IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 15, May 2023

IOT Based Smart Power Grid Control and Energy Monitoring

Mr. Sandip R. Aher[1], Samble Krushna Balasaheb[2], Pagare Tejas Anil[3]
Parwat Shriniwas Raosaheb[4]
Assistant Professor, Department of Electronics and Telecommunication Engineering[1]
Students, Department of Electronics and Telecommunication Engineering[2,3,4]
Pravara Rural Engineering College, Loni, Maharashtra, India

Abstract: *The Internet of Things (IoT) has emerged as a promising technology for transforming traditional power grids into smart and efficient systems. This paper presents an IoT-based smart power grid control and energy monitoring system that combines the power of connected devices, sensors, and data analytics to enable real-time monitoring, control, and optimization of energy consumption in power grids. The proposed system leverages IoT devices and sensors deployed across the power grid infrastructure to collect and transmit real-time data on energy consumption, generation, and distribution. This data is then processed and analysed using advanced analytics techniques to provide valuable insights and enable effective decision-making for energy management. The smart power grid control and energy monitoring system offer several key features. Firstly, it provides real-time monitoring of energy consumption at various levels, including individual appliances, buildings, and the overall grid. This enables users to identify energy-intensive areas, track usage patterns, and implement energy-saving strategies. Secondly, the system enables remote control and automation of energy-consuming devices, allowing for dynamic load management and demand response. By optimizing energy usage based on real-time data and demand forecasts, the system helps to reduce peak loads, balance energy supply and demand, and enhance grid stability. Furthermore, the system facilitates the integration and management of renewable energy sources, such as solar panels and wind turbines, by monitoring their generation and optimizing their utilization within the grid.*

Keywords: Power monitoring, IOT, Smart Grid, Blynk, voltage and current, sensor

I. INTRODUCTION

While many of the world's developed countries have long lost power variability, many developing countries still suffer slowdowns from constant blackouts. Alternative energy planning would not have been successful without the consistent challenges associated with manual conversion. In several developing cities, the uncertainty of energy supply requires automation of power plants and other energy sources to ensure power supply. This automation is necessary due to the high rate of blackouts. Intelligent power grids have become a rapidly developing field. A smart grid implementation will provide more efficient energy transmission, faster power restoration after outages, a mix of renewable energy sources, and lower utility management and service costs. The presence of developed systems for monitoring real-time data of networks services to realize all these advantages. The distribution companies of energy production from renewable energy sources such as solar and wind turbines plays a key role to the network complexity, making it important to monitor the flow of energy on the grid. Monitoring systems collect, store, and process detailed information about network operations. Grids can be controlled and managed using processing results. Nearly of the control tasks can be automated or manually operated. A smart power grid generally refers to a highly combined power grid that can distinguish between different types of energy such as wind, solar, and hydropower. It is a mixture of remote control technology from a computer, physical network and wireless measurement technology. The main problem with smart power grid technology is coordinating consumer-generated power with the utility company to allow bi-directional power flow on inner connected transmission lines.

A smart power grid is a system that distributes electrical energy generated from multiple sources to various stations using interconnected transmission lines. Power system failures due to voltage fluctuations in one system or improper maintenance lead to failures in neighbouring systems, resulting in large economic losses. The repair process requires manual repair or the process of switching from the main system to the alternate system. This will require automated processes to avoid causality and health issues as workers deal with high voltages and radiation in solving problems. The proposed system is designed to perform multiple operations such as voltage, current, temperature and humidity monitoring using various sensors recorded on computerized devices. It has also included unattended switching of load between two different sources if one the system fails. Due to various reasons the primary transformer fails, it is necessary to perform a switching operation (backup) between the primary and secondary transformers so that the transmission of electrical energy can continue. The switching operation is manual, but the high radiation, voltages and frequencies present various health hazards to those working there. Automation is required to proactively prevent hazards and anticipate possible problems and failures.

II. PROBLEM SATEMENT

Problems can occur due to power grid failures, resulting in power outages throughout the area served by that particular power grid. This project aims to solve this problem using his IoT as a means of communication, as well as various other problems that intelligent systems can address to avoid unnecessary losses in energy processes.

III. LITERATURE SURVEY ON SMART GRID

OlufemiBabajideOdeyinde John Junior Agidani, Obasi, ChijiokeChukwuemeka, VictorOnyedikachi Ibiam1 Ubadike,ChieduOsichinaka[1]A work on the design, construction and implementation of a conversion system for power supplies is presented. The purpose of this item is to reduce maintenance costs and limit the use of generators for utilities such as fuel when outages are extended. In the design and construction of the system, a modular approach of parts and buttons was used. The AT89S52 microcontroller is used for this implementation in the, which runs the control program in its memory. For selection of the various modes and functions of the, a four-button pushbutton switch is used. This automation technology will also automatically add some intelligence to the power conversion by allowing the user to select the mode in which they want their automation system to operate. The proposed system upgrades the existing automated and manual power conversion.

M Gouzman,D. Gavrilov, S Luryi[2] A job concurrency function is proposed to estimate the operation of the grid. This paper focuses on real-time monitoring of the smart grid, where comprehensive information about power flows in the grid is required. Here, a dense network of sensors is implemented to collect and process large-scale real-time data, which facilitates the construction of grid maps. The proposed network monitoring uses a dense network of sensors at low cost installed at each branch point of the power lines. The RMS current is measured periodically and the phase shift between current and voltage is obtained in the conductor using a sensor. To achieve global time synchronization by monitoring anomalies in the electromagnetic fields around conductors to estimate all required parameters, each sensor is equipped with a GPS receiver

Ali Azizi, Saeed Peyghami, Hossein Mokhtari,FredeBlaabjerg[3]A work is presented on independent and distributed styles of power sharing and energy operation for DC microgrids without the use of communication systems. This document presents a steady state operation and a cost effective result for DC micro grids. thus, the generation and the cargo must work rightly. support and power consumption(ESC) precedence is introduced then to ameliorate the system performance of the. In addition, power inflow from a full battery to an empty battery is avoided and SOC (state of charge) of battery is meetly acclimated as anticipated by control action. therefore, the cycle life of the battery and the overall performance of the system can be bettered. The system provides draw- and- play functionality for the to use amicro-grid for each battery cell grounded on its control system and voltage information.

TruptiSudhakarSomkuwar , Mahesh. G Panjwani[4] A work is presented that uses a Wireless Sensor Network (WSN) to control and monitor a power distribution line that allows cost effective monitoring [5]. The purpose of this item is to control and monitor power transmission lines, while locating faulty nodes in the power supply. The system consists of a radio frequency transceiver module for sending and receiving information between the central server and the stem, an Atmega16 single-chip microcomputer module, a electrical relay and a power supply. In this system, the power off message is sent to the monitoring station through the RF transceiver, and the monitoring station uses the GSM model to

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 15, May 2023

transmit the detailed information from the node to the lineman. concerned with SMS, and the central server fault line pole position is at the turn Provides better support for client, also time reduction.

IV. DESIGN PLAN

1. Hardware Prototype

Hardware design of an IoT-based energy monitoring system connects a load to this hardware setup and evaluates its performance. a Wi-Fi module to communicate loading data to his Blynk application.

Hardware is tested with various loads for voltage and current, power and energy. Wi-Fi sends real-time data to the Blynk for storage. After the simulation program the device receives data from the cloud via his MQTT. MQTT is a protocol for collecting device data and sending this data to a server. The device is controlled via Blynk application. Displays the electrical measurements of the load (voltage, current, power and energy consumption). Consumers can view load information at any time (hourly, weekly, or monthly). A load on/off scenario is shown in Figure 10. where 0 and 1 represent on-load and off-load respectively. Inform the layman of the on or off state of the load.

2. System Overview

The develops system consists of grid monitoring, communication and analysis units. The monitoring function consists of an ACS712 current sensor and voltage detection circuit connected to the consumer's load. The communication unit consists of a NODE MCU Wi-Fi module. The Analysis Unit is a remote application on consumer mobiles that can be accessed to retrieve voltage and current, load profile, grid energy consumption and more.

3.System Design

A block diagram of an IoT-based energy monitoring system is a Wi-Fi-based node consisting of consumer load, voltage, and current sensors and a Wi-Fi communication module (ESP-32). The Arduino is connected to sensors, collects load data and stores it in internal memory. Wi-Fi gets the load data from the Arduino through the UART interface and communicates the load data to the server. A Wi-Fi module acts as a gateway between the monitoring site and the web server.

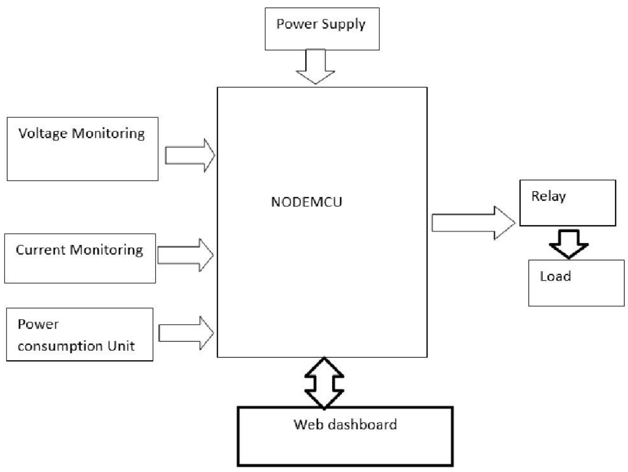

Fig 1: Block diagram of Smart power grid.

Node ESP 32 Wi-Fi Controller

Fig 2: Node MCU ESP 32 Wi-Fi Controller.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 15, May 2023

ESP32 is a powerful microcontroller module with built-in Wi-Fi and Bluetooth capabilities. The ESP32 is powered by a dual-core Tensilica LX6 processor running at up to 240 MHz. This makes it possible to perform more complex tasks quickly and efficiently. The ESP32 has built-in Wi-Fi capability, which allows it to connect to a wireless network and communicate with other devices on the network. The ESP32 also has built-in Bluetooth capability for easy connection to other devices such as smartphones or other Bluetooth enabled devices. ESP32 is designed for low power operation, suitable for battery-powered applications. The ESP32 has a large number of general purpose input/output (GPIO) pins that can be used for a variety of purposes, such as reading sensors or controlling actuators. The ESP32 has a built-in ADC that can read analog signals, such as those from sensors. ESP32 supports serial peripheral interface (SPI), inter-integrated circuit (I2C), universal asynchronous transceiver (UART) and other communication protocols to facilitate the communication with other devices. The ESP32 also has a range of built-in peripherals, including timers, watchdog timers and a real-time clock (RTC), making it easy to implement complex applications. ESP32 has various security features, including support for Secure Sockets Layer (SSL) and Transport Layer Security (TLS) protocols, making it suitable for secure applications. ESP32 supports various development tools such as Arduino IDE and EspressifIoT Development Framework (ESP-IDF), making it easy to start programming and development.

Voltage Sensor

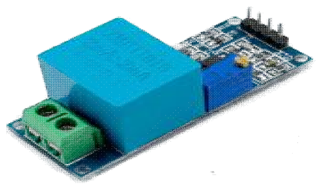

Fig 3: voltage sensor.

The ZMPT101B is a voltage sensor module that can be used to measure AC voltage levels. It is based on ZMPT101B voltage transformer with high precision and low temperature drift. The ZMPT101B voltage sensor module consists of a transformer, a rectifier and a voltage regulator. A transformer is used to step down the AC voltage to a lower level than the module can measure. The rectifier converts AC voltage to DC voltage and the voltage regulator stabilizes the output voltage. The ZMPT101B voltage sensor module has a built-in voltage divider that can be used to adjust the output voltage level. It has a wide voltage measurement range of 0 to 250V AC and can be used with microcontrollers or other devices with analog inputs. To use the ZMPT101B voltage sensor module, it is necessary to connect the power supply and measure the voltage. The module's output voltage can then be read using an analog input on a microcontroller or other device.

Current Sensor

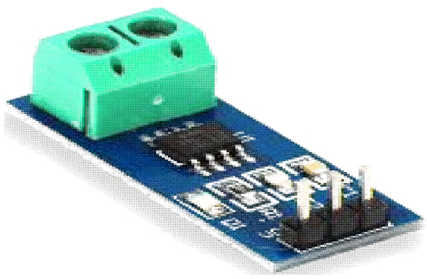

Fig 4: Current sensor

The ACS712 is a current sensor that can be used to measure the amount of current flowing in a circuit. It is a Hall effect sensor that uses a magnetic field to measure the current through a conductor. The sensor produces an output voltage proportional to the measured current and is usually calibrated to give a known output voltage per ampere of current. The ACS712 is available in several different variants with different current ratings ranging from a few amps to over 30 amps. It is commonly used in applications such as motor control, power monitoring and energy management systems. The ACS712 operates on a single supply voltage and can provide analog or digital outputs. It has low offset voltage and high accuracy, making it suitable for use in high precision applications. The sensor is also designed to be easy to use, with a simple three-pin interface including power, ground, and signal pins. Overall, the ACS712 is a versatile and reliable current sensor that can be used in a wide range of applications requiring accurate current measurement.

Relay

The 1 Channel 5V Relay Board Module is an electronic device that can be used to control a single circuit or device with low voltage signals. It usually consists of a relay, a control circuit, and a set of input and output pins. The relay is an electromagnetic switch that can be used to control a high voltage or high current circuit with a low voltage signal. When an input signal is applied to the relay, it activates the solenoid, which opens or closes the relay contacts. The driver circuit is responsible for providing the voltage and current needed to drive the relay coil. Input pins are typically used to provide control signals to the relay board module, and output pins are used to connect high voltage or high current circuits or controlled equipment. The relay board module is powered by a 5V DC supply, usually through an input pin. The 1-Channel 5V Relay Board Module is commonly used in a variety of applications including home automation, robotics, and industrial control systems. They can be used to control lights, motors, pumps and other types of electrical equipment. They are easy to use, economical, and provide a reliable method of controlling high voltage or high current circuits using low voltage signals.

Fig 5: Relay

IV. SOFTWARE APPLICATION

Blynk is an open source IoT web application used to store, analyse and retrieve data from loads. Stored information allows utilities and consumers to view device and computer load data. The stored information helps provide load patterns, ensure dynamic billing, and better balance electricity demand and supply between generation and consumption.

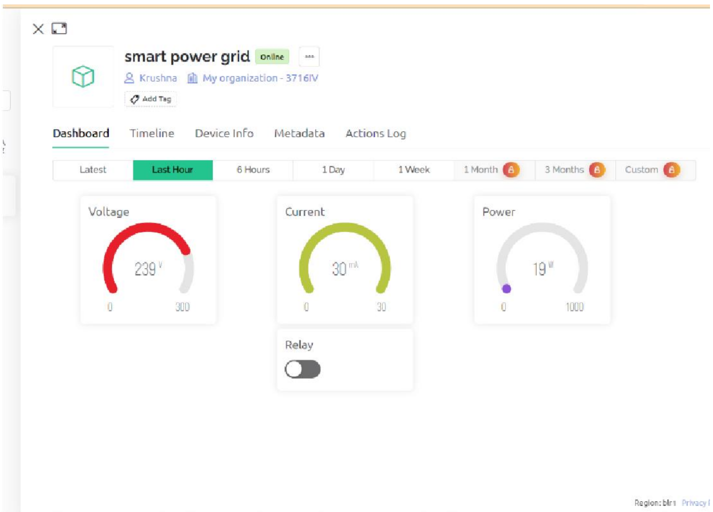

Fig 6: Web Dashboard.

IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

Impact Factor: 7.301

Volume 3, Issue 15, May 2023

V. RESULT AND CONCLUSION

The hardware portion of the project. The Blynk application provides an on/off switch for load control. The electrical parameter Voltage, current and Power are shown in Blynk application.

An intelligent energy monitoring and control system was designed and developed to realize intelligent buildings. A system that remotely monitors and controls the power consumption of home appliances via a wireless network. It also protects the load from high voltage. The entire system is designed in an embedded platform that is easy to design, low power consumption, low cost and portable size. In this way, continuous monitoring of electrical equipment can be monitored via the website and Android app. You can also extend this task to the electricity usage of the entire building to determine electricity charges. Install this project on a transformer to detect improper connections in your home and check the power of each transmission line so that the load at the end of the transmission line can be adjusted by the transformer.

VI. ACKNOWLEDGMENT

We are grateful to our project guide Prof. S. R. Aherfor their help in the design and experiments. We also thank Dean of R&D Dr. S. L. Kurkute, for helping us to reach various resources of study.

REFERENCES

[1]. Fahad Khan1, Muhammad Abu Bakar Siddiqui2, Ateeq Ur Rehman3, Jawad Khan4, Muhammad Tariq Sadiq5 ,Adeel Asad2 "IoT Based Power Monitoring System for Smart Grid Applications," COMSATS University Islamabad, Abbottabad Campus, Pakistan., pp. 765-771, February 2020. *(references)*

[2]. VijayalaxmiMunisamy&JaneshwaranGunasekaran, IoT Based Energy Management System (EMS) Using SOFAT Technique for Smart Grid Distribution System". https://www.tandfonline.com/loi/ljge2,2022

[3]. R .Morello, C. De Capua, G. Fulco and S. C. Mukhopadhyay, "A Smart Power Meter to Monitor Energy Flow in Smart Grids: The Role of Advanced Sensing and IoT in the Electric Grid of the Future," in IEEE Sensors Journal, vol. 17, no. 23, pp. 7828-7837, 1 Dec.1, 2017.

[4]. R. Ma, H.-H. Chen, Y.-R. Huang, and W. Meng, Gao, Ping Li, and Qicheng Lao Design of "Smart Grid Communication: Its Challenges and Opportunities," IEEE Transaction on Smart grid, vol. 4, no, 4, pp. 1878-1887, 2013.

[5]. Obasi,ChijiokeChukwuemeka,OlufemiBabajideOdeyinde,JohnJunior Agidani,VictorOnyedikachi Ibiam1 Ubadike,ChieduOsichinaka, "Design and Implementation of Microcontroller Based Programmable Power Changeover", ISSN 2222- 1719,Vol.6,No.12,2015.

[6]. D Gavrilov,MGouzman,SLuryi , "Monitoring Largescale Power Distribution Grids", DOI:10.1016/j.sse.2019.03.012.

[7]. Ali Azizi,SaeedPeyghami,HosseinMokhtari,FredeBlaabjerg , "Autonomous and Decentralised Load Sharing and Energy Management Approach for DC Microgrids", DOI:10.1016/j.epsr.2019.106009.

[8]. Amit Sachan , "GSM Based Automated Embedded System for Monitoring and Controlling of Smart Grid", scholar.waset.org/1307- 6892/9997170,Vol.7,No.12,2013.

[9]. TruptiSudhakarSomkuwar,MaheshG.Panjwani, "Design and Implementation of Electrical Distribution Line Monitoring and Controlling Using Wireless Network",DOI- 978-1-4673-6524-6/15 - 2015 IEEE.

[10]. SholehHadiPramono,SapriestyNainySari,EkaMaulana, "Internet-Based Monitoring and Protection on PV Smart Grid System",DOI:978-1-5386-2182- 0/17,2017 IEEE.