JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Multiple Areas Load Shedding Management Using Renewable Energy Source & IoT

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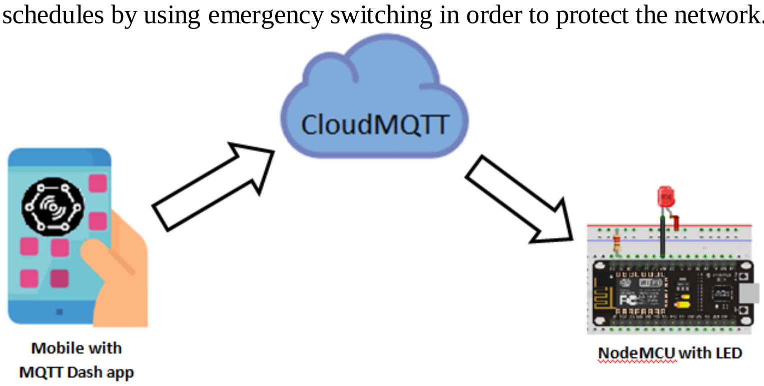
Abstract: This project titled "Multiple Areas Load Shedding Management Using Renewable Energy Source & IoT" focuses on managing load shedding across multiple areas. The project utilizes ESP8266 and relay modules for load shedding control, along with solar panels and battery charging for renewable energy integration. Bidirectional communication is established through the Blynk app. The aim to effectively manage load shedding using renewable energy sources and IoT technology. It emphasizes the use of ESP8266, relay modules, solar panels, battery charging, and the Blynk app in achieving efficient load shedding across multiple areas. The primary objective is to balance the electricity demand and supply across multiple areas. By integrating renewable energy sources and IoT technologies, the aim is to optimize the distribution of electricity, avoid overloading the grid.

IndexTerms **–Blynk App, ESP8266, MQTT.**

I. INTRODUCTION

Load shedding is often implemented when the demand for electricity exceeds the available supply. When there is insufficient power station capacity to supply the demand (load) from all the customers, the electricity system becomes unbalanced, which can cause it to trip out country-wide (a blackout), and which could take days to restore. When power is insufficient, Eskom can thus either increase supply or reduce demand to bring the system back into balance. As the difference between supply and demand becomes small, we refer to the system becoming “tight”. This implies that action has to be taken to prevent the system from becoming unstable. Eskom normally takes a sequence of steps to keep the system stable and to avoid load shedding. The steps include first asking large customers to reduce load voluntarily. However, if several power station units trip suddenly and unexpectedly, we may have to skip those steps and go straight to load shedding to prevent the system from becoming unstable. Scheduled load shedding is controlled by way of sharing the available electricity among all its customers.

By switching off parts of the network in a planned and controlled manner, the system remains stable throughout the day, and the impact is spread over a wider base of customers. Load shedding schedules are drawn up in advance to describe the plan for switching off parts of the network in sequence during the days that load shedding is necessary. On days when load shedding is required, the networks are switched off according to the predetermined plan, to ensure that, as far as possible, customers experience load shedding in accordance with the published load shedding schedules. In exceptional circumstances, if scheduled load shedding is not achieving the required load reduction and/or unexpected emergencies or failures occur, then System Control Centres will shed load outside the published schedules by using emergency switching in order to protect the network.



MQTT is a lightweight publish-subscribe messaging protocol that enables efficient and real-time communication between devices and applications. It is particularly well-suited for IoT scenarios where low bandwidth and low power consumption are critical factors. MQTT brokers play a central role in managing message distribution and ensuring reliable communication between publishers and subscribers.

By integrating renewable energy sources such as solar, wind, or hydro power, areas can reduce their reliance on fossil fuel-based power generation, promote sustainability, and contribute to the global effort to combat climate change. Over time, the use of renewable energy can lead to significant savings for areas, which can be reinvested in other infrastructure development. IoT technologies enable efficient monitoring and management of electricity demand. By integrating IoT devices, areas can collect real-time data on energy consumption patterns, identify peak demand periods, and optimize energy distribution.

The primary objective is to balance the electricity demand and supply across multiple areas. By integrating renewable energy sources and IoT technologies, the aim is to optimize the distribution of electricity, avoid overloading the grid. The objective is to minimize the impact of load shedding on residents, businesses, and critical infrastructure. By effectively managing and monitoring the energy demand and supply, the goal is to reduce the frequency and duration of power interruptions, ensuring a reliable and consistent power supply.

II. RESEARCH METHODOLOGY

Load Management System with Integration of Renewable Energy Resources, this paper describes implementation of a load management system that integrates renewable energy resources such as solar and wind. It utilizes a hybrid system that combines wind energy, solar energy, utility supply, and a battery energy storage system. The use of a Load Management System that integrates renewable energy resources offers numerous advantages, including improved energy efficiency, grid stability, cost savings, user priority consideration, backup power, remote control capabilities, and environmental benefits. These benefits make such a system a valuable solution for managing energy resources effectively and sustainably. These methods and technologies work together to create a comprehensive load management system that optimizes the use of renewable energy sources, manages power distribution, allows for remote control, and ensures reliability and efficiency in energy supply. The combination of renewable energy sources, energy storage, load management, and remote control capabilities makes the system robust and adaptable to various energy scenarios and user needs. [1]

In this paper Load Shedding and Smart-Direct Load Control Using Internet of Things in Smart Grid Demand Response Management in this ARIMA (Auto-Regressive Integrated Moving Average) is used for load forecasting. It helps predict future electricity demand accurately based on historical data, allowing for efficient load management. Accurate load forecasting is essential for optimizing the operation of the smart load control system. the use of algorithms, particularly ARIMA for load forecasting, plays a crucial role in the smart load control system described in the paper. These algorithms enable proactive load management, reduction of power outages, optimization of grid performance, and the integration of IoT and real-time analytics to create a more reliable and efficient electrical grid. [2]

This paper proposes an incentive-based load shedding management scheme in micro-grid environments using IoT infrastructure. The proposed incentive-based load shedding management scheme using a reverse combinatorial auction approach, IoT infrastructure, and optimization algorithms has the potential to improve grid stability, reduce power outages, engage consumers, and advance the reliability of micro-grid environments. This research is valuable for creating more efficient and sustainable energy management systems. [3]

In this paper addresses the frequency stability issues in micro-grid systems operating in island mode. When power generation sources are insufficient, load shedding becomes necessary to restore frequency stability. The proposed method for coordinated load shedding in micro-grid systems operating in island mode is valuable because it addresses the critical issue of frequency stability while considering renewable energy sources, technical and economic criteria, and load importance. It provides a structured approach to load shedding that can enhance the reliability and stability of micro-grid operations. [4]

III. PROPOSED SYSTEM

The transformer steps down (or up) the input AC voltage to the desired level. The bridge rectifier converts the AC voltage into pulsating DC voltage. The capacitor smooths out the pulsations, resulting in a relatively stable but unregulated DC voltage. The voltage regulator further refines the voltage, providing a precise and regulated output voltage (e.g., 5V in the case of an LM7805). A 5V DC supply is connected to the ESP8266's VCC and GND pins. Relay is connected to the ESP8266 pins like D4, D5, and D6 & D7. MQTT (Message Queuing Telemetry Transport) is a lightweight communication protocol commonly used in Internet of Things (IoT) applications to facilitate communication between devices and servers. In the context of your project, the “Multiple Areas Load Shedding Management Using Renewable Energy Source & IoT," you can use MQTT to connect your IoT devices to the Blynk app, enabling remote monitoring and manage the system. These devices should be capable of connecting to the internet and communicating using MQTT. An MQTT broker is a server that acts as an intermediary between your IoT devices and the Blynk app. Configure your IoT devices to connect to the MQTT broker. This involves specifying the broker's address, port, and credentials (username and password) for authentication. In the code running on your IoT devices, publish data (e.g., sensor readings) to the appropriate MQTT topics and subscribe to topics that receive control commands from the Blynk app. This involves specifying the MQTT broker's details (address, port, username, and password) within the Blynk app so that it can communicate with the MQTT broker. With everything set up, now monitor the status of your parking system in the Blynk app and send control commands to your IoT devices.

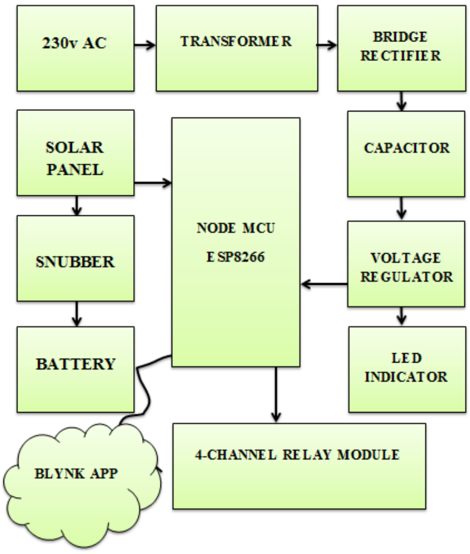


Fig.1: Block diagram

Power Supply: The transformer steps down (or up) the input AC voltage to the desired level. The bridge rectifier converts the AC voltage into pulsating DC voltage. The capacitor smooths out the pulsations, resulting in a relatively stable but unregulated DC voltage. The voltage regulator further refines the voltage, providing a precise and regulated output voltage (e.g., 5V in the case of an LM7805). Accurate and fixed 5V output. Low standby current only 8mA

ESP8266: The ESP8266 microcontroller module provides a set of general-purpose input/output (GPIO) pins that can be used for both input and output operations. MQTT (Message Queuing Telemetry Transport) is a lightweight messaging protocol commonly used in IoT applications. The ESP8266 supports MQTT, enabling seamless communication between devices and IoT platforms. It has 11 (digital) GPIO pins and 1 analog pin. Operating Voltage: 3.3V. Input Voltage: 7-12V. 10-bit ADC (successive approximation ADC).

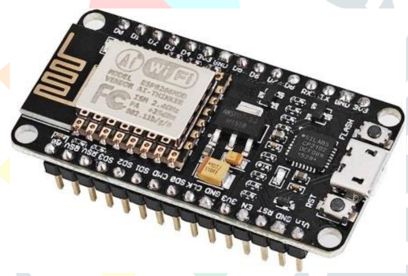


Fig.2: ESP8266

Relay Module: Relay modules are controlled using a binary logic, where energizing the relay coil (applying 12V) causes the contacts to change state. For example, a normally open (NO) contact will close, and a normally closed (NC) contact will open when the coil is energized. It is operated on 12v. Coil voltage: 12V. Max switching voltage: 250VAC / 30VDC. Max switching current: 10A.

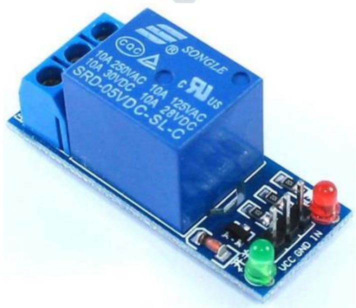


Fig.3: Relay Module

Blynk App: Blynk is an Internet of Things (IoT) platform that simplifies the process of creating mobile applications to control and monitor IoT devices. It provides a user-friendly interface and a drag-and-drop app builder, allowing users to create custom mobile apps.

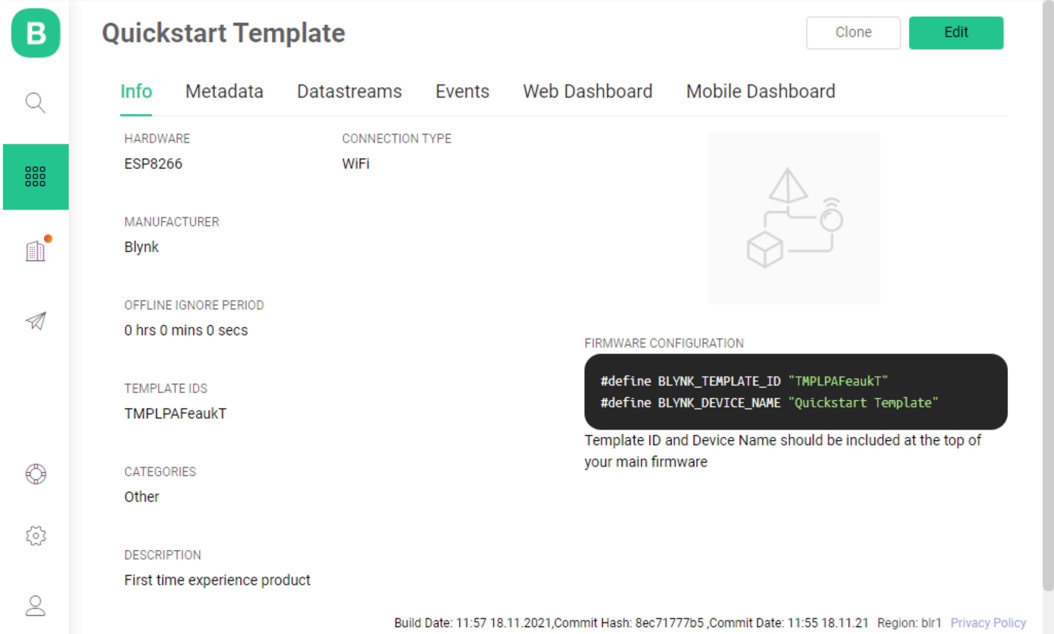
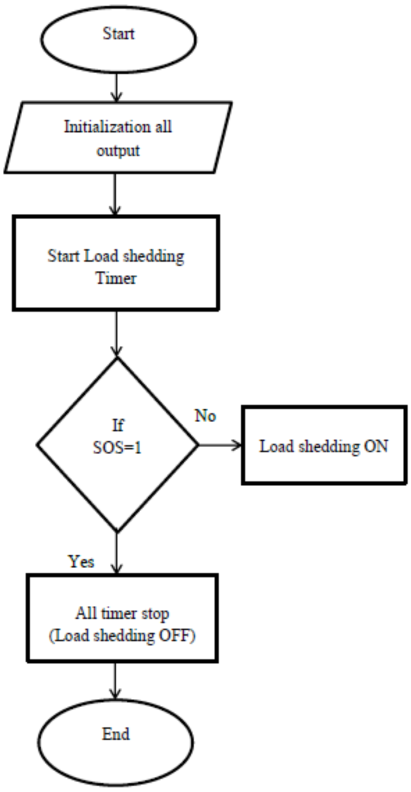


Fig.4: Blynk App web page

Fig.5: Blynk App

Flow Chart



IV.RESULTS AND DISCUSSION

Load Shedding in electrical supply networks is a controlled process in which the utility company drops off part of the load in order to balance the demand and the generated capacity. Utility company use scheduled load shedding so that the available electricity is fairly shared by the consumer. To understand this procedure in deep we propose “Multiple areas load shedding management using IoT”.

Multiple areas load shedding management system is a reliable circuit that takes over the internet task of switch ON/OFF the electrical devices with respect to time. In our project we connect 3 loads which represent 3 different areas. The user will see the switching the load of the particular areas. After taking all the inputs from the system will start monitoring time which is been entered by the system in the start. So as and when the time for switching ON/OFF a particular areas occurs the system will accordingly switch ON/OFF that particular areas. To keep a track of the load shedding that mean if someone wants to know which city is going through load shedding then they can check it on mobile app as it will display the area number which is going through load shedding thus keeping a track or monitoring is made easy.

In this project, there are two main components: the solar panel and the 230V AC system. 230v power supply is given to the step down transformer. Rating of the transformer is 12v. It can be given to bride rectifier which consists of rectifier, filter and a voltage regulator. Rectifier converts the ac into pulsating dc and filter gives the pure dc signal by blocking ripples. The dc voltage is further regulated and Microcontroller (ESP8266) receives this DC power from rectifiers.

The solar panel captures sunlight and converts it into DC electricity. This generated electricity is sent to the load or connected devices. The snubber helps protect the connected devices from voltage spikes or transients that may occur in the system. It regulates and dissipates excess voltage, safeguarding the components from potential damage. During periods of high sunlight or low load demand, the excess electricity generated by the solar panel is used to charge the battery. The battery stores this energy for later use when sunlight is limited or during peak demand periods. When the solar panel's output is insufficient to meet the load demand or during peak demand periods, the stored energy in the battery is discharged. This ensures a continuous and reliable power supply to the connected devices.

Connect the 4-relay module to the GPIO pins of the Node MCU. Toggling the button on the Blynk app will send a command to the Node MCU, which will in turn control the relays and switch them on or off accordingly.

Develop a user interface, such as a mobile app or a web-based platform, where users can access real-time energy consumption data, receive notifications about load shedding schedules, and have control over their energy usage. Continuously monitor the system's performance, gather feedback, and make necessary adjustments to optimize the load shedding management system and improve energy distribution efficiency.

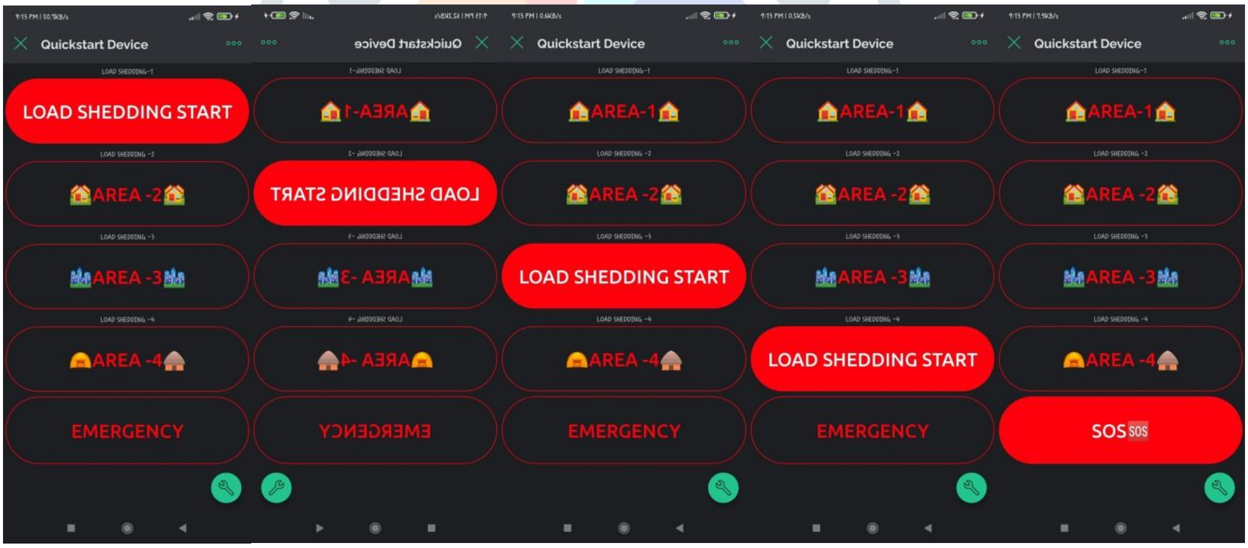


Table 1: Solar Voltage

Sr. No.	Time	Voltage (Volt)
1	8 AM	4
2	10 AM	6.1
3	12 PM	11.78
4	4 PM	10.1
5	6 PM	2.5

V. CONCLUSION

In conclusion, the "Multiple areas Load Shedding Management Using Renewable Energy Source & IoT" application presents a promising solution for efficient power distribution across multiple cities. By leveraging renewable energy sources and IoT technology, the application aims to ensure a sustainable and reliable energy supply while minimizing power shortages.

Application

- The application provides a user-friendly interface accessible via a web-based platform or a mobile app.
- Renewable energy sources such as solar panels, wind turbines, or hydroelectric power systems are installed in various locations across the cities.
- IoT devices, including smart meters and sensors, are deployed throughout the cities to monitor energy demand, consumption, and renewable energy generation.
- Real-time Monitoring and Analysis.

Future direction

- Incorporate smart grid technologies to enable bidirectional communication between the utility provider, consumers, and the load shedding management system. This would allow for more dynamic load management, demand response programs, and real-time pricing incentives for energy consumption.
- Utilize predictive analytics and machine learning algorithms to forecast energy demand, renewable energy generation, and weather patterns. This can improve the accuracy of load shedding schedules and enable proactive energy management strategies.

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