Design and Modelling of Power-shifting Circuit for Hybrid Power Generation in Rural Area

DR. RAVI MISHRA[1], ANIKET KHADGI[2], DEVKUMAR HALADKAR[3], MANVI ZARARIA[4], PAWAN SHINGANE[5], SANIKA KHAIRWAR[6], VRUSHALI RAHATE[7]

[1]*Associate Professor, Electronics & Telecommunication Engineering, G. H Raisoni College of Engineering and Management, Nagpur, India*

[2, 3, 4, 5, 6, 7] Student, Department of Electronics and Telecommunication, G. H. Raisoni College of Engineering, and Management, Nagpur, India

Abstract— An effective way to satisfy the energy needs of rural areas is through hybrid power production systems, which integrate renewable energy sources like wind and sun. The idea of power shifting in hybrid power generation systems is examined in this research, with an emphasis on energy distribution optimization to improve dependability and affordability. Power shifting reduces reliance on non-renewable energy by intelligently managing power loads by moving energy demand from peak to off-peak hours or from less dependable to more sustainable power sources. Power shifting can increase energy efficiency, decrease operating costs, and lessen the environmental effect of energy systems in rural areas by using energy storage devices, real-time monitoring, and sophisticated control algorithms In off-grid and impoverished areas, the application of this strategy can greatly increase access to clean and dependable electricity, promoting sustainable development. The study examines a range of power shifting methods, tools, and approaches while taking into account the particular difficulties that rural communities confront, including resource unpredictability, erratic power consumption, and poor grid connectivity.

Goals

Switch to Hybrid Power: Depending on availability and load demand, switch power from the main grid to a hybrid system powered by wind and solar resources.

Energy Stability: Ensure continuous energy for agricultural operations by supplying a steady power supply from the wind-solar hybrid system.

Monitoring System: Create a monitoring system that uses an LCD to show important characteristics like power, voltage, and current for in-the-moment power generation analysis.

I. INTRODUCTION

The world's energy security is seriously threatened by the sharp reduction in fossil fuel supplies. Currently, only a small portion of the world's energy needs are met by renewable energy sources like geothermal, biomass, sun, and wind. The shift to renewable energy sources becomes essential as we confront the possibility of a major gasoline scarcity.

Theoretical Framework

Conservation of Energy: Energy can only be changed from one form to another; it cannot be created or destroyed. This idea emphasizes how crucial energy saving and effective use are in the contemporary research environment.

Project Goal

To use Internet of Things technology to build and simulate a power-shifting circuit for hybrid power generation in rural locations, guaranteeing a continuous power supply and integrating online status monitoring.

Important Elements

1. Generating Power Hybridly: Combines wind and solar power to create a dependable and sustainable power source.Lessens reliance on fossil fuels, supporting international sustainability objectives.
2. Circuit with Power Shifting: It is an intelligent circuit design that, in response to load demands and availability, dynamically switches the power supply between hybrid and main grid sources.
3. IoT-Based Monitoring System: Using IoT technology, real-time status monitoring of energy production and consumption is possible. It offers power, voltage, and current statistics that can be accessed by mobile or web applications. It promotes proactive energy resource management and well-informed decision-making.

Advantages

- Sustainable Energy Access: Promotes agricultural practices and raises living standards by increasing energy availability in rural regions.
- Increased Reliability: By guaranteeing a steady power supply, the hybrid system reduces the dangers connected with depending solely on one energy source.
- Smart Management: Energy saving initiatives and effective energy management are made possible by IoT monitoring.

II. BLOCK DIAGRAM

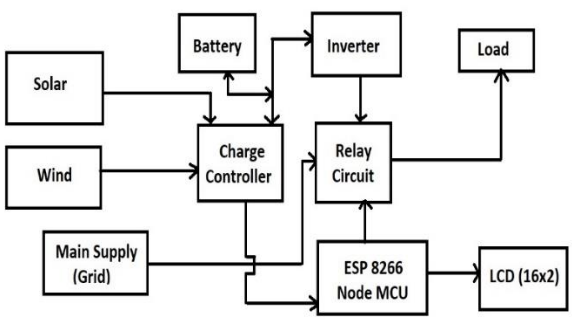
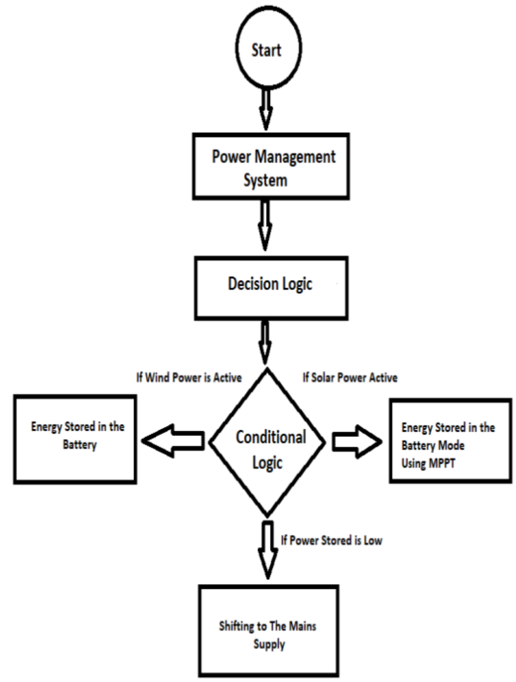


Fig: 1 Block Diagram of the System

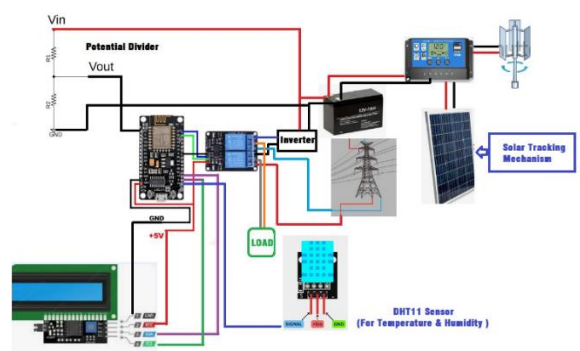
III. LITERATURE

- In their study work, "Hybrid Wind-Solar and Battery Storage System: Case Study In UIT Rgpv Bhopal," the authors "Bhave A.G." examined the techno-economic viability of putting in place a solar photovoltaic-wind hybrid system. This method uses supplementary power from the AC mains and a lead acid battery for electrical storage. A model for maximizing the size of a hybrid photovoltaic wind energy system has been created by the author, Habib M.A.
- In a research article titled "NASA/ADS," author Rajesh Karki claims that they created a modelling method for photovoltaic and wind energy consumption in small isolated power systems based on reliability/cost implications. Evaluation of the cost and dependability of tiny, isolated power plants that use wind and solar energy.

IV. FLOW CHART



V. CONNECTION DIAGRAM



VI. METHODOLOGY

- A number of crucial elements and procedures must be included in the design and modelling of a power-shifting circuit for hybrid power generation with online status monitoring. Here is a thorough walkthrough of the procedure:

1. System specifications and requirements describe the needs for the system:

- Hybrid Power Sources: List and describe each power source, such as wind, solar, etc. Power Demand: Evaluate the rural area's power needs, taking into account both critical and peak demands.

- Uninterrupted Power Supply: Indicate the level of dependability and uninterrupted power supply that you want.

2. Design of Circuit Mechanism for Shifting Power:

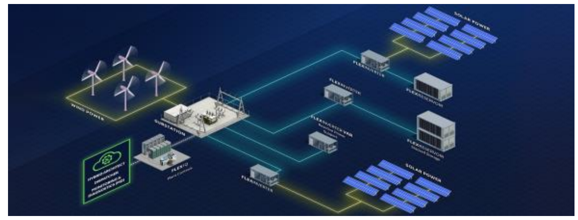
- Automatic Transfer Switch (ATS): Create a dependable ATS that can alternate power sources in response to load demand and availability.
- Converters: To control varying voltage levels and guarantee compatibility, use DC-DC converters for solar power and AC-AC converters for wind or diesel power.
- Battery Management: If batteries are utilized for energy storage, incorporate a battery management system (BMS), which includes controls for charging and discharging. Management of Load:
- Load balancing: that maximize efficiency, design circuits that distribute the load among several power sources. • Load Shedding: To prioritize important loads during power outages, provide circuits for automatic load shedding.

3. Internet of Things Integration for Online Surveillance

Data acquisition and sensors:

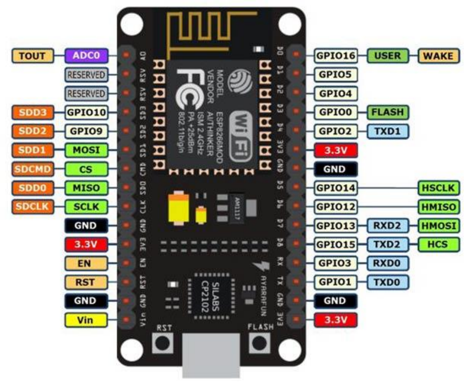
- Sensors: Install sensors to keep an eye on temperature, voltage, current, and other pertinent variables.
- Data Acquisition: Create systems for collecting data from sensors in real time.
- Communication Protocols: When sending data to the cloud or central monitoring system, pick appropriate communication protocols (such as MQTT or HTTP).
- Network: Depending on the availability and needs, use wired connections or wireless technologies (Wi-Fi, LoRa, cellular).
- Cloud Platforms: For data processing, storage, and visualization, use IoT platforms (such as AWS IoT, Azure IoT, and Google Cloud IoT).

VII. BASIC INSTALLATION



VIII. CONTROLLER TECHNOLOGY

ESP8266 Node MCU Model



ESP-32 Microcontroller Features:

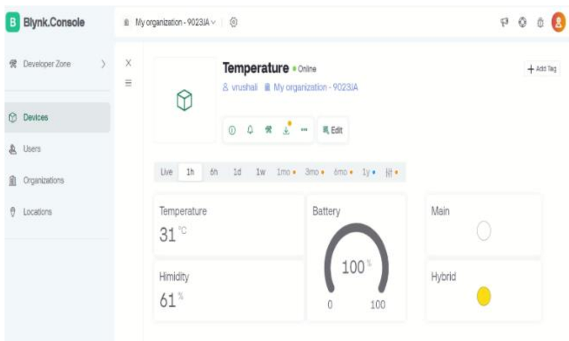
The ESP32 microcontroller features two separately managed cores.

- Bluetooth connectivity
- A digital to analog converter (DAC) with capacitive touch sensors and four separate timers.

Applications:

- The ESP32 is capable of functioning as a fully functional standalone system.
- The main application processor's communication stack overhead is decreased; the ESP32 may interact with other systems to offer Bluetooth and Wi-Fi capabilities.

IX. ONLINE MONITORING



X. FINAL MODEL

CONCLUSION

Rural energy usage in agricultural applications might be greatly impacted by this hybrid power generating project, which would have positive effects on the economy and the environment. It opens the door to a more sustainable energy future by combining wind and solar power with real-time monitoring.

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