International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Smart Energy Meter for Data Reading and Energy Monitoring System

Vaibhav V. Khandare

Assistant Professor, Electronics & Computer Engineering, Sharad Institute of Technology College of Engineering, Yadrav, Maharashrta, India

ABSTRACT:

The field of energy monitoring and management has undergone a transformation through the Internet of Things (IoT) technology's integration into smart energy meters. The Smart Energy Meter system, which uses the Internet of Things to read data and monitor energy use. This system's architecture calls for the installation of smart energy meters with IoT-capable communication and sensor modules. These meters gather wirelessly transmitted real-time energy consumption data and send it to cloud- based system. This configuration makes it possible to remotely monitor, analyze, and dynamically control energy consumption patterns. These meters make proactive demand management, predictive maintenance, and efficient load balancing across the grid possible for utility companies. Block chain integration may also improve data security and transparency in energy transactional processes .

Keywords: -Smart Energy Meter, IoT, GSM module, Microcontroller ESP32, energy monitoring, architecture, real-time data, remote monitoring, data security, privacy, interoperability, machine learning, artificial intelligence, block chain, grid optimization.

I. INTRODUCTION

A revolutionary method of energy management and monitoring has emerged: the incorporation of Internet of Things (IoT) technologies into Smart Energy Meters. With the goal of developing a more sophisticated and effective energy consumption monitoring system, this project sets out to investigate and realize the potential of combining these two cutting-edge technologies.

The advanced or digital meters, commonly referred to as smart energy meters, mark a substantial shift from conventional energy monitoring tools. These meters surpass their conventional counterparts by providing real-time insights into energy usage trends thanks to their digital intelligence and communication capabilities. The Internet of Things, on the other hand, refers to a system of linked gadgets that are equipped with sensors, communication interfaces, and data processing capabilities. These technologies' convergence offers a tremendous chance to change the energy monitoring environment.

Designing and implementing an IoT-enabled Smart Energy Meter system that collects real-time data on energy consumption and gives consumers useful insights is the main goal of this project. This system intends to enable customers to make knowledgeable decisions about their energy usage while helping utility providers to optimize energy distribution and management by utilizing the power of IoT connectivity.

The symbiotic interaction between IoT and Smart Energy Meters underpins the suggested system's architecture. Sensors in these smart energy meters can measure energy factors including voltage, current, and power usage. The acquired data is subsequently sent to centralized repositories or cloud-based platforms for additional analysis using wireless communication protocols like Wi-Fi or cellular networks.

The IoT-enabled Smart Energy Meter system has two main functions. It first gives customers current information on their patterns of energy consumption. Users are now able to monitor their usage with a level of detail that was previously not possible thanks to this level of visibility. Second, the system provides utility providers with a wealth of data for managing grid stability, demand optimization, and predictive maintenance.

Both customers and utility companies stand to gain greatly from the combination of IoT technology and smart energy meters. The real-time data analytics give users an unmatched level of insight into their energy usage. This awareness acts as a motivator for sensible choices and energy-saving behaviors, which ultimately results in less waste and maybe cheaper energy costs. Additionally ,users can evaluate how their energy use is affected by changes in behavior or the use of appliances, encouraging more thoughtful energy use.

Additionally, utility firms stand to benefit greatly from this connection. Smart energy meters with IoT connectivity offer a method for effective demand management. Utility providers can adopt demand response tactics during periods of high usage by continuously monitoring energy use. This helps to reduce excessive demand and grid stress. Furthermore, the system's capacity to anticipate maintenance needs through data analysis enables utility providers to take proactive measures before problems worsen and cause interruptions.

II. LITERATURE REVIEW

A total of 622,900 smart meters were installed by the large energy suppliers in the second quarter of 2016 (268,300 gas and 354,600 electricity meters). This represents a 15 per cent increase in smart meter installations compared to the previous quarter (15 per cent increase for gas smart meters and 16 per cent increase for electricity smart meters). It should be noted, an additional large supplier has been included for the first time in this quarterly series, as their customer base now exceeds 250,0009[1].Single phase or three phase digital electric meter can be used with indigenously developed add on transmission module, which takes the meter reading and utilizes the GSM network to transmit the energy usage reading using Short Message Service (SMS) back to the energy supplier.[2]

Lower transmit power is an advantage and can decrease the chance of multipath propagation and it's eliminating the Doppler Effect . LoRa is characterized by three parameters Spreading Factor (SF), Bandwidth (BW) and Coding Rate (CR) . Represents the number of chirps in one bit.[7]

III. BLOCKDIAGRAMAND COMPONENTS

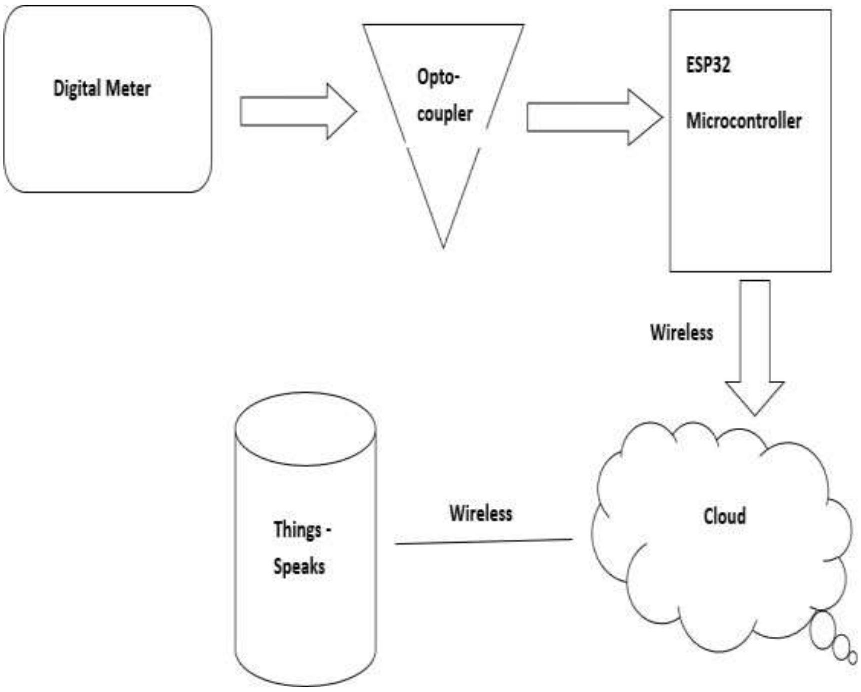

Fig1-Block Diagram

The smart energy meter for data reading and energy monitoring system is shown in the block diagram below. The primary five units in the block diagram are those used for base station data monitoring and data computation.

The digital meter, which is now installed in the user's home, is the first component of the system or block diagram. The voltage and current across the load will be used to calculate the data or consumption of use in this unit. The current transformer will be used to determine the current, and the voltage sensor will be used to calculate the voltage. The energy will be calculated in KWH on the digital meter.

The Optocoupler, a sort of device that is actuated by light, is the following block. The meter detects and sends the data to the controller if it detects a pulse.

The focal point of this project is the controller. In this case, the pulse from the digital meter is calculated or counted using the ESP32 microcontroller. The Wi-Fiin theESP32isbuilt-in. Compute the reading in the ESP32 first, then transfer it to the cloud.

The data handling software is the final component of this. The final section contains all of the user data. In doing so, we compute the invoice and transform the information into the Excel format.

A. Components For the System

• Digital Energy Meter

• Opto-Coupler

• ESP32Microcontroller

• Wi-Fi Router

• Thing Speak Software

IV. WORKING

This project's primary components are an optocoupler and an ESP32 microcontroller. The digital meter that is currently installed in our home must be able to measure the voltage across the load, measure the current using a current transformer (CT) across the load, and calculate the power using the formula below.

Power=Current x Voltage(KW)………(1)

Power is multiplied by time to determine the energy used by that user because this power is used by the load for a specific amount of time. Thus, the formula appears below.

Energy=Σ(Power xTime) (KWH)·········(2)

The total power in a certain amount of time is called the energy. In accordance with that, an energy meter has calculated the energy.

There is one pulse-generating LED included in the digital meter. This LED or pulse is produced following each use of one KWH. To send an LED or pulse to the microcontroller, we connect the optocoupler to the digital meter. An electrical device called an optocoupler is powered by light. The optocoupler receives the pulse that is generated by the digital meter. An optocoupler is made up of a photo resistor on one side that detects light and a light-emitting diode (LED) on the transmit or pulse side. The optocoupler's LED becomes active when the meter pulses. LED light strikes a photoresistive diode. The voltage or current is produced by the photo resistive diode, which detects light. The microcontroller is receiving this voltage or current.

The ESP32 microprocessor determines how many blinks or pulses the optocoupler will receive, and then uses that information to calculate the user's consumption. The Internet of Things (IoT) is used to move all of the microcontroller's data to the cloud. Utilise the ThingSpeak website, which was made with MATLAB. Multiple user data can be obtained at the same station in the form of text, graphs, gauges, and other displays. Depending on which graph the data will appear in, we can create a different graph for each user. Thus, for invoicing purposes, we also arrange the data or export it all to an Excel sheet. One API key is generated in ThingSpeak. The ESP32 programme dumps this API key, allowing the utility center's billing or controlling department to access all the data. A certain user is granted access to the data by the power board. The consumer is therefore aware of how much energy they utilise.

V. RESULTS

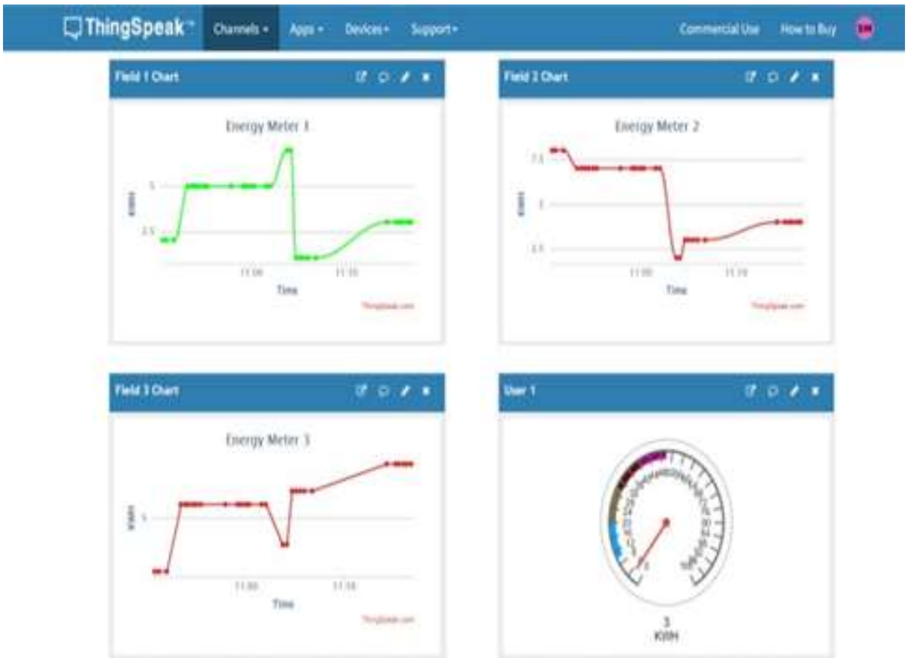

Fig2-DatastoredinThingSpeak

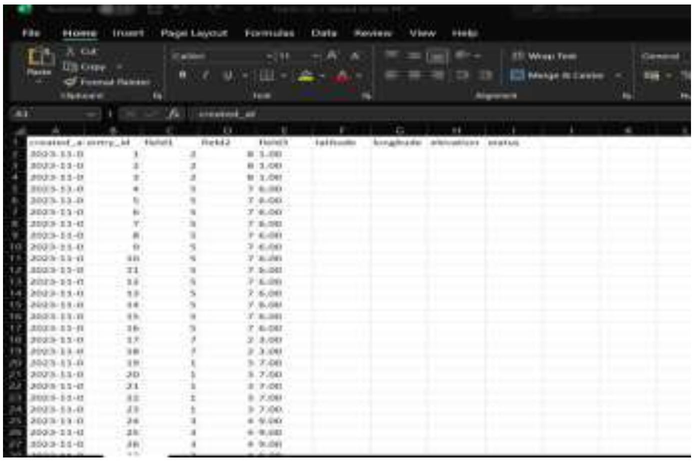

Fig3-DataStoredinExcel

VI. CONCLUSION

In conclusion, the adoption of smart energy meters represents a revolution in the field of energy management. These meters provide many benefits, including improved billing accuracy, remote reading for ease of data collecting, and real- time energy monitoring. Time-of-use pricing incentives consumers to exercise caution in their energy consumption, while load management features contribute to system stability. Smart meters are notable for preventing energy theft and manipulation, which safeguards utility revenue. Utility firms can also use the abundance of data that is produced to improve grid operation, react quickly to power outages, and lower emissions in order to support environmental sustainability. This increased consciousness encourages energy- efficient behavior and makes possible connection with home automation systems possible. Because of their built-in scalability, smart meters are flexible and well-positioned to spur ongoing innovation in the ever-changing energy industry.

REFERRENCES

1. Department for Business Energy and Industrial Strategy, "Smart Meters, Quarterly Report to end December 2016, Great Britain," Tech. Rep., 2017

2. Adnan Rashdi, R. Malik, S. Rashid, A. Ajmal, S. Sadiq , "Remote Energy Monitoring, Profiling and ControlThrough GSM Network" , International Conference on Innovations in Information Technology (IIT) 2012

3. Bacco, M. et al.: Smart farming: opportunities, challenges and technology enablers.In:2018IoTVerticalandTopical Summit on Agriculture-Tuscany (IOT Tuscany),pp.1–6(2018)3.Hur,H.:Chirp spread spectrum-based indoor localization (2009)

4. Fusko, M. et al.: The importance of digitization and innovations for small and medium-sized enterprises. Proc. CBU Econ. Bus. 2, 32–40 (2021)

5. Abbasi, M., Khorasanian, S., Yaghmaee, M.H.: Low-power wide area network (LPWAN) for smart grid: an in-depth study on LoRaWAN. In: 2019 5th Conference on Knowledge Based Engineering and Innovation (KBEI). IEEE (2019)

6. Grübel, J. et al.: Dense indoor sensor networks: towards passively sensing human presence with LORAWAN. Pervasive Mob. Comput. 84, 101640 (2022)

7. Raychowdhury, A., Pramanik, A.: Survey on LoRa technology: solution for internet of things. In: Intelligent Systems, Technologies and Applications, pp.259– 271 (2020)