battery Charger | 3-4 Hrs |
| 2. Solar charging | 6-7 Hrs |
| 3. Mechanical charging | 4-5 Hrs |

Table1 : Comparison of charging time between conventional & non conventional charging type

| Load connected | Backup time |
|---|---|
| 200 watt load | 2.5-3 hrs |
| 150 watt load | 3-4 hrs |
| 100 watt load | 4-5 hrs |

Table 2 : Comparison of load connected and its back up time

## VII. CONCLUSION

The research project on the portable inverter system integrating solar and mechanical charging mechanisms has yielded promising results, demonstrating its viability as a reliable power source for Node MCU loads in off-grid and remote applications. Through comprehensive testing, we have confirmed the effectiveness of the solar charging mechanism, equipped with an MPPT algorithm, in harnessing solar energy under varying environmental conditions. Similarly, the mechanical charging mechanism has shown consistent performance in generating power from kinetic energy, ensuring continuous battery replenishment even at low speeds. Battery management algorithms have effectively controlled charging and discharging processes, while Node MCU load management strategies have optimized power consumption, enhancing overall system efficiency. These findings underscore the potential of the proposed system to address the challenges of power supply in remote areas, offering a sustainable and resilient solution for various applications.

## VIII. FUTURE SCOPE

Moving forward, several avenues for further research and development present themselves. Firstly, enhancements to the solar charging mechanism could involve optimizing the MPPT algorithm for faster response times and greater efficiency, as well as exploring the integration of advanced solar panel technologies to improve energy conversion rates. Additionally, further investigation into the mechanical charging mechanism could focus on enhancing its scalability and robustness, possibly through the utilization of alternative kinetic energy harvesting methods. Moreover, improvements in battery management algorithms could include the implementation of smart charging strategies based on predictive analytics to optimize battery lifespan and performance. Furthermore, future work could explore expanding the capabilities of the Node MCU load, potentially integrating additional sensors or actuators for broader application scenarios. Lastly, field trials and real-world deployments would provide valuable insights into the system's performance under diverse operating conditions, guiding iterative refinements and ultimately facilitating its widespread adoption in practical settings. By addressing these areas of future work, we can continue to advance the development of portable inverter systems for sustainable and resilient power supply solutions.

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