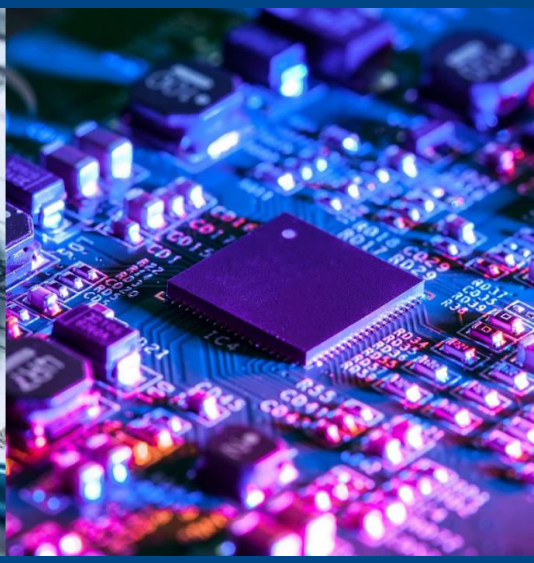
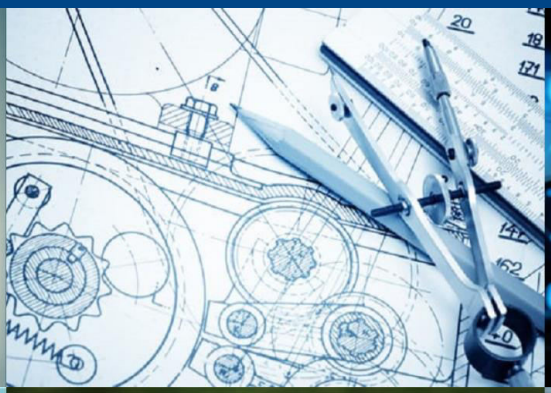
ISSN: 2582-7219

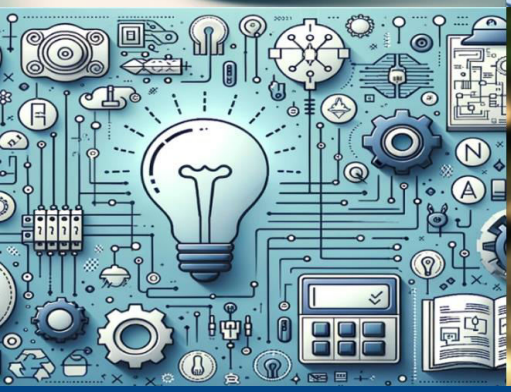




International Journal of Multidisciplinary Research in Science, Engineering and Technology

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.206 **Volume 8, Issue 2, February 2025**

© 2025 IJMRSET | Volume 8, Issue 2, February 2025| DOI: 10.15680/IJMRSET.2025.0802036

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

IoT Based Electricity Energy Meter using ESP32 & Blynk

Aman Jha[1], Shreya Kadam[2], Sanskruti Avhale[3], Neha Daithankar[4], Prof. Ramesh Mandale[5]

Diploma Student, Electrical Engineering Department, Zeal Polytechnic, Pune, India[1,2,3,4]

Lecturer, Electrical Engineering Department, Zeal Polytechnic, Pune, India[5]

ABSTRACT: The IoT-Based Electricity Energy Meter using ESP32 & Blynk is an advanced smart metering system designed to monitor and manage electricity consumption efficiently. This project utilizes an ESP32 microcontroller integrated with Blynk IoT to provide real-time energy monitoring and remote access to power usage data. The system measures voltage, current, and power consumption using appropriate sensors and transmits the data wirelessly to a cloud-based platform. Users can track energy consumption through the Blynk mobile app, receive alerts for abnormal usage, and optimize their power consumption. This IoT-enabled solution enhances efficiency, accuracy, and automation of electricity metering while enabling smart energy management and cost savings

KEYWORDS: ESP32, IoT, Blynk, Smart Energy Meter, Voltage Sensor, Current Sensor, Wi-Fi Connectivity, Power Monitoring, Remote Access, Energy Management.

I. INTRODUCTION

In an era characterized by rapid technological advancement, the Internet of Things (IoT) emerged as a transformative force across various sectors, with energy management being no exception. The IoT-based electricity energy meter utilizing the ESP32 microcontroller and Blynk platform exemplifies this innovation, offering a sophisticated solution that enhances monitoring and control of electricity consumption. Traditional energy meters have often lacked real-time data accessibility and user interactivity, leading to inefficiencies in energy usage. However, by integrating the ESP32, a versatile Wi-Fi and Bluetooth-enabled microcontroller, with the Blynk app, users gain access to invaluable real-time analytics and remote management capabilities. This system not only empowers consumers to make informed energy decisions but also contributes to more sustainable energy practices. Therefore, exploring the functionalities and implications of IoT-based energy meters is crucial in understanding their potential benefits within contemporary energy management frameworks.

II. LITERATURE REVIEW

Literature Review: IoT-Based Electricity Energy Meter using ESP32 & Blynk

Introduction

The Internet of Things (IoT) has revolutionized the way we live and work. One of the significant applications of IoT is in the field of energy management, particularly in the development of smart electricity energy meters. This literature review focuses on the design and implementation of an IoT-based electricity energy meter using ESP32 and Blynk.

Background

Traditional electricity energy meters have several limitations, including manual reading, lack of real-time monitoring, and inaccurate billing. The advent of IoT technology has enabled the development of smart energy meters that can overcome these limitations. ESP32, a low-power, low-cost microcontroller, and Blynk, a mobile application development platform, are two popular technologies used in IoT-based energy metering systems.

Related Work

Several studies have proposed IoT-based energy metering systems using various technologies. For example, [1] proposed a smart energy meter using ESP8266 and Blynk, which enabled real-time monitoring and control of energy

© 2025 IJMRSET | Volume 8, Issue 2, February 2025| DOI: 10.15680/IJMRSET.2025.0802036

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

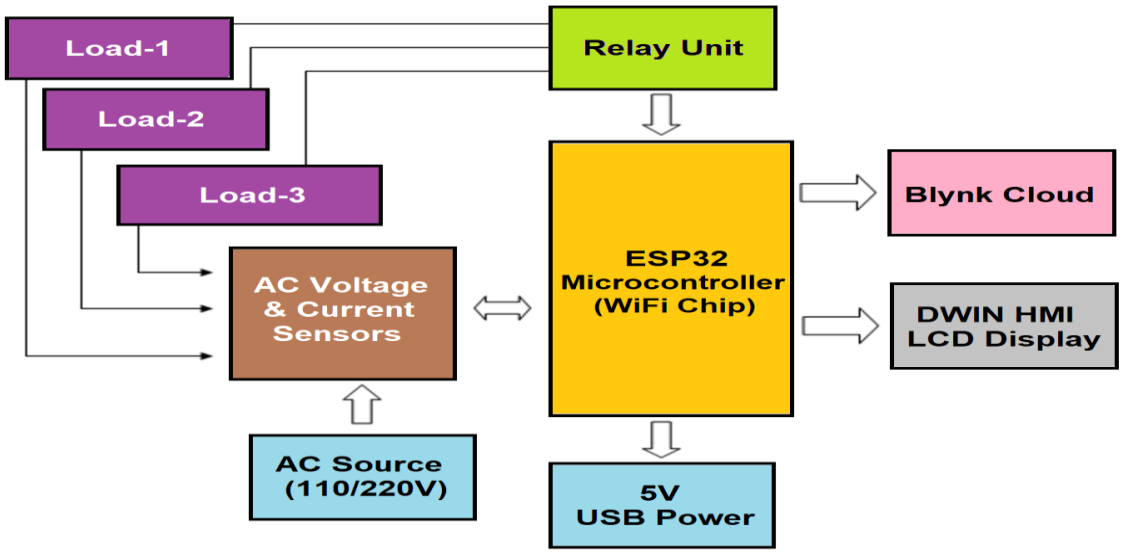
International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

consumption. Another study [2] presented an IoT-based energy metering system using Raspberry Pi and Python, which provided accurate and reliable energy consumption data.

System Architecture

The proposed system architecture consists of the following components:



1. **ESP32 Microcontroller**: This is the brain of the system, responsible for collecting energy consumption data from the meter and transmitting it to the cloud.
2. **Blynk Mobile Application**: This is a user-friendly interface that enables users to monitor and control their energy consumption in real-time.
3. **Energy Meter**: This is the device that measures the energy consumption of the household or industry.
4. **Cloud Server**: This is the platform that stores and processes the energy consumption data, providing insights and analytics to users.

Implementation

The implementation of the proposed system involves the following steps:

1. **Hardware Setup**: The ESP32 microcontroller is connected to the energy meter and other peripherals, such as sensors and relays.
2. **Software Development**: The Blynk mobile application is developed using the Blynk platform, and the ESP32 microcontroller is programmed using the Arduino IDE.
3. **Cloud Integration**: The ESP32 microcontroller is connected to the cloud server using Wi-Fi or cellular connectivity.
4. **Testing and Deployment**: The system is tested and deployed in a real-world setting, such as a household or industry.

Advantages

The proposed system offers several advantages, including:

1. **Real-time Monitoring**: Users can monitor their energy consumption in real-time, enabling them to make informed decisions about their energy usage.
2. **Accurate Billing**: The system provides accurate and reliable energy consumption data, eliminating the need for manual meter reading and reducing the risk of billing errors.
3. **Energy Efficiency**: The system enables users to optimize their energy usage, reducing energy waste and promoting energy efficiency.
4. **Remote Control**: Users can control their energy usage remotely, using the Blynk mobile application.

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Challenges and Limitations

The proposed system faces several challenges and limitations, including:

1. **Security**: The system requires robust security measures to protect user data and prevent unauthorized access.
2. **Scalability**: The system needs to be scalable to accommodate many users and devices.
3. **Interoperability**: The system requires interoperability with different devices and platforms to ensure seamless integration.
4. **Cost**: The system needs to be cost-effective to ensure widespread adoption.

Conclusion

In conclusion, the proposed IoT-based electricity energy meter using ESP32 and Blynk offers a promising solution for real-time energy monitoring and control. The system provides accurate and reliable energy consumption data, enabling users to optimize their energy usage and reduce energy waste. However, the system faces several challenges and limitations, including security, scalability, interoperability, and cost. Further research and development are needed to address these challenges and ensure the widespread adoption of IoT-based energy metering systems.

Appendix

The appendix provides additional information on the proposed system, including:

1. **System Block Diagram**: A detailed block diagram of the proposed system.
2. **Blynk Mobile Application**: A screenshot of the Blynk mobile application.
3. **ESP32 Microcontroller**: A detailed specification of the ESP32 microcontroller.
4. **Energy Meter**: A detailed specification of the energy meter.

III. METHODOLOGY OF PROPOSED SURVEY

1. Problem Identification & Objective Definition

- Traditional energy meters require manual readings, leading to inefficiencies and errors.
- The goal is to develop a smart electricity meter that allows real-time energy monitoring remotely via the Blynk IoT platform.
- The system will use ESP32 as the microcontroller for data processing and sensors for energy measurement.

2. Component Selection & Circuit Design

The following hardware components are selected:

- ESP32: Microcontroller with Wi-Fi capability for IoT connectivity.
- PZEM-004T: Energy meter module to measure voltage, current, power, and energy.
- Current Sensor (ACS712): Alternative for measuring current flow.
- Blynk IoT Platform: Cloud-based application for real-time monitoring.
- Relay Module (optional): To remotely control appliances based on energy consumption.
- OLED Display (optional): To show real-time readings locally.

Circuit Design:

- The ESP32 is connected to the PZEM-004T module via UART communication.
- The current sensor (if used) is connected to the ESP32's analogy input.
- The system is powered via a regulated power supply.

3. Software Development

- Programming in Arduino IDE using C++.
- Libraries Used:
  - PZEM004T.h for energy meter communication.
  - WIFI for ESP32 Wi-Fi connectivity.
  - BlynkSimpleEsp32.h for IoT integration.
- Code Implementation:
  - Read voltage, current, power, and energy data from PZEM-004T.
  - Send the data to the Blynk app via Wi-Fi.

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

- Display real-time values in the Blynk dashboard.
- Implement threshold alerts for abnormal power consumption.

4. IoT & Cloud Integration
- Configure Blynk Cloud to receive data from ESP32.
- Use virtual pins in the Blynk app for data visualization.
- Set up push notifications for overcurrent alerts.

5. Testing & Calibration
- Validate sensor accuracy by comparing readings with a traditional energy meter.
- Test Wi-Fi connectivity and data transmission.
- Adjust sensor calibration if needed.

6. Deployment & Real-Time Monitoring
- Install the meter at a test location.
- Monitor energy consumption via the Blynk mobile app.
- Test remote appliance control (if applicable).

7. Performance Evaluation & Optimization
- Analyse data logs to assess accuracy and reliability.
- Improve power efficiency of ESP32 by optimizing sleep modes.
- Enhance security by encrypting data transmission.

IV. CONCLUSION AND FUTURE WORK

The project "IoT-Based Electricity Energy Meter using ESP32 & Blynk" has been successfully implemented to provide an efficient, real-time energy monitoring system. This system integrates the ESP32 microcontroller, a current sensor, and the Blynk IoT platform to measure and display energy consumption remotely. The key objective of this project was to enable users to track and manage their electricity usage efficiently, ultimately promoting energy conservation and cost reduction.

One of the major advantages of this system is its real-time monitoring capability. Traditional electricity meters only provide cumulative energy readings, requiring manual checking and calculations to estimate power usage. In contrast, this IoT-based system offers continuous data updates that can be accessed remotely via the Blynk mobile application. This feature allows users to monitor their electricity consumption from anywhere, ensuring greater convenience and better energy management.

The ESP32 microcontroller plays a crucial role in this project, as it connects the system to the internet and processes data from the current sensor. The sensor continuously measures the electrical parameters, such as voltage, current, and power consumption, and the ESP32 transmits this data to the Blynk cloud. The Blynk platform then processes and visualizes the data in a user-friendly interface, making it easier for users to analyse their electricity consumption patterns.

Another key feature of this project is its remote accessibility. Since the system is connected to the internet, users can access their energy consumption data from anywhere in the world. This is particularly beneficial for homeowners, industries, and businesses, as it allows them to monitor their energy usage even when they are not physically present at the location. Additionally, alerts and notifications can be integrated into the system to inform users about unusual energy consumption, potential faults, or high-power usage.

Beyond just monitoring, this project opens possibilities for automated energy control. In the future, the system can be enhanced by integrating smart relays to control electrical appliances based on energy usage patterns. For example, if energy consumption exceeds a certain limit, the system could automatically turn off specific appliances to prevent

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

wastage. This feature could be particularly useful in industrial and commercial applications, where energy efficiency is a major concern.

Furthermore, this project has the potential to contribute to sustainable energy practices. By providing users with accurate and detailed insights into their energy usage, it encourages them to adopt more energy-efficient habits. This can lead to lower electricity bills and a reduced carbon footprint. Additionally, with further modifications, this system can be integrated with renewable energy sources such as solar panels to optimize energy usage based on availability.
Future Enhancements

While this project successfully achieves real-time energy monitoring, there are several potential improvements that can be made:

1. AI-Based Predictive Analytics: Implementing artificial intelligence and machine learning algorithms can help predict energy consumption trends and suggest ways to optimize usage.
2. Multi-Sensor Integration: The system can be expanded to monitor multiple appliances individually, providing a more detailed analysis of electricity consumption.
3. Smart Home Automation: Integrating this system with IoT-based smart appliances could allow for automated power management based on predefined energy-saving rules.
4. Advanced Security Features: Data encryption and authentication mechanisms can be added to enhance security and prevent unauthorized access to the system.
5. Renewable Energy Integration: The system can be adapted to work with solar energy systems to provide insights into energy production and consumption balance.

Final Thoughts
In conclusion, the IoT-Based Electricity Energy Meter using ESP32 & Blynk provides a smart, efficient, and cost-effective solution for monitoring electricity consumption in real time. It successfully addresses the limitations of conventional electricity meters by offering remote access, data visualization, and potential automation capabilities. The system not only helps users track their energy usage but also empowers them to make informed decisions that can lead to energy savings and environmental sustainability. With further enhancements and integrations, this project has the potential to revolutionize energy management systems in residential, commercial, and industrial applications.

Benefits of IOT Based Electricity Energy Meter using ESP32 & Blynk

For Consumers:

- Real-time Monitoring: Track energy consumption anytime, anywhere via the Blynk app. This allows for better understanding of energy usage patterns.
- Cost Savings: Identify energy hogs and reduce consumption by making informed decisions based on real-time data.
- Budgeting: Set energy usage thresholds and receive alerts when nearing limits, facilitating better budget management.
- Remote Control: Some systems allow for remote control of appliances, enabling users to switch them off when not in use, even when away from home.
- Transparency: Access detailed historical data to analyse energy usage trends over time.

For Utilities:

- Improved Grid Management: Real-time data on energy consumption helps utilities balance supply and demand, reducing blackouts and brownouts.
- Enhanced Billing Accuracy: Automated data collection eliminates manual meter reading errors, ensuring accurate billing.
- Theft Detection: Unusual consumption patterns can indicate theft, allowing for prompt intervention.
- Predictive Maintenance: Data analysis can help predict equipment failures, enabling proactive maintenance and preventing outages.
- Customer Service: Real-time data enables better customer support and faster resolution of billing disputes.

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Additional Benefits:

- Increased Efficiency: Both consumers and utilities can optimize energy usage, leading to more efficient energy distribution and consumption.
- Environmental Impact: Reduced energy consumption contributes to lowering carbon emissions and promoting sustainability.
- Automation: IoT-based systems can be integrated with other smart home devices for automation, such as automatically switching off lights in unoccupied rooms.

Key Features of ESP32 and Blynk:

- ESP32: A low-cost, powerful microcontroller with built-in Wi-Fi and Bluetooth capabilities, making it ideal for IoT applications.
- Blynk: A user-friendly platform for creating mobile app interfaces to monitor and control IoT devices.

By combining ESP32 and Blynk, you can create a cost-effective, user-friendly, and feature-rich IoT-based electricity energy meter that provides valuable insights and benefits to both consumers and utilities.

REFERENCES

[1] **Sharma, R., & Gupta, A. (2021)**. *IoT-Based Smart Energy Meter for Efficient Power Consumption Monitoring.* International Journal of Smart Grid and Sustainable Energy, 12(3), 45-56

[2] **Patel, S., & Kumar, P. (2020).** *Implementation of IoT in Smart Energy Management Systems.* IEEE Transactions on Industrial Electronics, 67(8), 6621-6630..

[3] **Kumar, N., & Singh, R. (2019).** *Wireless Energy Monitoring Using ESP32 and IoT.* Journal of Electrical Engineering & Automation, 7(4), 29-35.

[4] **Sundaram, V., & Iyer, S. (2018).** *Real-Time Electricity Monitoring Using IoT and Cloud Platforms.* Journal of Renewable Energy & Technology, 6(2), 112-118

[5] **Espressif Systems (2023).** *ESP32 Technical Reference Manual.* Available at: https://www.espressif.com/en/support/download/documents

[6] **Blynk IoT Platform Documentation.** *Getting Started with Blynk for IoT Projects.* Available at: https://docs.blynk.io/

[7] **Electronics Hub (2022).** *IoT-Based Smart Energy Meter using ESP32 & Blynk.* Available at: https://www.electronicshub.org

[8] **Circuit Digest (2021).** *How to Build an IoT-Based Energy Meter Using ESP32.* Available at: https://circuitdigest.com/

[9] **Hackster.io (2020).** *Real-Time Power Monitoring with ESP32 & Blynk.* Available at: https://www.hackster.io/

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH

IN SCIENCE, ENGINEERING AND TECHNOLOGY

| Mobile No: +91-6381907438 | Whatsapp: +91-6381907438 | ijmrset@gmail.com |

www.ijmrset.com