Journal of Energy Environment & Carbon Credits (JOEECC)

ISSN: 2249-8621

Volume-14

Issue-1

Year-2024

Research Article

Date of Receive- 27th April 2024

Date of Acceptance- 1st May 2024

Date of Publication- 15th May 2024

ENERGY MANAGEMENT SYSTEM WITH HOME AUTOMATION

Hisham Abbas*1, Ajaz N S[2], Hisham Abbas[3], Nandhu Jayaram[4], Thara s[5] , Tensy Thomas[6]

[1,2,3,4,5]Student, Department of Electronics & Communication Engineering, Bishop Jerome Institute, South Kollam, Karunagappally
[6]Assistant Professor, Department of Electronics & Communication Engineering, Bishop Jerome Institute, South Kollam, Karunagappally

Corresponding mail- hishamabbas17.04.2002@gmail.com

Abstract

The surge in population and industrial activity is leading to higher energy consumption rates daily, yet there's a shortage of expertise in monitoring and managing this usage. Traditional energy meters used in homes are offline and necessitate manual readings, which can be addressed through the adoption of smart energy meters. Proposed as an IoT-based solution, these meters enable users to access readings globally, providing detailed information on voltage, current, power, frequency, and energy usage, facilitating precise load control. Each room is equipped with a Passive Infrared (PIR) sensor to aid load control. This IoT-driven solution offers consumers enhanced control over their energy consumption through accurate load control, user-friendly interfaces, remote monitoring, and customizable tariff options. By promoting sustainable energy practices and leveraging automation and advanced technology, it addresses challenges arising from escalating energy demands. Additionally, users can tailor tariffs based on their income, facilitated by the system. The system employs PZEM-004T sensors to measure parameters, with data transmitted to the server via Node MCU, and users can operate it through online and mobile applications.

Keywords: *EMS, Home Automation, Wireless control, Smart system, Peak load management.*

INTRODUCTION

Access to electricity is indispensable for human survival, serving critical functions in agriculture, industry, and households. However, the existing electricity metering system is time-consuming. Smart energy meters, leveraging IoT technology, offer a solution to various challenges such as power theft, load control, energy monitoring, and reducing manpower. Unlike conventional meters, smart meters enable two-way communication, swiftly monitoring and providing real-time data access to users. They also detect power interruptions and relay such information to users. Smart meters are distinguished by their ability to measure multiple parameters, eliminating the need for additional components to collect readings. Utilizing IoT, they facilitate remote load switching. This article proposes a system utilizing PIR sensors, relays, NodeMCU, and PZEM-004T sensor modules to monitor and regulate home energy usage, aiming to optimize usage and prevent excessive bills. Integration of IoT enhances data collection speed and accuracy, enabling seamless device connectivity and user-friendly interfaces. This technology signifies a significant advancement in sustainable energy management, empowering users with real-time insights to make informed decisions [1-5]. The presented home automation system employs a multi-agent paradigm, where each agent corresponds to a power resource or equipment, collaborating to achieve efficient solutions. The PZEM-004T module measures various parameters, with NodeMCU transmitting data to the server. A PIR sensor detects occupancy, while the relay controls room power supply based on NodeMCU data. Real-time monitoring and manual relay operation are possible through Android or web applications [7-10].

PROPOSED SYSTEM

Electricity is the cornerstone of our modern world, impacting virtually every aspect of our lives. With increasing power consumption across all sectors, there's a growing emphasis on leveraging technologies like IoT, smart meters, sensors, and microcontrollers to automate appliances, prevent power theft, and regulate voltages [3].

Despite these advancements, little attention has been paid to the significant energy costs we currently face. Often, power bills exceed monthly budgets, prompting the need for effective monitoring and regulation systems. The proposed solution addresses this challenge by utilizing sensors and relays to manage loads according to selected monthly tariffs. Users have the flexibility to choose tariffs based on their budget constraints and adjust them as needed, ensuring energy efficiency while reducing unnecessary expenses [4].

In essence, the proposed system aims to provide a user-friendly platform for real-time energy monitoring. Data collected by electronic devices is transmitted to the server via NodeMCU, facilitating efficient management of energy usage.

THE IoT WE USE

We utilize ThingSpeak IoT to retrieve data from our Energy Management System (EMS), which monitors real-time energy usage and voltage, as depicted in Figure 1. The dashboard displays a list of devices, allowing users to view data and charts through the interface, as illustrated in Figure 2. The usage data is updated every 10 seconds, and it can be further utilized by our system to calculate the current electricity cost by adding it to the previous value. ThingSpeak is an IoT analytics service that enables the aggregation, visualization, and analysis of live data streams in the cloud. It supports data transmission from any internet-connected device via Rest API or MQTT. Moreover, cloud-to-cloud integrations with The Things Network, Senet, Libelium Meshlium gateway, and Particle.io allow sensor data to be transmitted to ThingSpeak over LoRaWAN® and 4G/3G cellular connections.

IMPLEMENTATION

ThingSpeak, an open-source Internet of Things platform, empowers users to collect, analyze, and visualize data in real-time from diverse sensors and devices. Its cloud-based architecture provides an ideal environment for IoT projects, research, and applications, offering storage, analysis, and sharing capabilities for sensor data. Figure 1 illustrates the interface of ThingSpeak, while Figure 2 displays a graph plotting energy parameters against time.

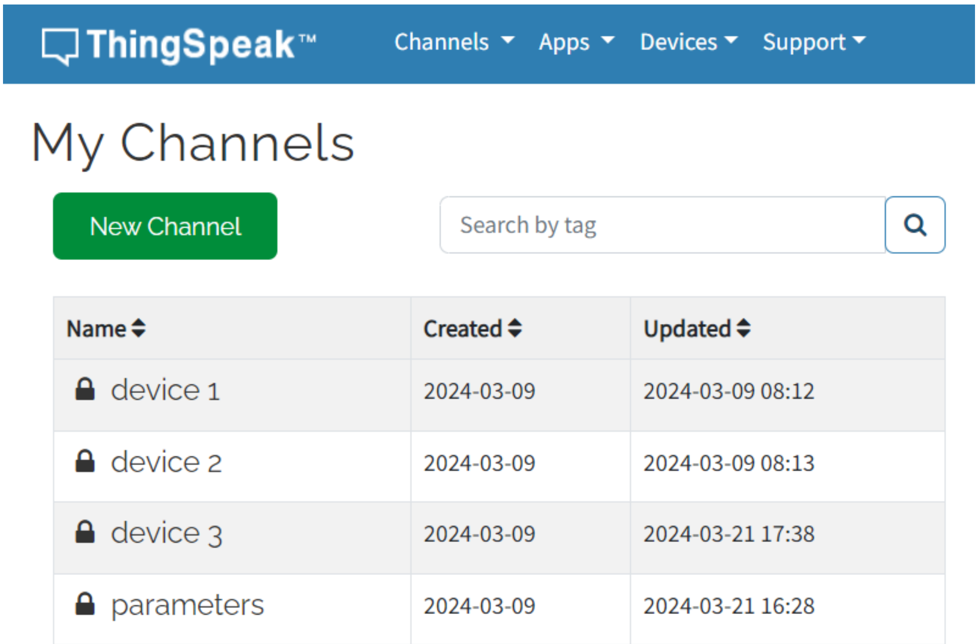

Fig. 1: *Interface of Thingspeak.*

The change can be noticed in the graph and the scheduling has reduced the overall load usage by adjusting the load.

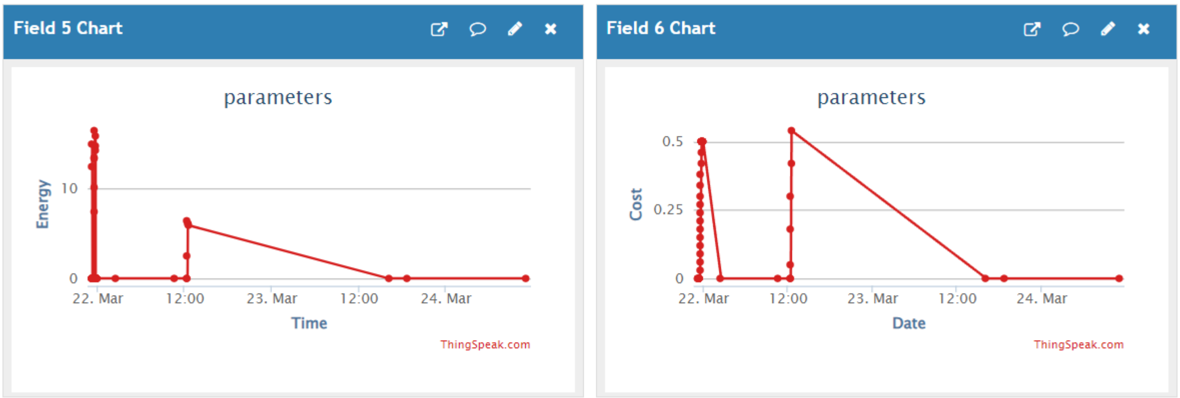

Fig.2: *Thingspeak server result*

FINAL SYSTEM

The entire Energy Management System (EMS) can be accommodated within a switchboard or its cavity, as depicted in Figure 3. This setup eliminates the need for physical switches in the switchboard, as all control functions are managed through the relays in the EMS. The accompanying mobile app, illustrated in Figure 4, provides real-time data such as current voltage, energy usage, and total cost in rupees. Additionally, the app offers options to toggle devices on and off, along with a priority mode that restricts the energy consumption of devices based on user-defined settings [6].

***Fig.3**: The system in a switchboard.*

The thinkspeak readings of the devices is shown in figure 4.It provides the details of the varous device readings of power consuption, Energy(KWh),and xost of consuption in this user interface.

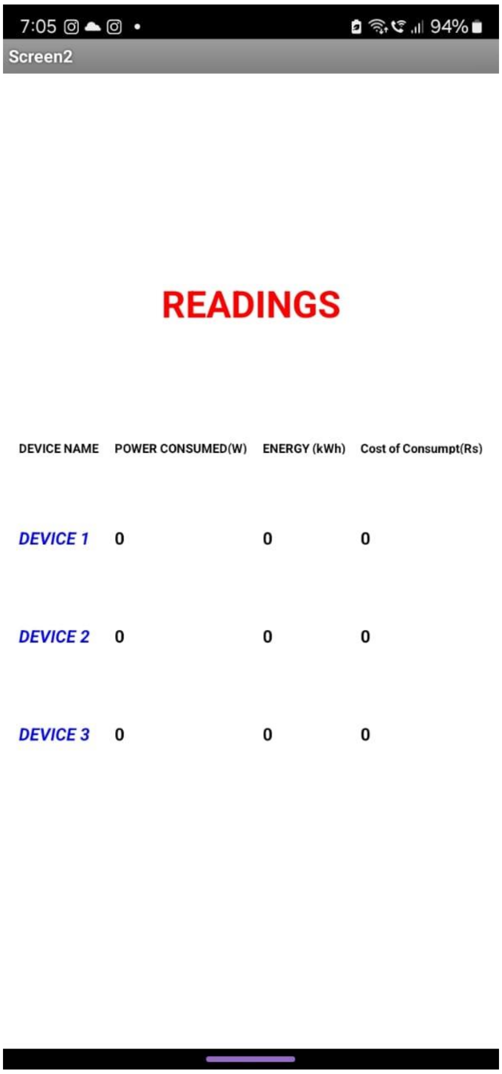

Fig.4: Thinkspeak reading results of the devices

WORKING AND COMPONENTS

The fundamental concept behind our energy management system is to restrict overall load usage and deactivate unnecessary loads when they are not required, especially during peak hours. This is the primary reason for implementing WiFi control, enabling users to manage and toggle devices remotely from any location, provided they are within WiFi or cellular network coverage.

The components we used here are:

Pzem-004t: The PZEM-004T is a widely used electrical parameter measurement module renowned for its versatility. Designed to assess various electrical characteristics within a circuit, including voltage, current, power, energy consumption, and frequency, it serves as the equipment we employ to gauge the voltage and current drawn by a device.

Node MCU: The NodeMCU, built upon the ESP8266 WiFi module, forms the core of an open-source firmware and development board. Tailored for Internet of Things (IoT) applications, it facilitates the swift and straightforward creation of WiFi-enabled devices. The integration of the ESP8266 module with a USB-to-serial converter in the NodeMCU development board streamlines programming and code uploading processes, enabling seamless network connectivity, device control, and data transmission to our IoT platform in this article [7].

SMPS: The power supply necessary to operate the MCU and Arduino, along with the required relays and meters, is known as a Switched-Mode Power Supply (SMPS). This type of power supply efficiently converts electrical power from one form to another by rapidly switching the input voltage on and off. SMPSs are frequently utilized in electronic devices and equipment, particularly where efficiency, weight, and size are critical factors.

PIR sensor:

The sensor used is an infrared motion sensor, which detects movement within an area and sends a signal. We utilize this signal to activate lights in the vicinity, thereby conserving energy by turning off lights when the room is unoccupied. A specific type of motion sensor capable of detecting changes in infrared radiation within its field of vision is the Passive Infrared (PIR) sensor. It operates on the principle that any object warmer than absolute zero emits infrared radiation.

Dth11: This sensor aids in monitoring and regulating room temperature to a desired level, consequently reducing the need for prolonged use of fans and air conditioning. The DHT11, a widely used digital temperature and humidity sensor in both residential and commercial settings, is cost-effective and popular. Its reliability, affordability, and ease of use contribute to its widespread adoption. The sensor's compact design with four pins makes it simple to incorporate into electronic circuits. The overall system design layout is depicted in Figure 5.

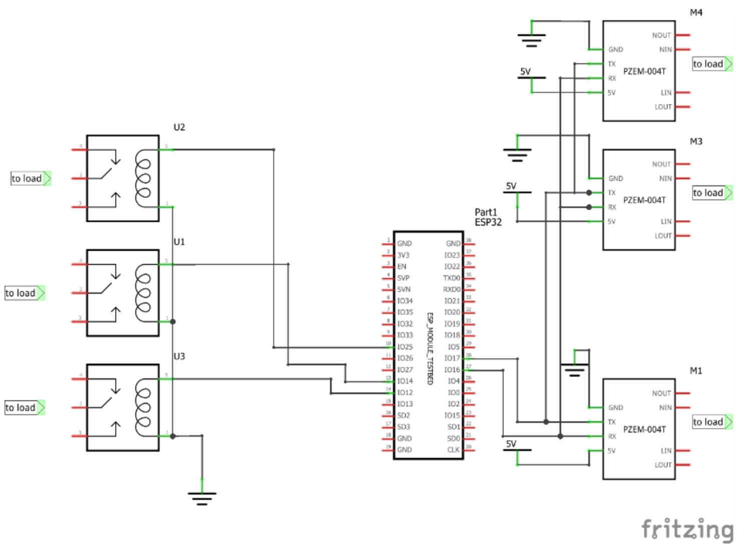

Fig.5: System Design Layout

We conducted a test using our system, and the results indicate a significant difference between the performance before and after implementing our load scheduling. Figures 6 and 7 illustrate the outcomes of the test. It's important to note that the same equipment was utilized in both scenarios.

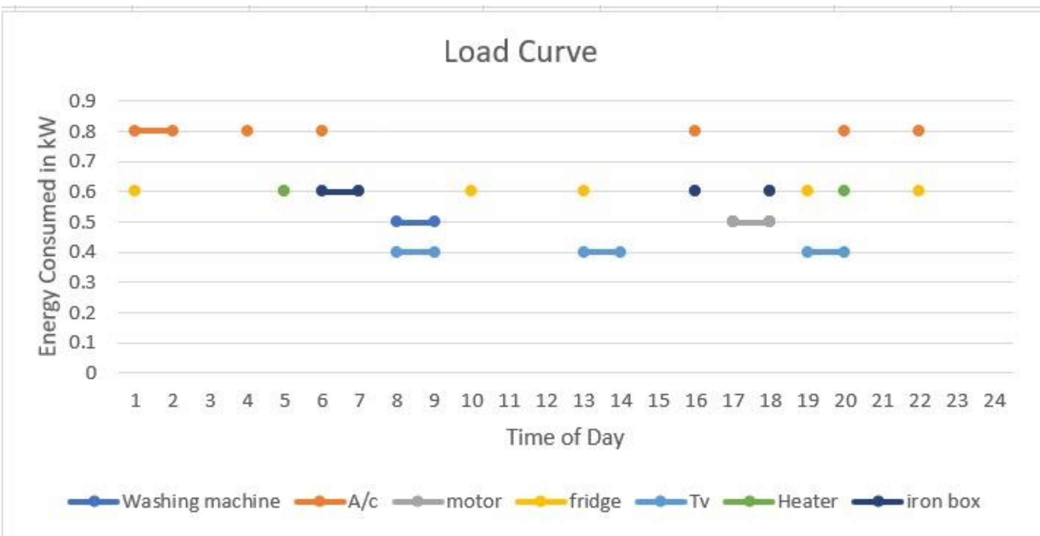

Fig.6: Control chart before implementation

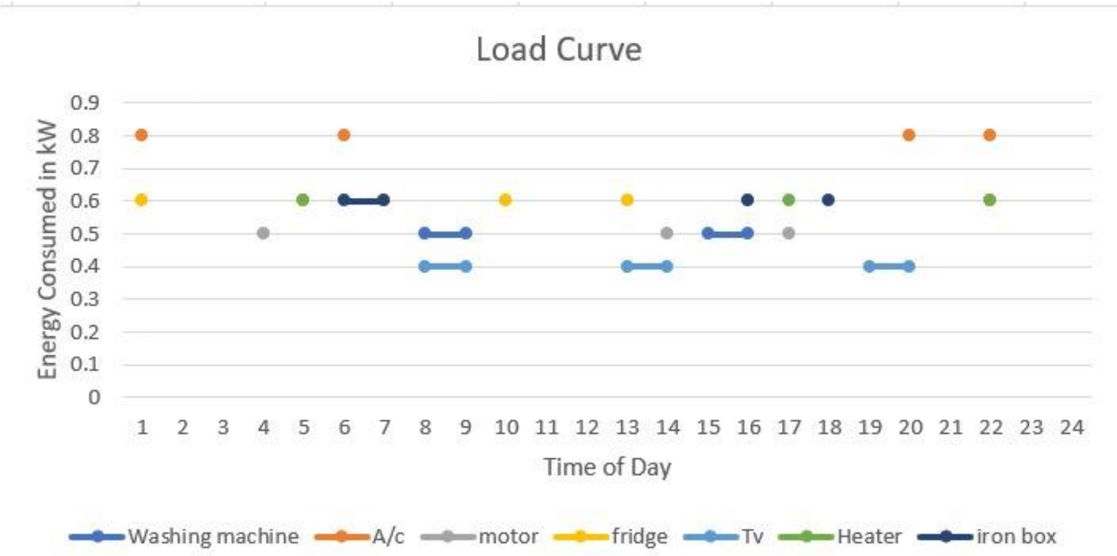

Fig.7: Control chart after implementation

CONCLUSIONS

The home automation system we developed is efficient, user-friendly, and accessible to individuals of all ages due to its simple user interface. It effectively reduces energy usage and provides clear information about the total active loads, wattage, and running costs. Furthermore, the system prioritizes safety, with equipment requiring minimal maintenance. The priority mode feature allows us to limit the total wattage consumed by the system, particularly beneficial during peak hours, resulting in significant reductions in energy consumption and billing costs.

ACKNOWLEDGMENTS

First and foremost, we extend our gratitude to The God Almighty for His divine grace and blessings, guiding us throughout this journey, and we pray for His continued guidance in the future. We would like to express our heartfelt appreciation to our Principal, Dr. Roshan Kumar, for granting us the opportunity to undertake this project during our 8th semester of the B. Tech degree program in May 2024. We are immensely thankful to our Head of the Department, Dr. Channu Lal, for her unwavering support and encouragement. Our sincere thanks go to our project guide, Assistant Professor Ms. Tensy Thomas, and project coordinator, Assistant Professor Mr. Sanjai Steve Stanly, from the Department of Electrical and Electronics Engineering, for their motivation, assistance, and guidance throughout the project. We also extend our gratitude to all the faculty members of the EEE Department for their invaluable assistance and support. Finally, we express our heartfelt thanks to our friends and family for their continuous feedback, support, and encouragement throughout this endeavor.

REFERENCES

Journal Articles

1. **C. C. Medina Joe Mel U. Pamplona, and Anna Patricia Uy**, “Monitoring AndControl of Electricity Consumption Using Raspberry Pi Through IoT,” *LPU–LagunaJ. Eng. Comput.* Stud., vol. 4, no. 1, pp. 50–66, 2018.

2. **N. A. Prasetyo ,A. G. Prabawati, and Suyoto,** "Smart home: Power electric monitoring and control in Indonesia," *Int. J. Interact. Mob. Technol.*, vol. 13, no. 3, pp. 143–151, 2019

3. **S. David , S., Akshara, P., Dixit, S., Purnimaa, S "**Decrease of power consumption utilizing IoT," Int. J. Innov. Technol. Explore. Eng., vol.9, no. 1, pp. 5316–5319, 2019.

4. **Ida Bagus Gede Purwania I Nyoman Satya Kumara, and Made Sudarma**" Application of IoT-Based System for Monitoring Energy Consumption", *International Journal of Engineering and Emerging Technology*, Vol.5, No.2, December 2020

5. **Sean Dieter Tebje Kelly, Nagender Kumar Suryadevara, and Subhas Chandra Mukhopadhyay**"*Towards the Implementation of IoT for Environmental Condition Monitoring in Homes*", *IEEE Sensors journal*, 2013

6. S. Sivasubramanian, S. Sivasankaran and S. ThiruNiraiSenthil, (2014). A Proposed Android Based Mobile Application to Monitor Works at Remote Sites. https://www.ijsr.net/archive/v3i2/MDQwMjE0MDE=.pdf (Accessed 15 November 2017).

7. Kodali RK, Sahu A. An IoT based weather information prototype using WeMos. In2016 2nd International Conference on Contemporary Computing and Informatics (IC3I) 2016 Dec 14 (pp. 612-616). IEEE.

8. Wibisono G, Badruzzaman N. Strategy of smart meter infrastructure implementation using LPWAN technology, pilot project PLN Bali Case Study. InMATEC Web of Conferences 2018 (Vol. 218, p. 03013). EDP Sciences.
9. Asghar MH, Negi A, Mohammadzadeh N. Principal application and vision in Internet of Things (IoT). InInternational Conference on Computing, Communication & Automation 2015 May 15 (pp. 427-431). IEEE.

10. Celebre AM, Dubouzet AZ, Medina IB, Surposa AN, Gustilo RC. Home automation using raspberry Pi through Siri enabled mobile devices. In2015 International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment and Management (HNICEM) 2015 Dec 9 (pp. 1-6). IEEE.