IJMRT: Volume (8), Issue 1, 2026, Pages 14-24
International Journal of Multidisciplinary Research Transactions
(A Peer Reviewed Journal)
www.ijmrt.in
I SSN (Print):2663-2381
ISSN(Online):2663-4007
| Regular Article | Open Acess
Aravandi Publications

Smart Energy Meter Using Telegram BOT

Navaneetha Krishnan L*[1], Sukisivam T[2], Dr. Shanmugavalli M[3]

[1,]Student, Department of Instrumentation and Control Engineering, Saranathan College of Engineering, Tamil Nadu, India.
[2]Student, Department of Instrumentation and Control Engineering, Saranathan College of Engineering, Tamil Nadu, India.
[3]Professor, Department of Instrumentation and Control Engineering, Saranathan College of Engineering, Tamil Nadu, India.

Corresponding author(s):
DoI: https://doi.org/10.5281/10.5281/zenodo.18309302
Navaneetha Krishnan L, Student, Department of Instrumentation and Control Engineering, Saranathan College of Engineering, Tamil Nadu, India.
Email: krishnan232005@gmail.com

Citation:

Navaneetha Krishnan L, Sukisivam T, Dr. Shanmugavalli M (2026). Smart Energy Meter Using Telegram BOT. International Journal of Multidisciplinary Research Transactions, 8(1), 14–24. https://doi.org/10.5281/10.5281/zenodo.18309302

Accepted: 19 January 2026 Available online: 20 January 2026

Abstract

Increasing demand for electrical energy and efficient utilization of energy have led to the development of intelligent metering systems. This paper, therefore, presents the design and implementation of a smart energy meter based on an ESP32 microcontroller integrated with current and voltage sensors for real-time measurement of electrical parameters. This proposed system continuously monitors voltage, current, power, and energy consumption and transmits the data wirelessly using Wi-Fi. Measured parameters are visualized through the Blynk IoT platform, allowing their remote monitoring and analysis through a smartphone interface. Besides, this incorporated Telegram bot issues instant notifications, alerts, and on-demand energy usage information under different user-defined commands. This approach provides various access to user without the use of specialized hardware devices. Hence the smart energy meter is a low-cost, scalable and reliable output for residential and small commercial energy monitoring and cost utilization for the required applications. This increases energy consumption cost and energy utilization awareness, hence enabling cost reduction and proper utilization of power to meet the required cost control.

Keywords: Smart Energy Meter, Telegram, BOT, Energy Utilization.

1. Introduction

Traditional energy meters have limited functionality because they are not automatic in reading, do not have the capability for real-time monitoring, and are incapable of data analysis. These factors make it difficult for consumers to understand their electrical energy usage and for the implementation of efficient management of the same. Internet of Things (IoT) has been identified as a vital enabler for next generation energy networks since it makes it possible for physical devices to communicate, monitor, and exchange data through the internet. Smart energy meters based on IoT technology are going to make conventional energy meters more effective by allowing real-time measurement of electrical variables such as voltage, current, power, and energy. The IoT technology enables users to check and control data from anywhere in the world using a cellphone or computer through a web browser. This project created a wireless-powered smart electric meter that is powered by a microcontroller (Esp32) and utilized sensors to measure voltage and current. The Esp32 microcontroller offers the following benefits in the area of measuring energy: it operates on low voltage and consumes very little power, and has the capability to provide high-speed processing. A graphical depiction of the data received from the electric meter is sent over wireless channels via the Blynk IoT app, which provides a simple and easy-to-use graphical interface for monitoring and analyzing energy consumption. A Telegram bot can also be used with this system to provide real-time notification about your energy consumption and provide you with access to data whenever you'd like. This system will help provide low-cost, efficient ways to monitor energy use in residential and small business settings. By constantly monitoring energy use and sending alerts, this system is intended to help improve awareness of energy usage and develop smart management systems.

Recent research in smart energy metering systems has focused on the integration of IoT technologies to surpass the drawbacks of traditional meters. The traditional meters rely on manually collected data and lack real-time monitoring; as such, they allow for poor efficiency management and lower user awareness. Different works have proposed IoT-based smart energy meters using the microcontrollers Arduino, Raspberry Pi, and ESP32 integrated with voltage and current sensors. Various researchers have demonstrated that ESP32-based systems provide reliable real-time monitoring due to the presence of Wi-Fi connectivity inside and very low power consumption. Data visualization and remote access via cloud platforms using Blynk and web dashboards have also been applied. Some have incorporated theft detection and abnormal consumption analysis in their attempts, with a view towards energy security and power losses reduction. Alert mechanisms, making use of SMS or email notifications, have also been reported in literature to improve responsiveness by the user. However, the majority of the existing systems make use of a single monitoring system with limited user interaction. The concept of implementing instant messaging apps for energy monitoring and alerts has still not been thoroughly investigated. The proposed system works on the objective to make use of the Blynk system and the Telegram Bot to enable real-time monitoring, immediate alerts, and on-demand energy consumption data.

2. Layered Architecture Of Smart Energy Meter

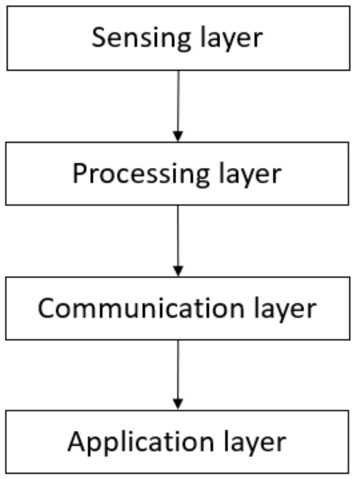

Figure.1. Layer architecture of smart energy meter

2.1. Sensing Layer

The role of the sensing layer is to sense the electrical parameters from the load or power supply line. This is achieved by a voltage sensor and current sensor module integrated with the electrical system. Voltage Sensor calculates the reading of the line voltage by either a voltage divider sensor or an isolation sensor. Current Sensor senses the value in the form of a current transformer, calculates the load current without making any physical contact with the powers supply wires. These sensors produce analog output reading based on proportion to voltage and current that the load or device consumed.

2.2. Processing Layer

The processing layer is equipped with a microcontroller, the microcontroller used is ESP32.

Key functions include:

- Analog-to-Digital Convertor (ADC)
- RMS Voltage and Current
- Energy Consumption (kWh)

2.3. Communication Layer

The communication layer allows transfer of data to remote areas using IoT connectivity. The microcontroller unit adopts Wi-Fi technology transmit processed data to the cloud server. APIs are utilized in the communication layer to ensure efficient and secured data transfer. Data packets carry voltage, current, power, and energy values. This layer makes remote meter reading unnecessary because continuous monitoring is made possible.

2.4. Cloud and Application Layer

The cloud layer stores and analysis the received energy data.

2.4.1. Key components

- Cloud database for historical data storage
- Data analytics engine for usage trend analysis
- Visualization dashboard accessible via mobile or web applications

2.5. Overall System Operation

1. Real-time measurement of electrical properties is done using voltage and current sensors.
2. The microcontroller is able to process raw signals as well as calculate the related energy.
3. The calculated data is then wireless connected to the cloud server.
4. Users are able to access data in real time as well as historical data through the mobile or web interface.
5. Alerts or analytics functionality helps optimize energy usage.

3. Technical And Implementations Of Smart Energy Meter

The design of the smart energy metering system was conducted using the ESP32 microcontroller with the inclusion of voltage and current sensors for the measurement of electrical parameters. The data was processed using the ESP32 to determine the voltage, current, power, power factor, and energy consumptions. The processed information was transmitted to the Blynk cloud platform using Wi-Fi connectivity. At the same time, a Telegram Bot was developed using the Telegram Bot API with the inclusion of secure authentication using the access token. Customizable commands were developed to receive real-time data, status, and energy consumptions using Telegram. To provide solutions for smart energy meters, the system continually extracts and transmits data to our customers and provides a seamless communication experience for customers who want to have their questions answered instantly and efficiently. By using cloud-based technology, we are able to eliminate any variability in the data acquisition and communication processes associated with smart energy metering, providing the most cost-effective and effective solutions. The system employs Telegram as a communication medium between the customers and the system. A Telegram bot has been built into the system, which allows the customer to receive instant messages from the system, thus enhancing customer satisfaction and generating customer loyalty through immediate gratification. It uses Telegram's Bot API to provide instant messaging and an authentication token has been integrated into the ESP32 firmware, which will allow secure data transfer. Predefined commands have been added to the system; this allows the customer to query the real-time values of voltage, current, power, total energy, and system status via the bot. Upon receipt of these commands, the ESP32 will send back the requested information via a Telegram message. The continuous command-driven automation of the system will allow the customer to have real-time access to their system without delay, providing the customer with peace of mind. This design will create a low-cost, scalable, and effective smart energy metering experience.

4. Telegram BOT Creation

Telegram is a messaging application and web service offering an open and secure bot application programming interface (API), creating telegram bot using Bot Father appropriate for notification/ monitoring energy consumption information. In the smart energy metering system, a Telegram bot is created for distant access to the energy usage information as well as immediate notification to the user. The bot is developed using the Telegram BotFather service are showed in (fig 1.1 & 1.2) provide by telegram application, that service provides a unique authorization token for a secure communication link between the ESP32 controller board and Telegram application/webpage. The authorization token is integrated into the ESP32 by the embedded c program to provide a communication between the ESP32 board and the Telegram Bot API in the HTTPS request. Finally, the bot enables the user to control the smart energy meter by utilizing the predefined commands.

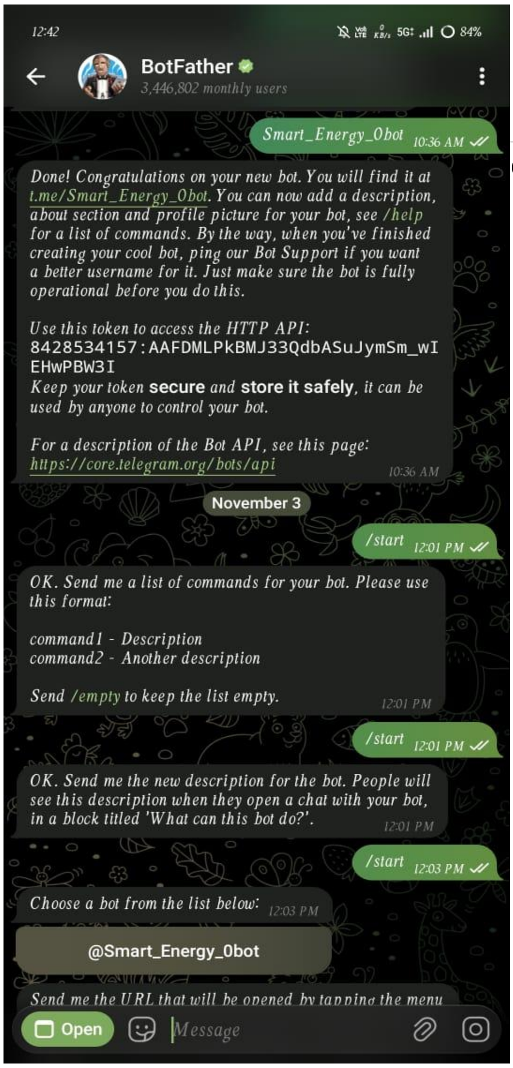

Figure.1.1. Features of BOT **Figure. 1.2. User name for BOT**

Inclusion of Telegram services upgrades the usability of the system as it enables instant notification services, alerts for irregular consumption, as well as monitoring services at the customer's request. The use of Telegram services as an interface is much cheaper compared to traditional monitoring services.

5. Telegram Integration

The flowchart below shows the sequence of operations of the Telegram bot integrated with the smart energy meter system. The process starts with installing the Telegram application on the smartphone of the user. Following this, the user looks for and opens the BotFather service to create a new Telegram bot and then name it uniquely. If creation is successful, BotFather issues an authentication token.

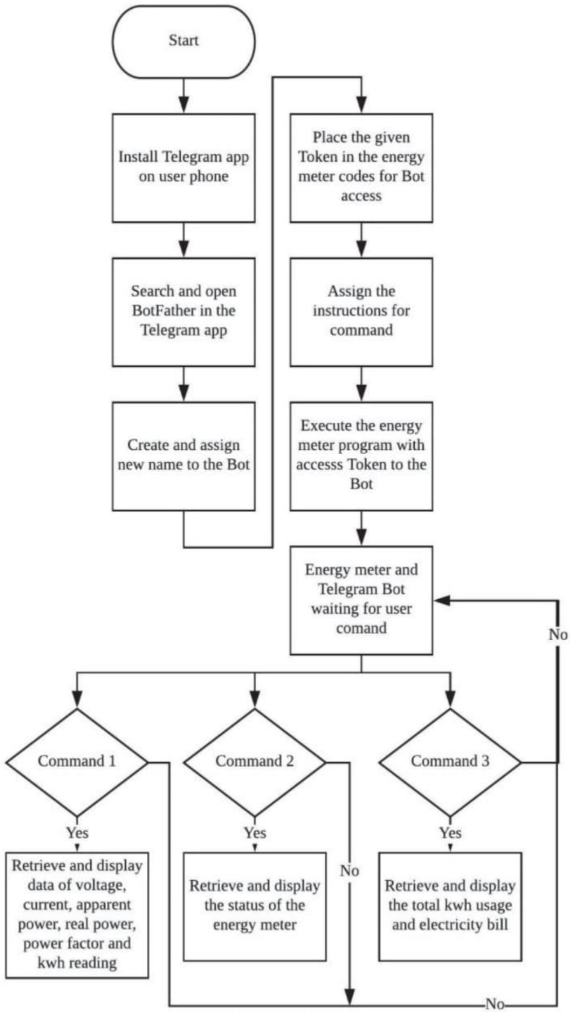

Figure.2. Flowchart of the program code

This token is integrated with the ESP32-based energy meter firmware in order to have secure communication between the energy meter and the Telegram Bot API. Then, after setting up the token, predefined instructions and commands are set up for the bot. After that, the program of the energy meter starts running with enabling access to the bot. The smart energy meter and the Telegram bot keep the system in running mode and waits for the commands through the user. Once the command is received, the system verifies the command type. In case of Command 1, it retrieves the electrical parameters like voltage, current, apparent power, real power, power factor, and energy consumption in kWh. If Command 2 is received, then the operation status of energy meter is returned. In case of selection of Command 3, system calculates and shows the total energy consumption along with the estimated electricity bill. It goes back, after the execution of the requested operation is performed by the system in a continuous real-time interaction and monitoring.

6. Hardware Implementation

All the hardware components and specification, process are explained below and represented in the fig 3.

6.1. Current Sensor (CT):

The conductor carrying the load current is passed through the opening of the CT, where the magnetic field produced by the current induces a proportional secondary current in the transformer winding. In this sensor, the rated specification of 100A/50mA indicates that when a primary current of 100 A flows through the conductor, a secondary current of 50 mA is generated at the output. This low-level current signal is then supplied to an energy metering module, such as the PZEM004T, where it is converted into usable electrical parameters like current, power, and energy consumption.

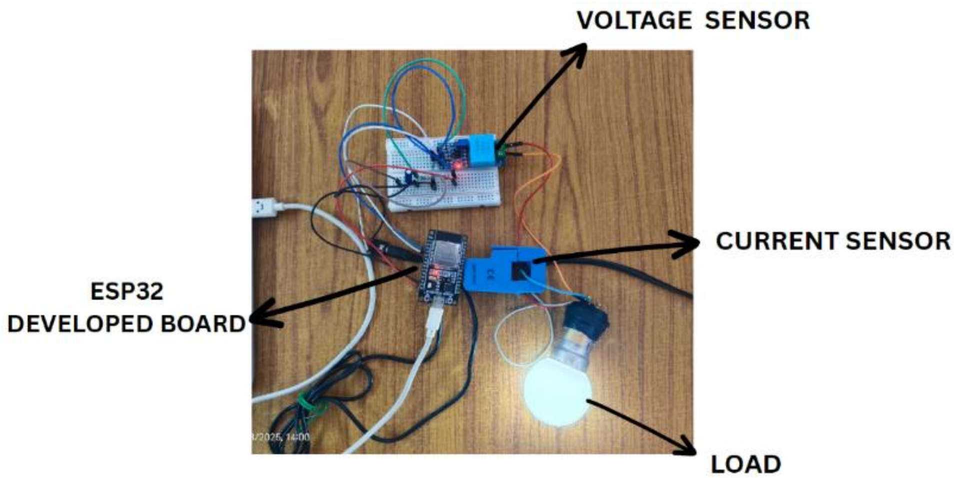

Figure.3. Components

6.2. Voltage Sensor

The ZMPT101B AC Voltage Sensor is a module that can be used to safely detect high-voltage AC mains by a microcontroller. It uses a precision transformer to detect the voltage, thereby offering a safe interface from high voltages to low voltages, thereby safeguarding your circuit from dangerous spikes. It steps down high voltages to a lower-level signal so that you can adjust this signal using a built-in potentiometer to suit the requirements of a circuit like Arduino to detect real-time voltages.

6.3. ESP32 Developer Board

The ESP32 is an advanced microcontroller with a dual-core processor and in-built Wi-Fi and Bluetooth connectivity. This makes it ideal for real-time data acquisition and wireless communication. The ESP32 receives electric parameter data of voltage, current, power, and energy from the energy metering sensor module. It processes this parameter data and formats it for display and transmission. The ESP32 uses its in-built Wi-Fi connectivity feature and transmits processed energy consumption data from the microcontroller to a cloud-based online monitoring system known as Blynk.

6.4. Load

Load is anyone of electrical device or equipment that consumes electrical energy for the power supply, such as tungsten lamp (for demo), in industrial level like blowers, fans, coolers, pumps etc.

7. Result

The cost calculations are performed by the embedded c program with the pre-defined formula and with the measured inputs of current and voltage values. The calculated are notified through the telegram application once the bot has been activated. The pictorial represent of notification is attached in fig 4.

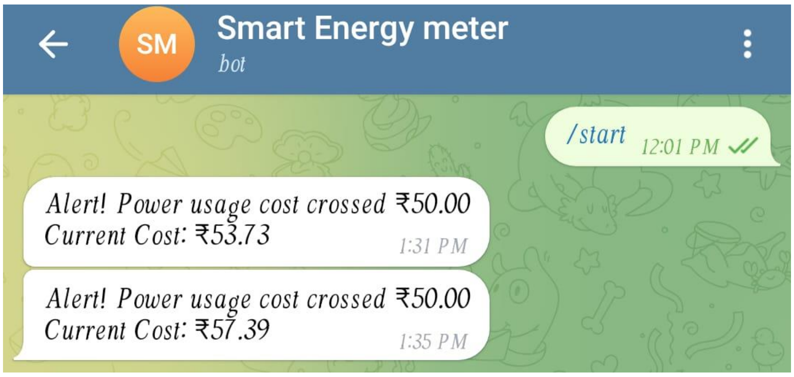

Figure.4. Telegram notification

The developed smart energy meter functioned perfectly for the real-time observation of electric measurements such as voltage, current, power, power factor, and energy consumption. The ESP32 chip enabled the transmission of the readings to the Blynk IoT cloud at a scheduled interval, reflecting the readings on the mobile application with satisfactory precision. There was immediate response from the Telegram bot to any commands, reflecting real-time readings of energy, the status of the energy meter, as well as the total consumption of energy measured in kWh. Hence the overall figure representation in fig 5.

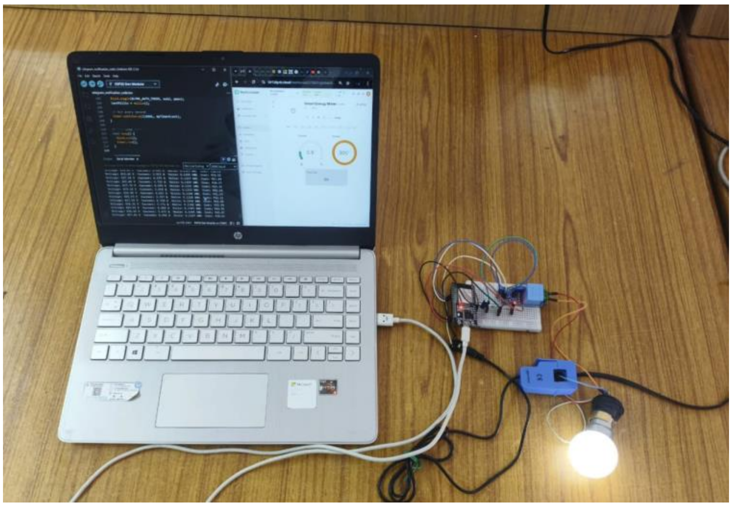

Figure.5. Overall setup of smart energy meter

8. Conclusion

This paper has described the design and development of a smart energy meter based on the IoT, with the ESP32 microcontroller, along with the integration of voltage and current sensors. This proposed method allows for uninterrupted measurements of the electric values such as voltage, current, power, as well as energy consumption, with a wireless data transfer mechanism enabled via Wi-Fi. Additionally, the integration of the Blynk app allows for easy viewing, along with the Telegram bot, which offers easy access to the energy consumption data.

The proposed systems make for a low-cost and scalable solution for residential and small business sectors. With the help of the smart energy meter, the system aims to develop an effective energy usages solution by raising user awareness and providing facilities for the remote reading of consumption. Future research areas with the smart energy meter can concentrate on the connectivity to the utility companies for enhancing the scalability of the proposed solution.

Acknowledgement
The authors have no acknowledgements to declare.

Funding
This study has not received any funding from any institution/agency.

Conflict of Interest/Competing Interests
No conflict of interest.

Data Availability
The raw data supporting the findings of this research paper will be made available by the authors upon a reasonable request.

REFERENCES

[1]. Ajinkya Valanjoo, Priyesh Chiplunkar, Sheryl Bellary, Sheetal Dixit, Soham Jadiye, Sarthak Bansod (2024), AI-Based Smart Home Energy Meter, International Research Journal of Engineering and Technology (IRJET), (Volume: 11 Issue: 04).

[2]. Md. Masudur Rahman; Noor-E-Jannat; Mohd. Ohidul Islam; Md. SerazusSalakin, Arduino® and GSM Based Smart Energy Meter for Advanced Metering and Billing System, Pabna University of Science & Technology, 2nd Int'l Conf. on Electrical Engineering and Information & Communication Technology (ICEEICT) 2015.

[3]. Chongjin Xie, Fiber Nonlinearities in Coherent Optial Communication Systems, 10th International Conference on Optical Communications and Networks (ICOCN 2011).

[4]. Patel H. K., D. Shah, M. Sheth, S. Trivedi, S.Bakliwal, I. Shah, R. Shrotriya, "Microcontroller and GSM Based Digital Prepaid Energy Meter", International Journal of Electronics, Computer and Communications Technologies (IJECCT), Vol. 4, Issue 1, pp 32-37, Oct.2013,ISSN(P): 2180-3536,ISSN(O):2180-3706, Malaysia.

[5]. Shreyash Gawande, R. M. Gharat (2023), Smart Energy Meter using IoT, International Journal of Advanced Research in Science, Communication and Technology (IJARSCT), DOI: 10.48175/IJARSCT-13502.

[6]. Noor Nateq Alfaisaly, Suhad Qasim Naeem, Eman K. Jassim, Adnan Ali Abdullah, Study on Smart Designed Power Monitoring System Using IoT Devices, International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169 Volume: 11 Issue: 10, October 2023.

[7]. M Senthamil Selvan, Dr R Ramesh, H Ragadeepa, T Sivabalan, Iot enabled Smart Energy meter for energy management, 2023 International Conference in Advances in Power, Signal, and Information Technology.

[8]. Kasireddy, Idamakanti, and Kasi Ramakrishnareddy Ch." An efficient selective harmonic based full bridge DC-DC converter for LED lighting applications." 2019 National Power Electronics Conference (NPEC). IEEE, 2019.