International Journal of Research Publication and Reviews

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

IoT- Based Smart Energy Meter

Ms. B. Tulasi Sowjanya[1], Haarini Tadiparthi[2], Kathyaeni Vidmahe Pidiyar[3], Sai Sri Gaddala[4], Deekshitha Sabavath[5]

[1]Assistant Professor, G. Narayanamma Institute of Technology and Science, India. b.tulasi@gnits.ac.in
[2]G. Narayanamma Institute of Technology and Science, India. tnp.haarini@gmail.com
[3]G. Narayanamma Institute of Technology and Science, India.. kathyaeni.pidiyar@gmail.com
[4]G. Narayanamma Institute of Technology and Science, India. gaddalasaisri1919@gmail.com
[5]G. Narayanamma Institute of Technology and Science, India.dkkinancy81@gmail.com
DOI: https://doi.org/10.55248/gengpi.4.1223.123314

ABSTRACT—

Energy consumption has increased in response to the rising energy demand, raising concerns about the environment and driving up energy prices. Researchers have created an Internet of Things (IoT)-based Smart Energy Meter (SEM) to address this problem. An IoT-based SEM that makes use of real-time data to optimize energy use and lower energy expenses is shown in this work as an overview.

The system uses a variety of sensors to gather data on energy use, which is then analyzed by algorithms to find chances for energy savings. Utilizing the technology could result in considerable reductions in energy expenditures and carbon emissions. The technology is also easily scalable, which makes it perfect for both small and large buildings. Overall, the IoT-based SEM offers hope for the future of effective and sustainable energy management.

I. Introduction

Energy consumption has increased in response to the rising energy demand, raising concerns about the environment and driving up energy prices. Researchers have created an Internet of Things (IoT)-based Smart Energy Meter (SEM) to address this problem. An IoT-based SEM that makes use of real-time data to optimize energy use and lower energy expenses is shown in this work as an overview.

The system uses a variety of sensors to gather data on energy use, which is then analyzed by algorithms to find chances for energy savings.Utilizing the technology could result in considerable reductions in energy expenditures and carbon emissions. The technology is also easily scalable, which makes it perfect for both small and large buildings. Overall, the IoT-based SEM offers hope for the future of effective and sustainable energy management.

These meters also make it possible for two-way communication between the utility company and the customer. This two-way data interchange eliminates the

need for predicted bills and enables more precise charging based on real consumption. Additionally, it makes load balancing and demand response programs possible, where utilities can encourage customers to use less electricity during peak hours, thereby improving the efficiency of the entire energy system.

The capacity to spot anomalies and pinpoint energy inefficiency is a significant advantage of IoT-based energy meters. They can identify unusual patterns of energy use, such as sharp spikes or sustained high use, which may point to a problem with the equipment or energy waste. Potential problems can be rectified quickly by contacting the user or utility provider right away, which will result in energy savings and improved system dependability.By tracking the energy produced and used, these meters can also aid in the integration of renewable energy sources like solar panels. They make it possible for net metering, which enables renewable energy producers to feed excess energy back into the grid in exchange for credits or lower energy costs.

An essential component of IoT-based energy meters is security. Advanced authentication and encryption mechanisms guarantee data transfer security and provide protection from illegal access. Additionally, security procedures are put in place to guarantee that only pertinent information about energy consumption is provided to the utility supplier, safeguarding customer privacy.

II. METHODOLOGY

The following steps are commonly included in an IoT-based smart electricity energy meter's methodology:

Installing sensors: Installing sensors is the initial stage in measuring energy use throughout the system. Smart meters, submeters, and other Internet of Things (IoT) gadgets that gather information on energy consumption can be among these sensors.

Data gathering and archiving: Following the deployment of the sensors, the generated data needs to be gathered and archived. This may entail gathering, processing, and storing the data on a local server or a cloud-based platform. potential challenges and opportunities.

Data collection and storage are followed by data collection and storage, which is followed by data analysis and visualization to uncover patterns and trends in energy consumption. In order to do this, machine learning techniques may be used to In order to make the data more user-friendly, visualizations can be made to highlight anomalies or forecast future use.

Utilizing the data to manage energy use comes after the data has been analyzed. Setting energy consumption goals, locating high-consumption locations, and putting energy-saving measures into practice can all help with this.

Feedback and improvement: The system must then be optimized to increase energy efficiency over time while also giving customers feedback on their energy usage. This can entail sending warnings and alarms when consumption exceeds certain criteria and iteratively upgrading the system in response to user feedback and data analysis.In general, the process for an IoT-based Smart Electricity Energy Meter entails deploying sensors, gathering and archiving data, processing and showing the data, controlling energy use, and offering feedback and adjustment to gradually increase energy efficiency.

It is necessary to employ a smart meter system that can examine various home equipment and collect data on active power and current. The device can connect to a central gateway with the aid of a wired or wireless connection, and the obtained data can then be uploaded and analyzed by the gateway management system. The information can then be shown on the graphical Android-based user interface of the platform. Users of the platform can access the data using any Android-enabled device. To cut costs, the system needs energy metering nodes that can connect to the gateway wiredly or wirelessly in such a way that a home with many of monitored appliances only needs one Wi-Fi access point. Additionally, it is necessary that the most recent data relating the appliances can also be viewed via a menu interface on a local display.

III. HARDWARE DESCRIPTION

EPS-32 (ESP32): The ESP32 is a dual-core microcontroller module with built-in Wi-Fi and Bluetooth functionality. IoT projects, wireless communication, embedded systems, prototyping, and wearable technology all frequently use it. The ESP32 has characteristics including energy economy, memory, and GPIO ports, as well as wireless connection.

Figure-1 ESP-32

Breadboard: An electronic circuit can be built and tested on a breadboard without the need for soldering. It has a grid of holes into which you may place electronic parts and use jumper wires to link them. Engineers and amateurs frequently use breadboards to quickly prototype circuits before soldering them onto a more durable circuit board.

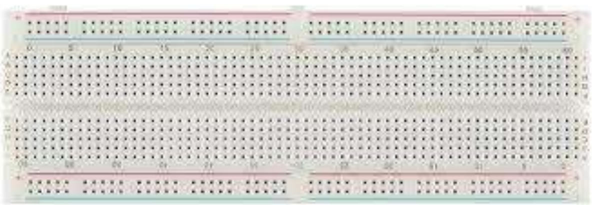

Figure-2 Breadboard

Relay: A relay is a switch that is electrically activated and used to switch on or off circuits or other electrically powered devices that require more power. It is made up of a switch or switches and an electromagnet. The switches are turned on when a signal is applied to the relay's coil, allowing electricity to flow through the high-power circuit.

Figure-3 Relay

AC Bulb: Different types of AC bulbs exist, including incandescent, fluorescent, LED, and halogen, each with unique properties and levels of energy efficiency.

Figure-4 AC Bulb

Current Sensor: Current sensors are tools that gauge the current moving through an electrical circuit. In proportion to the amount of current flowing through it, it produces an output signal. Applications for current sensors include power monitoring, energy management, motor control, and security systems.

Figure-5 Current Sensor

Folders: A lightbulb socket, lightbulb folder is a device which mechanically supports and provides electrical connections for a compatible electric lamp base. Sockets allow lamps to be safely and conveniently replaced (re-lamping). Its primary function is to provide a stable and safe connection between the light bulb and the electrical wiring, allowing the bulb to receive electrical power and emit light.

Figure-6 Folder

Jumper wires: Electrical cables with connectors at either end are used to establish temporary connections between parts on a breadboard or other electronic circuit boards. They normally come in a variety of lengths and colors and are composed of insulated wire. With the help of jumper wires, components can be quickly and temporarily connected, allowing for the prototype and testing of electronic circuits.

Figure-7 Jumper Wires

In numerous electronics projects, prototypes, and electrical systems, these parts—such as the ESP32, breadboard, relay, AC bulb, current sensor, folders, and jumper wires—are frequently used to build, connect, and control various components of a circuit or system.

IV. SOFTWARE DESCRIPTION

Arduino: The Arduino IDE is a platform for creating software that lets you control and program Arduino microcontrollers. Writing the required code for the Arduino board can be done using the Arduino IDE in the context of tracking the sun using an LDR (Light Dependent Resistor), a solar panel, and a servo motor. The Arduino analyzes the data from the LDR, which measures light intensity, and uses it to instruct the servo motor to move the solar panel in the direction of the sun to maximize exposure and energy production.

Blynk App: The Blynk platform is well-liked for creating Internet of Things (IoT) works and apps. It enables you to simply construct and control IoT devices and consists of a mobile app, a cloud service, and a hardware library. An explanation of the Blynk app's functionality is provided below:

1. Mobile App: Both Android and iOS smart phones can use the Blynk mobile app. Your IoT devices can be controlled and monitored using this interface. With the software, you can design unique dashboards that let you interact with your devices, display sensor data, and manage a variety of hardware elements.

2. Widgets: You can add a number of widgets to your dashboard using Blynk. Button, slider, graph, display, notification, and other widget types are among them. These widgets appearance and behavior can be altered to meet the needs of your work.

3. Blynk Cloud: Your IoT devices and the mobile app are connected through Blynk's cloud service. You can communicate with your hardware from anywhere in the globe when you link your gadget to the Blynk cloud. Data routing and device management are taken care of by the cloud service.

4. Supported Hardware: Hardware platforms supported by Blynk include Arduino, Raspberry Pi, ESP8266, ESP32, and a large number of others. These platforms can be integrated with the Blynk app and cloud using the Blynk library.

5. Programming: You normally use the Blynk library to develop code for your hardware and upload it to your device to create a Blynk-enabled IoT project. It also specifies how the hardware should respond to commands and transfer data. This code creates a connection with the Blynk cloud.

6. Authentication: Blynk employs authentication tokens to make sure that only approved individuals may manage and watch over your IoT devices. To provide a secure connection between the app and your device, each work has a different authentication token.

7. Data logging and notifications: Blynk may record data from your IoT devices and notify you when specific criteria are satisfied. For instance, you can configure alerts to send you a notification if a sensor reading exceeds a particular threshold.

8. Energy: To control the quantity of widgets and functionalities available in your wroks, Blynk employs a "energy" approach. varying widgets use up varying quantities of the energy that you have been allotted. In case you require more energy, you can buy it.

9.Community and Templates: Blynk members can share their works and code in a lively community. To get your own IoT initiatives off the ground, you can locate and utilize templates made by others.

V. CODE

```
#define BLYNK_TEMPLATE_ID "TMPL3bwafnvdN"
#define BLYNK_TEMPLATE_NAME "Quickstart Template"
#define BLYNK_AUTH_TOKEN "D5Heiz2Cq3mwx-fWz3Pjv2m9rsDPd3yW"
#define BLYNK_PRINT Serial
#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>
char auth[] = BLYNK_AUTH_TOKEN;
char ssid[] = "OnePlus Nord";
char pass[] = "Haarini26";
void setup()
{
  pinMode(14, OUTPUT);
  pinMode(27, OUTPUT);
  pinMode(35, INPUT);
  Serial.begin(115200);
  Blynk.begin(auth, ssid, pass);
}
BLYNK_WRITE(V0)
{
  int pinValue = param.asInt();
  digitalWrite(14, pinValue);
}
BLYNK_WRITE(V1)
{
  int pinValue = param.asInt();
  digitalWrite(27, pinValue);
}
void loop()
{
   Blynk.virtualWrite(V2, random(2, 8));
  delay(500);
  Blynk.run();
}
```

VI. BLOCK DIAGRAM

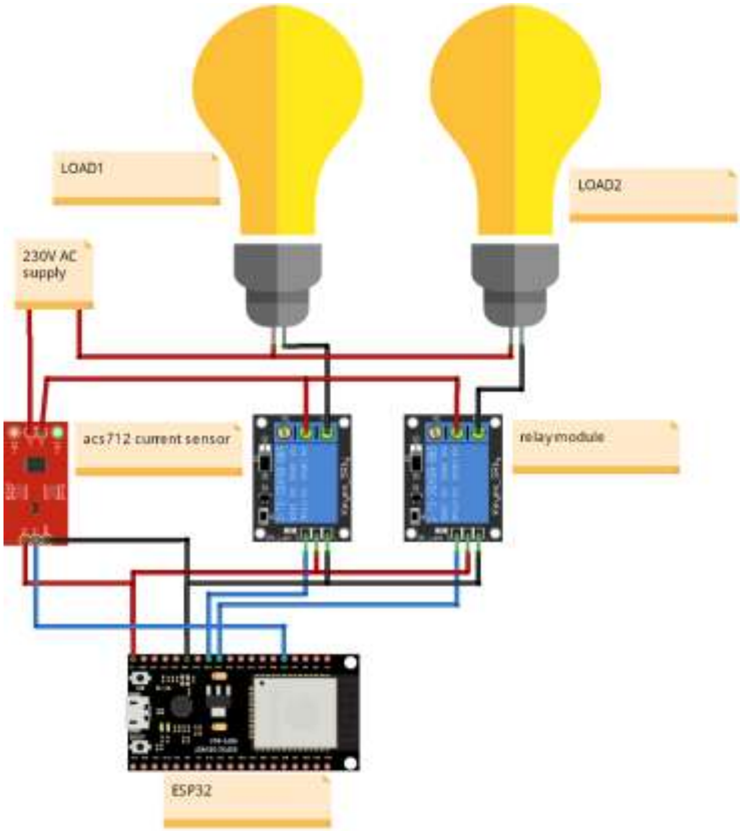

Figure-8 Block Diagram

VII. RESULTS

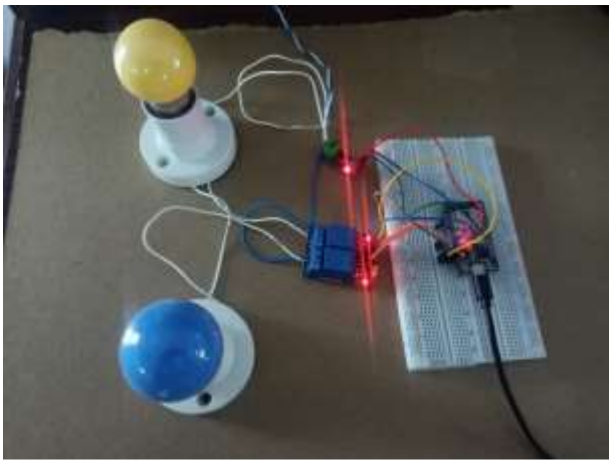

Figure-9 Hardware Connection

The above shown Figure 9 is the hardware connection of the IoT based Smart Energy Meter using all the hardware components.

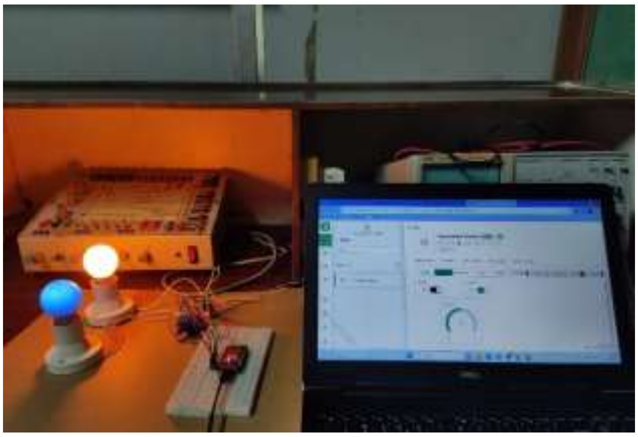

Figure-10 Output when two loads are in ON condition

Figure-11 Readings when both loads are ON

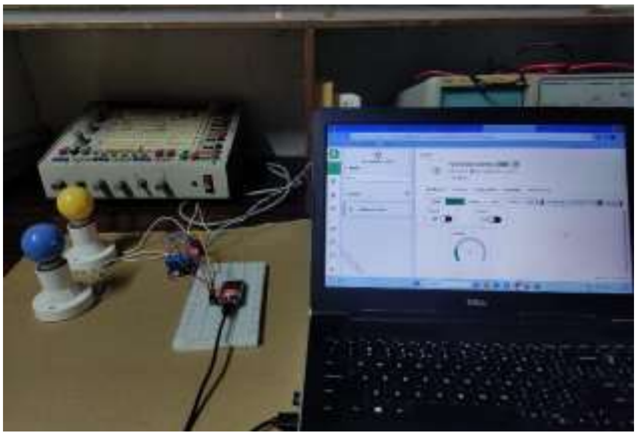

Figure-12 Output when both loads are OFF

Figure-13 Readings when both loads are OFF

The Figure-10 and Figure-11 are output and readings of the project respectively when both the loads are in ON condition.

The Figure-12 and Figure-13 are output and readings of the project respectively when both loads are in OFF condition.

VIII. CONCLUSION

Finally, the adoption of IoT-based smart energy meters signifies a crucial development in the fields of energy management and sustainability. These gadgets have the power to completely alter how we monitor and manage energy use. They let users to make knowledgeable decisions about their energy usage, resulting in significant financial savings and lessening the impact on the environment, by offering real-time data and remote accessibility.

Demand-side management facilitation is one of the major benefits of IoT-based smart meters. Together, utilities and customers can balance energy loads more effectively, easing the burden on the system and lowering the chance of blackouts. Additionally, smart meters allow for quick identification and remediation of energy fraud or issues, improving the overall security and dependability of the energy system.

Furthermore, by encouraging energy efficiency and the use of renewable energy sources, these meters advance sustainability. They make it possible for homeowners to recognize energy-saving techniques and modify their behaviour accordingly. They also make it easier for solar energy systems and other renewable energy sources to be integrated into the grid, resulting in a cleaner and more sustainable mix of energy.

IoT-based smart energy meters provide a potent solution that is in line with the objectives of energy efficiency, cost containment, and environmental stewardship in a world confronting escalating energy issues and environmental concerns. With these technologies continued development and widespread acceptance, the energy environment is expected to improve.

IX. FUTURE SCOPE

Smart metering is the finest option in this regard for effective electrical energy management as well as for increasing public awareness of how precisely they use electricity. The measurement method is more dependable and accurate when load and the digital billing system are regularly monitored. As a result, the fees are unrelated to how long the data transfer takes.

This plan's ability to eliminate the disadvantage of serial transmission increases the system's effectiveness. The implementation of a wireless computerized monitoring and mobile billing system is our work main goal. It appears that by adjusting the energy meter as for routine monitoring it, this device will prevent power theft. Additionally, as meters are now read digitally, it helps to reduce the labour needed for meter readings as well as the human error factor, which is nearly nonexistent. The power company will profit as a result rather than suffer losses.

However, the consumer will have access to the created bill. As a result, an affordable and simple to use service of automatic meter reading and digital invoicing system is guaranteed.

IoT-based smart energy meters have a lot of potential, and they offer a variety of interesting possibilities that might completely alter the energy landscape. These gadgets have the potential to significantly increase energy efficiency because they can deliver real-time data regarding energy usage trends. This data-driven approach enables users to identify and address energy waste, ultimately leading to more effective energy management.

Smart energy meters are also expected to be a major help in the integration of renewable energy sources. By maximizing the production, storage, and consumption of renewable energy, these meters can encourage environmentally friendly behaviours and aid in the widespread adoption of clean energy solutions.

The grid management process will benefit significantly from smart energy meters. By providing utilities with real-time data about energy use patterns, these meters enable more informed decisions about energy distribution and maintenance. As energy systems become more complex and linked, this data-driven methodology is increasingly crucial.

The potential for predictive analytics is yet another exciting aspect of smart energy meters built on the Internet of Things. As technology advances, these meters may estimate energy consumption patterns using cutting-edge analytics, allowing utility companies and consumers to better manage and optimize energy use.

The combination of smart energy meters with infrastructure for recharging electric vehicles offers a lot of promise for the future. This integration could encourage more people to utilize electric vehicles by expediting the charging process and increasing energy efficiency.

Additionally, the combination of smart meters and home automation systems can usher in a new era of energy-efficient living. These meters' connection capabilities with smart appliances, thermostats, and lighting systems enable automated energy use optimization based on user preferences and occupancy.

The possible societal influence is a crucial element. By gathering information on energy consumption, smart meters could aid urban planners in developing more energy-efficient towns and neighbourhoods. Additionally, the data insights offered by these meters may assist decision-makers in making more informed decisions regarding the consumption of energy and its effects on the environment.

X. REFERENCES

[1] "A GSM, Internet and Speech Controlled Wireless Internet Home Automation System", IEEE Transactions on Consumer Electronics, Vol. 52, No. 3, AUGUST 2006; Baris Yuksekkaya, A. Alper Kayalar, M. Bilgehan Tosun, M. Kaan Ozcan, and Ali Ziya Alkar

[2]. "Microcontroller Based Voice Activated Wireless Automation System: VSRD-IJEECE", Vol. 2(8), 2012, 642–649. Kailash Pati Dutta, Pankaj Rai, and Vineet Shekher

[3]. "Remote Controlled Home Automation System via Bluetooth Home Network" by Kwang Yeol Lee & Jae Weon Choi, SICE Annual Conference in Fukui, 2003, Vol. 3, pp. 2824–2829

[4]. "IoT Based Home Automation System Using Cell Phone," in Consumer Electronics, by R.Piyare and M.Tazil, 2011, pp. 192–195

[5]. "Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry" written by Maciej

[6].”Bluetooth Based Home Automation Systems,”Journal of Microprocessors and Microsystem by N.Srikanthan and Tan Karande,2002,Vol. 26,pp. 281-289

[7].”Design and Implementation of a WiFi based General Purpose Controlling Module” by Wijetunge S.P., Wijetunge U.S., Peiris G.R.V, Aluthgedara C.S. & Samarasinghe A.T.L.K., IN IEEE, 2008,PP.209-211

[8]."IoT Inc: How Your Company Can Use the Internet of Things to Win in the Outcome Economy" by Bruce Sinclair

[9]. "Designing Connected Products: UX for the Consumer Internet of Things" by Claire Rowland, Elizabeth Goodman, Martin Charlier, and Ann Light