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IoT based Smart Grid to Remotely Monitor and Control Renewable

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ABSTRACT: The growing demand for energy and the environmental concerns surrounding fossil fuels have emphasized the need for smarter, renewable-based power systems. This research proposes an IoT-based Smart Grid system that enables remote monitoring and control of renewable energy sources, particularly focusing on solar energy integration. This research presents an IoT-based Smart Grid system that remotely monitors and controls a solar-powered energy setup with automatic changeover capability. The Blynk app is integrated to allow users to remotely monitor voltage, current, and load status, and switch loads accordingly. The main objective is to enhance the reliability, sustainability, and flexibility of the power grid while minimizing dependence on traditional sources like MSEB (grid supply). This solution is especially useful in rural or remote areas where grid access is inconsistent. By using IoT technology, we bring automation, fault detection, and intelligent decision-making into the power system. This smart grid model demonstrates a scalable approach toward building future-ready, green energy systems with user-friendly control and monitoring features.

KEYWORDS: IOT of things, Smart Grid, Power control and manage, modernization of electricity.

I. INTRODUCTION

In recent years, the integration of renewable energy sources (RES) into the power grid has become a crucial strategy to combat climate change and reduce reliance on fossil fuels. The advent of the Internet of Things (IoT) has significantly enhanced the capabilities of smart grids, allowing for more efficient and effective management of energy resources. This paper explores the concept of an IoT-based smart grid system designed to remotely monitor and control renewable energy sources, ensuring a reliable, efficient, and sustainable power supply. The traditional power grid, which relies heavily on centralized power generation from fossil fuels, is increasingly being supplemented and replaced by distributed renewable energy sources such as solar, wind, and hydroelectric power. While these sources offer substantial environmental benefits, they also pose challenges related to variability, integration, and management. This is where smart grid technology, enhanced by IoT, comes into play.

The Internet of Things refers to the network of interconnected devices that communicate and exchange data in real-time. In the context of smart grids, IoT devices include sensors, meters, and controllers that collect and transmit data on various parameters such as energy production, consumption, and grid stability. The global shift towards renewable energy is accelerating, driven by the need to mitigate climate change and reduce dependency on fossil fuels. However, renewable energy sources like solar and wind are inherently variable and intermittent. Effective integration of these resources into the existing grid infrastructure requires advanced technologies that can handle their unpredictability and ensure a stable power supply.

Traditional grids lack the capability for real-time monitoring and control, making them inefficient in managing the dynamic nature of renewable energy sources. IoT-based smart grids provide continuous real-time data from various grid components, enabling operators to monitor energy production, consumption, and grid stability instantaneously. This real-time insight is essential for balancing supply and demand, optimizing energy usage, and preventing grid overloads or blackouts.

The main objectives of this research

- To develop a smart energy system that integrates solar power, battery backup, and grid supply using an automated changeover mechanism.



- To implement IoT technology (NodeMCU and Blynk app) for real-time monitoring and remote control of power sources and connected loads.
- To design an efficient power management system that ensures uninterrupted power supply by intelligently switching between solar, battery, and MSEB.
- To monitor key parameters such as voltage, current, and load status using sensors and A/D converters for precise data acquisition.
- To provide a user-friendly mobile interface that allows users to view system status and manually control devices if needed.
- To reduce dependency on the conventional grid (MSEB) by maximizing the use of renewable solar energy.
- To promote sustainable and eco-friendly power solutions, especially for rural or remote areas with unstable electricity access.

II. LITERATURE SURVEY

| Sr. No. | Author name | Title | Publication Name | Method |
|---------|--|---|------------------|---|
| [1] | P. Arul Selvam, P.Essaki Raja, S. Jeyaraj, A. Johnson | IoT Based Smart Grid System to Monitor and Control Renewable Energy Source. | IJRPR | Utilizes Internet of Things (IoT) devices and sensors to continuously monitor and manage the performance and output of renewable energy sources, enabling real-time data collection and control. |
| [2] | Adinath S. Satpute , Dr. G. U Kharat , R. S Bansode | Smart Grid System to Monitor & Control Renewable Energy Source based on WoT | IJERT | Employs the Web of Things (WoT) framework, integrating web technologies with IoT to enhance interoperability and provide a platform for monitoring and controlling renewable energy sources remotely. |
| [3] | Priyanka Madhukar Gawali1, Prof.S.V.Murkute | A Review on IoT Based Smart Grid System to Monitor and Control Renewable Energy Source | IJSREM | Conducts a comprehensive review of existing IoT-based smart grid systems, summarizing the technologies, methodologies, and performance outcomes related to the monitoring and control of renewable energy sources. |
| [4] | Antonio Cano-Ortega FS Francisco Sánchez- | Smart IoT System for Renewable Energy Resource | MDPI | Details the design and implementation of an IoT system specifically aimed at managing renewable energy resources, focusing on optimizing resource usage, and enabling remote control. |
| [5] | Saswat Mohanty; Bikash Narayan Panda; Bhawani Shankar | Implementation of a Web of Things based Smart Grid to remotely monitor and control Renewable Energy Sources | IEEE | Describes the practical implementation of a smart grid system based on the Web of Things (WoT) architecture, highlighting the system's ability to remotely monitor and control various renewable energy sources, including performance metrics and user interface design. |
| [6] | Hiray Pallavi Ashok ¹ , G.U.Kharat | IOT based Smart Grid to remotely monitor and control Renewable Energy Sources | IJIRCE | A smart grid which is based on Web of things are made, and implementation in typical application including Solar power prediction, condition monitoring of overhead transmission lines, power monitoring, asset management |
| [7] | Priyanka Bhausheb Deshmukh, Prof V.M.Joshi | IOT based Smart Grid to Remotely Monitor and Control Renewable Energy Sources using VLSI | IJRSET | Employs Very Large-Scale Integration (VLSI) technology in conjunction with IoT to enhance the monitoring and control capabilities of renewable energy sources in a smart grid, enabling efficient and scalable hardware implementations. |



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|------|---|---|---------------|--|
| [8] | Maninder Kaur ¹ and Dr. Sheetal Kalra ² | A Review on IOT Based Smart Grid | gvpress | Provides a comprehensive review of IoT-based smart grid systems, summarizing existing technologies, methodologies, and their effectiveness in monitoring and controlling renewable energy sources. |
| [9] | NP G. Bhavani ^a , Ravi Kumar | Design and implementation of iot-integrated monitoring and control system of renewable energy in smart grid | sciencedirect | Develops an integrated IoT system for monitoring and controlling renewable energy sources within a smart grid, aimed at enhancing the sustainability of computing networks through improved energy management. |
| [10] | Sheeraz Kirmani, Sheeraz Kirmani | A Survey on IoT-Enabled Smart Grids: Technologies, Architectures, Applications, and Challenges | Mdpi | Surveys the current state of IoT-enabled smart grids, discussing various technologies, architectural frameworks, practical applications, and the challenges faced in implementing. |

III. CONCLUSION

This project successfully demonstrates an intelligent, IoT-enabled smart grid system that integrates renewable energy sources with real-time monitoring and automatic power source switching. By combining a solar power system with battery backup and traditional grid supply, and controlling them through NodeMCU and the Blynk app, the system ensures seamless energy management. The auto-changeover feature guarantees an uninterrupted power supply, making the system highly reliable and efficient. This solution is particularly beneficial for remote and rural areas where power reliability is a major concern. It promotes the use of green energy while giving users complete control over energy usage from anywhere.

Advantages

- Automatic Changeover: Seamlessly switches between solar, battery, and grid without manual input.
- Remote Monitoring and Control: Users can monitor voltage, current, and control loads using the Blynk app.
- Efficient Energy Management: Maximizes the use of solar power, reducing dependence on the grid.
- Eco-Friendly: Promotes the use of renewable energy and reduces carbon footprint.
- Reliable Power Supply: Ensures continuous power with smart switching during power cuts.
- Cost-Effective: Reduces electricity bills by prioritizing solar energy usage.
- Scalable Design: Can be expanded with more sensors or integrated with other renewable sources.

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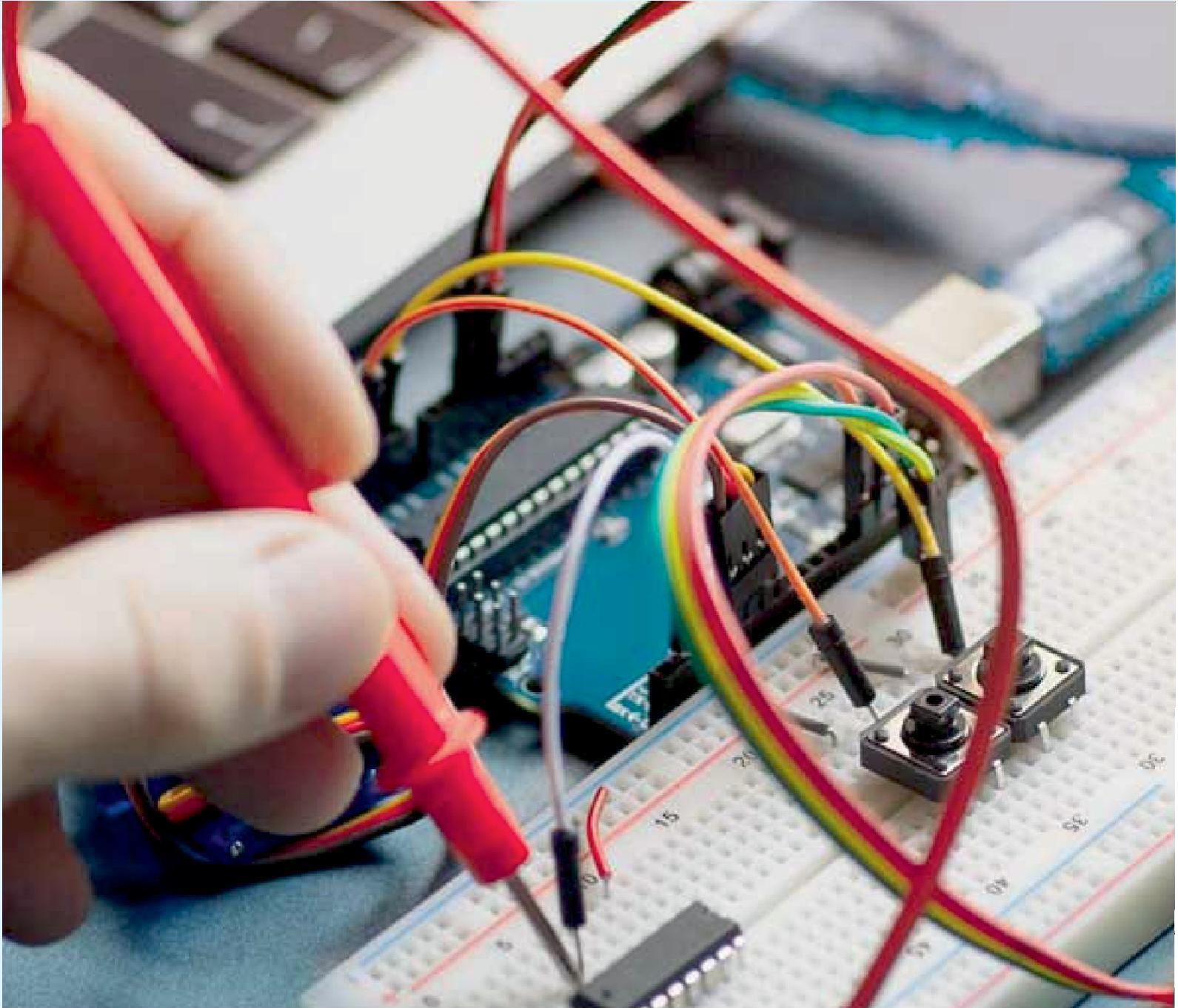
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