International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Smart Energy Monitoring & Appliance Control Using IOT Server & GSM Network

Shripad Kshreesagar[1], Aryan Baghele[2], Ankit Manekar[3], Rohit Selokar[4]

[1]Assistant Professor, Department of Electrical Engineering, Kavikulguru institute of Technology and science, Ramtek, Maharashtra India.
[2,3,4]B. Tech Scholar, Department of Electrical Engineering, Kavikulguru institute of Technology and science, Ramtek, Maharashtra India.

Abstract
This research includes a novel approach for energy management combining the Internet of Things (IoT) technology with Global System for Mobile Communication (GSM). Our system comes with both the capabilities i.e. real time monitoring as well as the remote-control capabilities, revolutionizing that how energy is consumed in both residential and industrial settings. The key components are the digital energy meters, IoT sensors and a GSM module creating a unified network for a smooth communication. This system enables the user to monitor usage, receive alerts or threshold limits and optimize energy efficiency easily. Due to which the user can take the precise decisions to reduce their energy consumption as well as reducing the environmental impact. This research not only promises to transform energy management but also nurtures a sustainable and cost-effective future.

Keywords: IoT, GSM, real time monitoring, remote controlling, environmental impact, cost-effective future etc.

1. INTRODUCTION

The growing demand for efficient energy management solutions in both residential and industrial sectors has spurred the development of innovative technologies aimed at monitoring energy consumption and optimizing resource utilization. In this context, the integration of Internet of Things (IoT) technology and the Global System for Mobile Communications (GSM) network offers a promising avenue for creating intelligent systems capable of real-time energy monitoring and appliance control. The aim of this project is to design and implement a Smart Energy Monitoring and Appliance Control System utilizing IoT and GSM technology.

This system enables users to remotely monitor energy usage, control appliances, and gain insights into power consumption patterns, thereby facilitating informed decision-making and promoting energy efficiency.

The project revolves around the central concept of utilizing IoT devices and sensors to collect data on energy consumption and appliance usage, which is then communicated to a central server for processing and analysis. The incorporation of GSM technology enables seamless communication between the system and users' mobile devices, allowing for remote control and monitoring capabilities from anywhere with cellular network coverage. At the heart of the system lies the Raspberry Pi Pico W microcontroller, chosen for its versatility and capabilities, including Wi-Fi connectivity and UART

communication. This serves as the main controller, orchestrating the interactions between various components of the system and facilitatingcommunication with the central server.

Key components utilized in the system include the GSM module SIM800C for communication, the PZEM module for energy monitoring, power supply SMPS module, DC-DC buck converter for voltage regulation, ACS712 current sensor for load monitoring, and relays for appliance control. Each component plays a crucial role in enabling the functionalities of the system, from data acquisition to load control. By providing users with real-time insights into energy consumption and enabling remote appliance control, the proposed system aims to empower individuals and organizations to make informed decisions regarding their energy usage.

2. Problem Formulation

The current landscape of energy management faces several challenges. Traditional methods lack detailed data on energy consumption at the individual load level, making it difficult for users to identify inefficiencies and opportunities for optimization. Additionally, the absence of remote appliance control limits users' ability to respond to changing energy needs and can result in unnecessary energy wastage. Existing systems also suffer from limited accessibility and usability, hindering their effectiveness, particularly in environments with varied technical expertise. These challenges underscore the need for a comprehensive energy monitoring and appliance control system that offers real-time insights, remote accessibility, and user-friendly interfaces. By addressing these issues, such a system can empower users to make informed decisions and optimize energy usage effectively.In this project, we aim to design and implement a Smart Energy Monitoring and Appliance Control System using IoT and GSM technology to tackle these challenges head-on. Through the integration of IoT devices and the GSM network, our goal is to provide users with real-time energy monitoring, remote appliance control, and actionable insights into energy usage patterns, contributing to the advancement of energy-efficient technologies and sustainable energy management practices

3. Objective

In response to the growing demand for efficient energy management solutions, this project aims to develop a comprehensive Smart Energy Monitoring and Appliance Control System. The main objectives of the project are:

- To develop a system for real-time energy monitoring of individual loads.
- To enable remote control of appliances using the GSM network.
- To provide users with insights into energy usage patterns.
- To ensure the reliability, scalability, and security of the system.

These objectives will guide the design and implementation process, ensuring that the system meets the requirements of users and addresses the challenges associated with energy management effectively.

4. Literature survey

Naziya Sultana, K B Shiva Kumar Proposed “Smart energy metering and monitoring system using IoT”. This system describes that efficient energy utilization is crucial for the development of smart grids in power systems. Traditional energy meter systems face challenges, such as lack of full duplex communication. To address this, a proposed solution utilizing Internet of Things (IoT) technology is presented. The smart energy meter incorporates PZEM module and Wi-Fi connectivity to monitor and

calculate energy consumption, enabling users to access readings remotely. This system enhances energy analysis, aids in detecting power theft, and promotes home automation through IoT, contributing to wireless communication advancements and the vision of Digital India. With IoT-based smart energy meters, users can conveniently monitor power consumption via LCD display or mobile/laptop devices, offering global accessibility and real-time insights.

Sandhya, Manoj Kumar Proposed "IoT Based Smart Energy Meter". This system describes that knowing which household electric appliance is consuming how much electricity is sometimes the key issue managing domestic power consumption. In this paper, design and analysis of a low-cost and easy to implement home electric appliance controlling and energy monitoring system is proposed. The proposed system is built based on Internet of Things (IoT) equipment and protocol. This will enable the user to monitor energy consumption of connected home appliances and control them via a mobile application. The proposed system consists of two major components: IoT hardware and user interface software for that hardware. The first part is the development of an IoT prototype device that would fit inside a traditional switchboard. This component contains the controlling hardware for electronic appliances, and a sensor to measure energy consumption. The prototype device has been constructed using Wi-Fi module, opto-isolated relays for communication and stability. The second part is a mobile application through which the user can control and monitor energy consumption for each home appliance. The proposed hardware and software package calculated energy consumption for a household with reliable accuracy while it was deployed for a month. Keeping users need in mind, real- time data visualization is made available through the mobile app. The app also provides historical data summary and temporal uses comparison as well as cross device power consumption comparison.

5. CONCEPT AND METHODOLOGY

A. Block Diagram

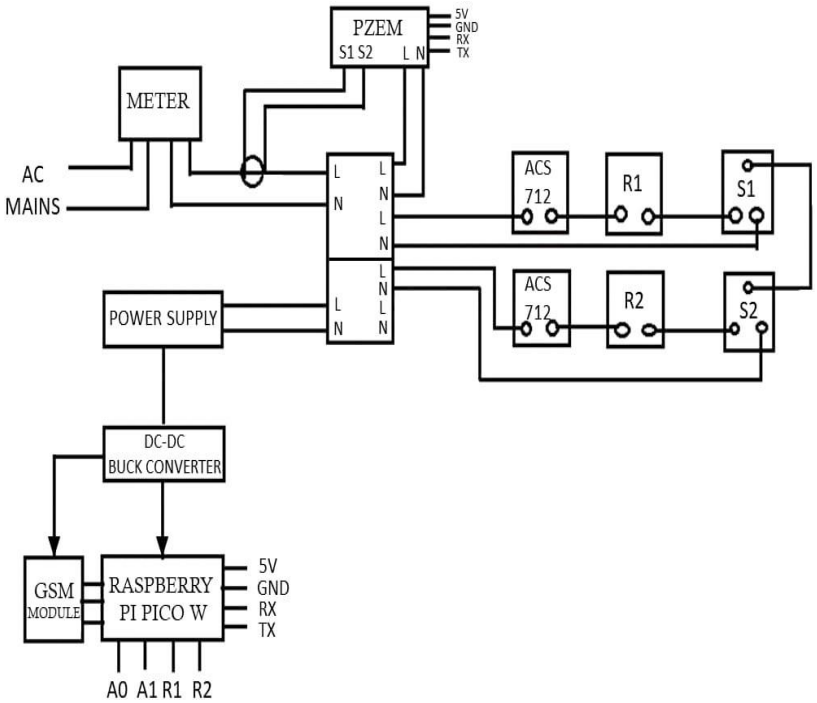


Fig.1. Block Diagram of system

B. Working of system

- We will set up the system as per shared circuit block diagram.
- PZEM module will read all the electrical parameters from AC mains and energy meter. The acquired data will be collected by Raspberry Pico W & processed.
- We will be using the two loads and for these two loads there will be separate current sensors and relay module.
- Using the relays and current sensors we will control & monitor the electrical loads and also calculate power consumption in real time.
- GSM module is also be used here to get the real time power consumption details for complete home as well as individual loads.
- This way we will acquire real time power consumption, unit cost of consumption & be aware of our usage daily.

Overall, the project aims to provide users with a comprehensive solution for smart energy monitoring and appliance control, empowering them to manage their energy usage efficiently and contribute to a more sustainable environment.

Fig.2. shows the connection diagram of our entire system having Raspberry Pi Pico W as the main controller as well as the PZEM Module, GSM Module, digital electric meter, SMPS module, Relays, Current sensors, socket, switches, current transformer etc.

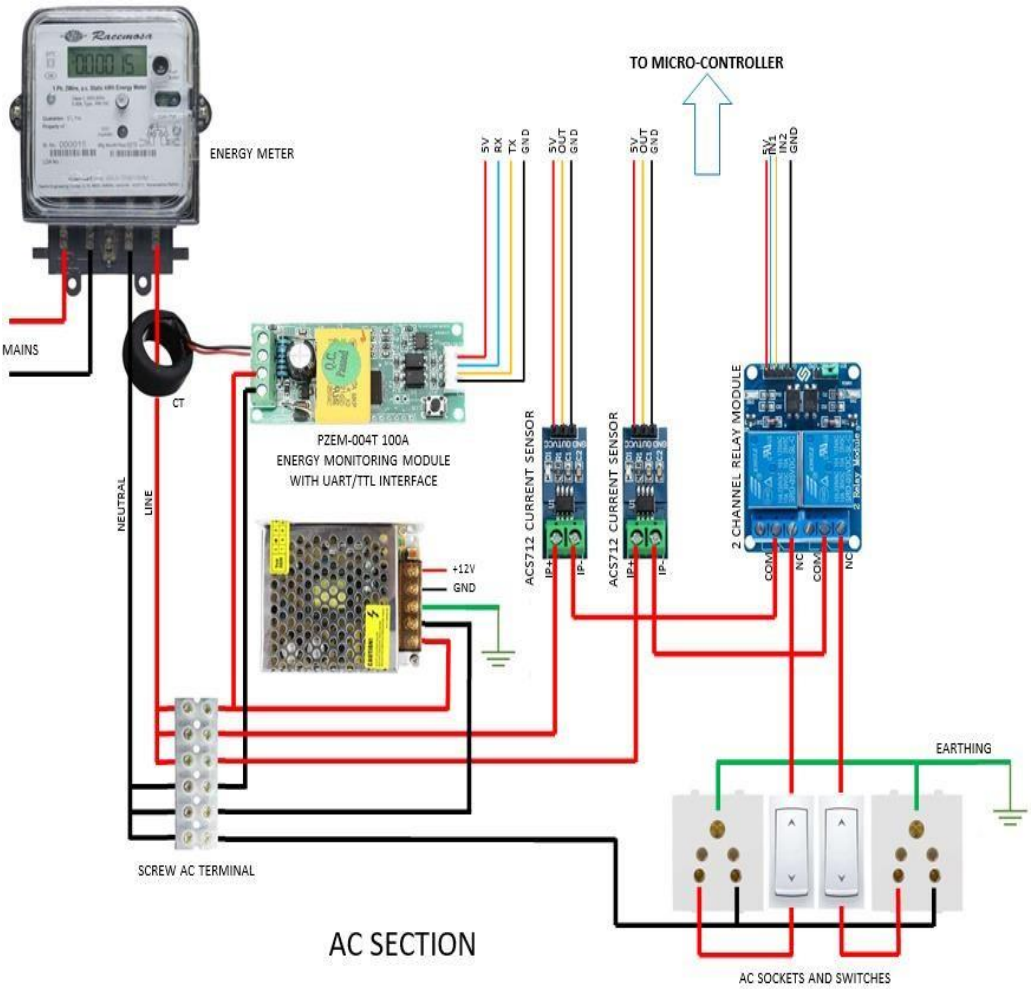


Fig.2. Connection Diagram Smart energy monitoring & appliance control using IoT server & GSM network.

6. COMPONENTS

In our proposed smart energy monitoring system, the block diagram encompasses various sensors including current and voltage sensors connected to a central controller. This central controller, in our case the Raspberry Pi Pico W microcontroller, gathers data from these sensors and processes it for transmission over the internet. The utilization of these sensors allows for comprehensive monitoring of energy consumption patterns and electrical parameters crucial for efficient energy management.

- Energy Monitoring Sensor (PZEM module)
- Current Sensor (ACS712)
- GSM Module (SIM800C)
- Wi-Fi Module
- Raspberry Pi Pico W Microcontroller
- Relay Modules (for appliance control)
- Power Supply (SMPS module)
- DC-DC Buck Converter (for voltage regulation)
- Others (such as resistors, capacitors, and connectors for circuit assembly)

7. RESULTS & DISCUSSION

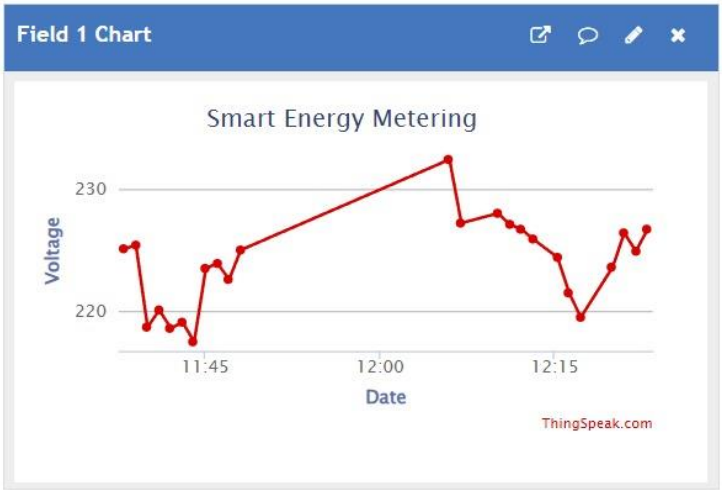
Following are the results of our project basically it contains the hardware setup also we have 8 graphs obtained from our IoT platform that are Voltage output, current output, power output, energy output, frequency output, power factor output, load current for load 1, load current for load 2.

Fig.3. Experimental Setup Image

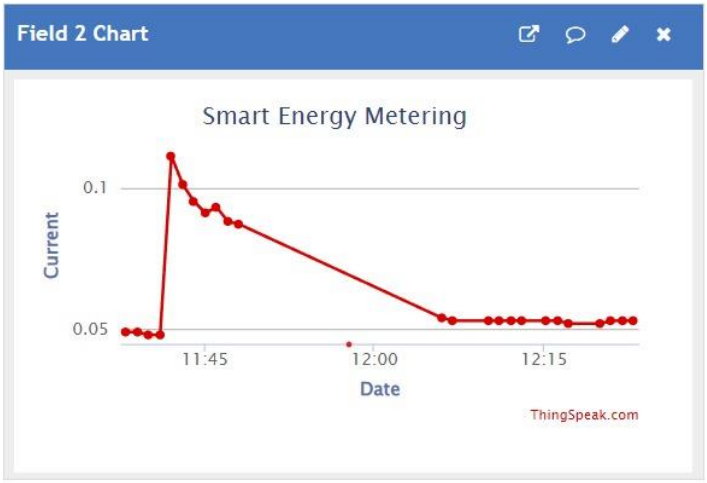
Results

The smart energy monitoring system enabled real-time monitoring and remote appliance control. It provided accurate insights into power usage and allowed users to control appliances remotely. The system effectively communicated with user's devices, ensuring precise measurement of energy consumption. Its user-friendly interface allowed for easy monitoring and control.

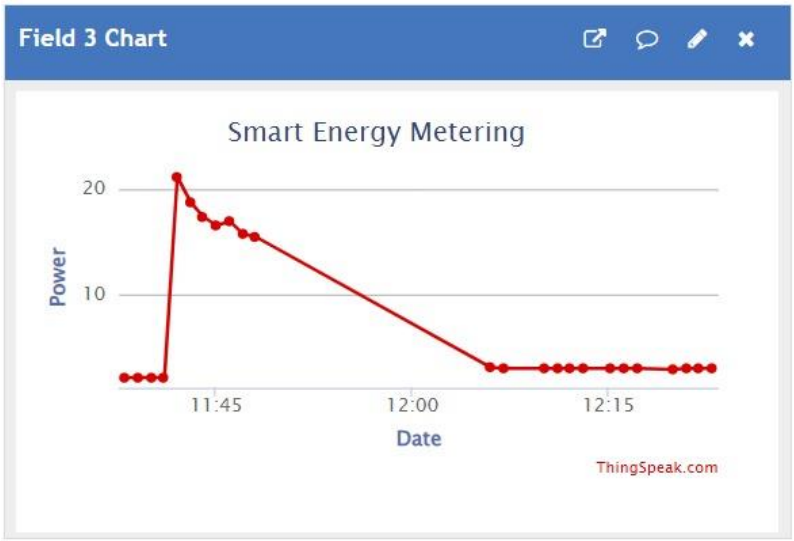
1. **Voltage output**



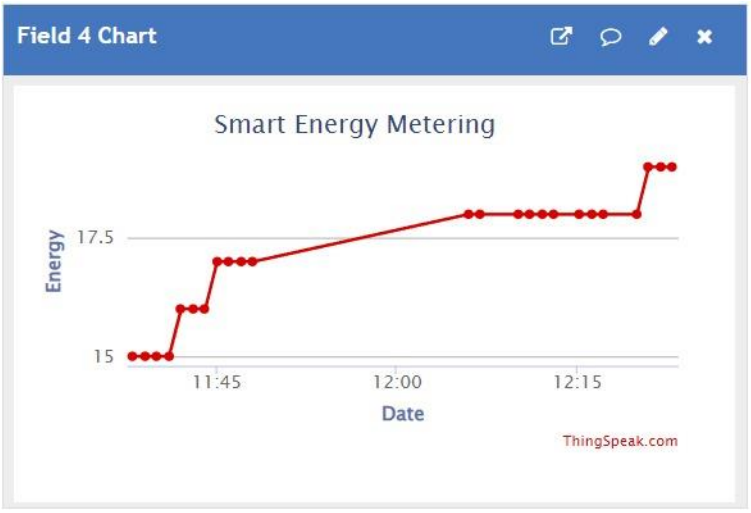
2. **Current output**



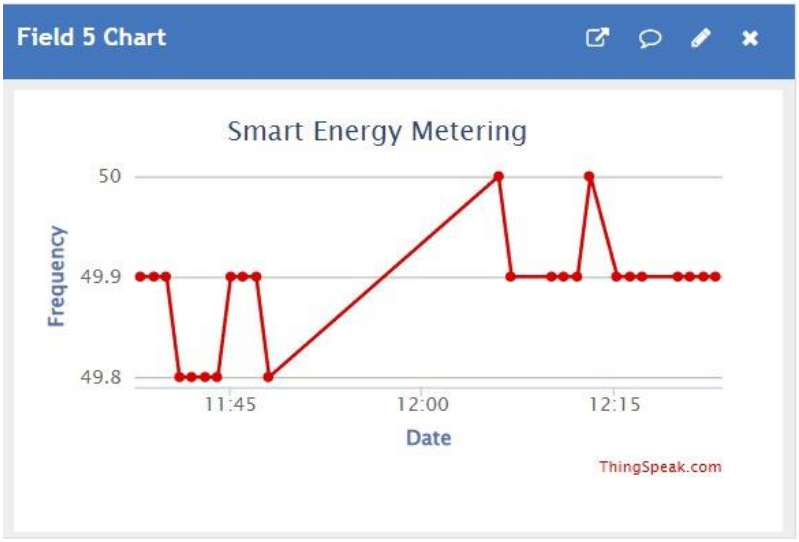
3. **Power output**



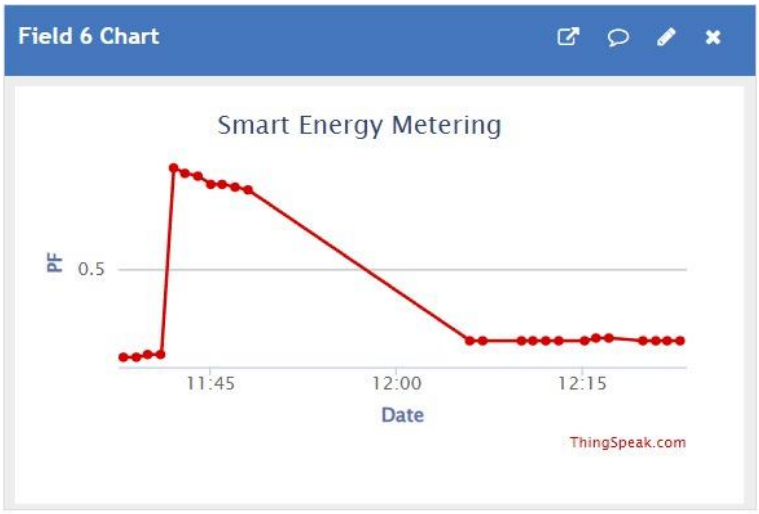
4. Energy output



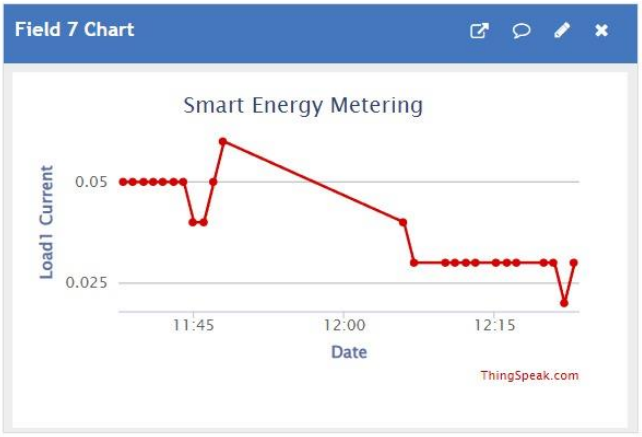
5. Frequency output



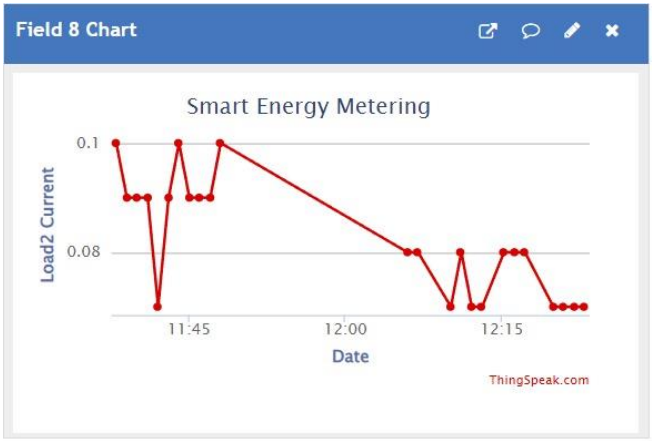
6. Power factor output



7. Output of load 1 current



8. Output of load 1 current



Discussion

The system's implementation shows promise for promoting energy efficiency and informed decision-making. Benefits include cost reduction, optimization opportunities, and enhanced user convenience. Its remote-control feature and seamless communication make it suitable for various applications, representing a significant advancement in energy management.

8. CONCLUSION

In conclusion, the Smart Energy Monitoring and Appliance Control System marks a significant advancement in energy management. Through real-time monitoring and remote-control capabilities, it offers users a comprehensive solution for optimizing energy usage. Implemented with various components like energy sensors and relay modules, the system provides valuable insights into consumption habits and offers newfound convenience. Positive user feedback confirms its effectiveness, though future enhancements could focus on compatibility and communication reliability. Overall, the system has the potential to revolutionize energy management, promoting efficiency and sustainability.

9. Future Scope

Exploring these avenues can extend the system's capabilities, enhancing its impact and relevance in diverse contexts.

- Smart Grid Integration: By integrating with smart grid technologies, the system can participate in demand response programs and optimize energy usage based on real-time pricing.
- Predictive Analytics: Incorporating machine learning algorithms can enable the system to forecast energy demands, offering proactive suggestions for energy optimization.
- Renewable Energy Integration: Further research into integrating renewable energy sources, such as solar or wind power, can augment the system's sustainability and resilience.
- Enhanced User Interfaces: Developing intuitive interfaces and the mobile phone applications can improve user interaction and engagement, fostering a more seamless experience in managing energy consumption.

ACKNOWLEDGMENT

We take this opportunity to express our profound gratitude and deep regards to Our Project Guide , Department of Electrical Engineering , KITS College of Engineering, Ramtek which provided guidance and space for us to complete this work.

REFERENCES

1. Antithssssa.k, prathik, “Smart Energy Meter surveillance Using IoT”, Institute of Electrical and Electronics Engineers (IEEE), 2019.
2. Mohammad Hossein Yaghmaee Design and Implementation of an Internet of Things Based Smart Energy Metering” 6th IEEE International Conference on Smart Energy Grid Engineering 2018.
3. R. Pereira, J. Figueiredo, R. Melicio, V.M.F. Mendes, J. Martins, J. C. Quadrado, “Consumer energy management system with integration of smart Meters”,Energy Reports, 2015 Md. Masudur Rahman; Noor-E-Jannat; Mohd. Ohidul Islam; Md. Serazus
4. Salakin, “Arduino and GSM Based Smart Energy Meter for Advanced Meteringand Billing System”, Int. Conf. on Electrical Engineering and Information & Communication Technology (ICEEICT), Jahangimagar University, Dhaka-I Bangladesh, pp. 1-6, 2015.
5. “Bibek Kanti Barman, et.al” proposed paper “smart meter using IoT” department. of international electronics and electrical engineering (IEEE) 2017.
6. Himanshu Patel “Arduino based smart energy meter” 2nd Int'l Conf. on Electrical Engineering and Information &Communication Technology (ICEEICT) 2018.