

SMART ECOTRICITY METER

Submitted in partial fulfillment of the
requirements for the award of
Bachelor of Engineering degree in Computer Science and Engineering with
Artificial Intelligence

By

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

SCHOOL OF COMPUTING

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **KANNAN R (40731040)** and **YUTHIKA P (40731134)** who carried out Project work entitled "SMART ECOTRICITY METER" under my supervision from November 2023 to April 2024.

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I, KANNAN R (Reg. No - 40731040), hereby declare that the Project Work entitled "SMART ECOTRICITY METER" done by me under the guidance of Dr. J. JESLIN SHANTHAMALAR, M.E., Ph. D., is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Computer Science and Engineering with Artificial Intelligence.

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ABSTRACT

The Smart Ecotricity Meter is an approach to the confluence of cutting-edge technology and environmentally friendly living. This system provides customers with a detailed awareness of their power consumption by precisely capturing real-time electrical characteristics through the seamless integration of voltage and current sensors. Remote monitoring is made easier by the specialized online interface, which lets users view and evaluate their energy usage trends from any location. Interestingly, the meter provides a thorough breakdown of electricity spending in addition to real-time tracking by computing consumed units and related expenses.

In addition to giving people the ability to make educated decisions about how much energy they use, the user-friendly web platform is a great resource for historical data visualization. This historical perspective is helpful in determining patterns of consumption, periods of peak usage, and possible areas for optimization. The Smart Ecotricity Meter aims to empower users to actively contribute to a greener and more environmentally conscious future by offering practical insights and encouraging a cost-effective and sustainable approach to electricity usage. This is in line with the global shift towards responsible resource management and sustainable living.

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ABBREVIATIONS

SEM	Smart Ecoticity Meter
kWh	Kilowatt hour
IEEE	Institute of Electrical and Electronics Engineer
IoT	Internet of Things
SG	Smart Grid
CFA	Confirmatory Factor Analyses
SMI	Smart Metering Infrastructure
EMS	Energy Management System
UNO	One
CNN	Convolutional Neural Network
DB	Database
HTML	Hyper Text Markup Language
CSS	Cascaded Style Sheet
JS	Java Script
IDE	Integrated Development Environment
VS Code	Visual Studio Code
MCU	Micro Controller Unit
CV	Computer Vision
AI	Artificial Intelligence
Wi-Fi	Wireless Fidelity
UAT	User Acceptance Testing

CHAPTER 1

INTRODUCTION

In an era marked by increasing concerns about energy consumption and sustainability, the development of innovative technologies to monitor and manage electrical usage has become imperative. This project introduces the Smart Ecotricity Meter (SEM), a sophisticated solution inspired by Smart Electric Meters, designed to revolutionize the way we perceive and interact with our energy consumption. SEM integrates advanced hardware components, including sensors for voltage and current measurements, creating a real-time system for accurate power calculation. The primary objective is to empower users with detailed insights into their electricity usage, allowing them to make informed decisions for energy conservation and cost management.

Building upon the principles of Smart Electric Meters, SEM not only calculates instantaneous power consumption but also accumulates data over time to derive energy consumption in units (kWh). A pivotal aspect of the project involves implementing a cost calculation algorithm, providing users with a clear understanding of the financial impact associated with their energy habits. The culmination of these features is a user-friendly website that serves as an intuitive interface for accessing and interpreting the collected data. The SEM project represents a significant step towards enhancing energy awareness and efficiency, offering a practical tool for individuals and businesses to monitor and optimize their electrical consumption in a sustainable manner.

In the face of escalating concerns surrounding climate change and the depletion of finite energy resources, the urgency to transition towards more sustainable energy practices has become a global imperative. With energy consumption patterns playing a pivotal role in determining our environmental footprint, there is a critical need for solutions that empower individuals and organizations to take proactive steps towards conservation and efficiency. It is within this context that the Smart Ecotricity Meter (SEM) emerges as a beacon of innovation and progress.

Informed by the principles of Smart Electric Meters, SEM represents a leap forward in the realm of energy monitoring and management. By harnessing the latest advancements in sensor technology and data analytics, SEM offers a comprehensive suite of features aimed at enhancing energy awareness and promoting responsible usage behavior. At its heart, SEM's ability to perform real-time power calculations sets it apart as a dynamic tool for monitoring electricity consumption. Through precise measurements of voltage and current, SEM provides users with instant feedback on their energy usage, enabling them to identify power-intensive activities and make immediate adjustments to minimize waste.

However, SEM's capabilities extend far beyond simple power monitoring. By aggregating data over time, SEM offers users a nuanced understanding of their energy consumption patterns, allowing them to discern trends, identify inefficiencies, and implement targeted strategies for optimization. Whether it's tracking daily usage fluctuations or analyzing seasonal trends, SEM empowers users with the insights needed to make informed decisions about their energy consumption habits. Crucially, SEM's integration of a cost calculation algorithm adds a financial dimension to the equation, enabling users to assess the economic implications of their energy choices. By correlating energy usage with prevailing electricity rates, SEM provides users with a clear understanding of the monetary costs associated with their consumption behavior, fostering a greater appreciation for the value of energy conservation.

The Smart Electricity Meter (SEM) represents a transformative tool for promoting energy awareness, efficiency, and sustainability. By putting actionable insights directly into the hands of users, SEM paves the way for a future where responsible energy consumption is not just a goal but a shared reality. In addition to its advanced technical capabilities, SEM also prioritizes user convenience and accessibility. Its user-friendly website interface serves as a central hub for users to access and interpret their energy consumption data. Through intuitive visualizations and personalized recommendations, users can easily understand their energy usage patterns, set consumption goals, and track their progress towards sustainability objectives.

Moreover, SEM's real-time monitoring capabilities enable users to respond promptly to

changes in energy usage, empowering them to make immediate adjustments to minimize waste and optimize efficiency. By providing instant feedback on energy consumption, SEM encourages proactive energy management practices, ultimately leading to significant reductions in electricity usage and associated costs. Furthermore, SEM's data accumulation feature facilitates long-term analysis of energy consumption trends, enabling users to identify opportunities for further optimization and efficiency improvements. Whether it's identifying peak usage hours, detecting patterns of energy wastage, or evaluating the effectiveness of energy-saving measures, SEM equips users with the knowledge and insights needed to make informed decisions about their energy consumption habits.

In a broader context, the deployment of SEM contributes to the larger goal of promoting sustainability and combating climate change. By empowering individuals and businesses to monitor and optimize their electricity usage, SEM plays a vital role in reducing carbon emissions and mitigating the environmental impact of energy consumption. Additionally, by fostering a culture of energy awareness and efficiency, SEM encourages collective action towards building a more sustainable future for generations to come. Expanding further, SEM's innovative features extend beyond its core functionalities. One notable aspect is its compatibility with smart home systems and emerging Internet of Things (IoT) devices. By integrating seamlessly with smart home ecosystems, SEM enables users to control and monitor their energy usage alongside other connected devices, such as smart thermostats, lighting systems, and appliances. This integration not only enhances convenience but also enables more holistic energy management strategies, where users can optimize their entire home's energy consumption with greater ease and precision.

Furthermore, SEM can serve as a valuable tool for energy auditing and benchmarking purposes, particularly for businesses and organizations seeking to optimize their energy efficiency. By providing detailed insights into energy consumption patterns and trends, SEM empowers businesses to identify areas of inefficiency and implement targeted strategies for improvement. Moreover, SEM's ability to track energy usage across different departments or facilities enables organizations to benchmark their performance against industry standards and peers, facilitating continuous improvement initiatives. In terms of future developments, SEM holds the potential for further integration with renewable energy sources and energy storage systems. By incorporating data from solar panels, wind turbines, or battery storage units, SEM can provide users with a comprehensive view of their energy ecosystem, allowing them to optimize the use of renewable energy and maximize self-consumption. Additionally, SEM's advanced analytics capabilities can enable predictive maintenance of renewable energy systems, helping users anticipate and prevent potential issues before they occur,

thereby enhancing system reliability and performance.

Moreover, SEM's data-driven insights can contribute to broader energy management initiatives at the community or city level. By aggregating anonymized data from multiple SEM installations, utility companies and local governments can gain valuable insights into energy consumption trends and patterns across different neighborhoods or regions. This information can inform targeted energy efficiency programs, infrastructure investments, and policy decisions aimed at reducing overall energy consumption and promoting sustainable development.

In real-time applications, SEM offers immediate feedback and insights into electricity consumption, allowing users to make informed decisions on the spot. For example, homeowners can monitor their energy usage in real-time through the SEM interface and adjust their behaviors accordingly, such as turning off non-essential appliances during peak usage times to lower electricity bills. Additionally, businesses can utilize SEM to monitor energy usage in real-time across different departments or production lines, enabling them to identify energy-intensive processes or equipment and take corrective actions promptly. Moreover, SEM's real-time monitoring capabilities make it valuable in detecting anomalies or abnormalities in energy consumption patterns. By continuously analyzing data, SEM can identify sudden spikes or fluctuations in energy usage, indicating potential issues such as equipment malfunctions or energy leaks. This early detection enables users to address problems promptly, minimizing downtime and reducing the risk of costly repairs or replacements. Additionally, SEM can be integrated with alarm systems or notifications to alert users in real-time of any abnormal energy usage patterns, allowing for immediate investigation and resolution.

SEM offers several advantages over the current system of energy monitoring and management. Firstly, its capability to aggregate data over time provides users with a nuanced understanding of their energy consumption patterns, allowing them to identify trends, inefficiencies, and areas for optimization. Unlike traditional systems that offer limited insights into energy usage, SEM empowers users with comprehensive data analysis, enabling informed decision-making and targeted strategies for efficiency improvement.

Secondly, SEM's integration of a cost calculation algorithm adds a crucial financial dimension to energy monitoring. By correlating energy usage with prevailing electricity rates, SEM enables users to assess the economic implications of their consumption behavior. This feature goes beyond simple power monitoring and provides users with a clear understanding

of the monetary costs associated with their energy choices. As a result, users are incentivized to adopt more energy-efficient practices and make informed decisions that align with their financial goals.

Furthermore, SEM's real-time monitoring capabilities offer a significant advantage over traditional systems. By providing immediate feedback on energy consumption, SEM empowers users to respond promptly to changes in usage patterns, enabling them to adjust their behavior and optimize efficiency in real-time. This proactive approach to energy management not only reduces waste and lowers electricity bills but also enhances overall awareness and accountability regarding energy usage. Compared to the delay and lack of real-time feedback in traditional systems, SEM's instantaneous monitoring capabilities revolutionize the way users interact with and manage their energy consumption.

Additionally, SEM's user-friendly interface and accessibility contribute to its superiority over the current system. Traditional energy monitoring systems often lack intuitive interfaces, making it challenging for users to interpret and act upon their energy consumption data effectively. In contrast, SEM's user-friendly website interface provides a central hub for users to access and interpret their energy data effortlessly. Through intuitive visualizations and personalized recommendations, SEM enables users of all backgrounds and technical abilities to engage with their energy usage effectively. This accessibility ensures that users can easily understand their consumption patterns and take meaningful actions to reduce waste and optimize efficiency.

Moreover, SEM's advanced technical capabilities and integration potential with smart home systems offer unparalleled convenience and flexibility. Traditional energy monitoring systems may lack compatibility with emerging technologies or smart home devices, limiting their functionality and usability. In contrast, SEM's compatibility with smart home ecosystems enables seamless integration with other connected devices, such as smart thermostats, lighting systems, and appliances. This integration not only enhances convenience but also enables more holistic energy management strategies, allowing users to optimize their entire home's energy consumption with greater ease and precision. By leveraging the latest advancements in technology and embracing compatibility with smart home systems, SEM sets a new standard for energy monitoring and management in the modern era.

CHAPTER 2

LITERATURE SURVEY

The proposed paper "Electricity Smart Meters Interfacing the Households" emphasizes the vital importance of efficient interfaces in smart meters to increase household awareness of energy consumption. Despite the interconnected nature of smart meters for broader energy-saving goals, there exists a disconnect between households and utility companies. Through an exploration of regulatory frameworks, global solutions, and practical implementations, the paper suggests architectural proposals for a consumer-centric smart meter network. Ultimately, the authors seek to narrow the communication gap between utility providers and households, enhancing the effectiveness of energy-saving initiatives.

Authors Savita Pawar and B. F. Momin discuss the global use of smart meters in their paper "Smart Electricity Meter Data Analytics: A Brief Review." They highlight these meters' role in measuring electricity, gas, and water usage within the smart grid system, offering benefits across social, economic, and environmental realms. Their paper focuses on smart meters' primary functionality: measuring, capturing, and analyzing data on energy consumption, meter status, and power quality. However, they note challenges such as data volume and collection speed in achieving this functionality.

From the authors' perspective, the paper introduces an innovative smart meter deployment strategy by Hao, Wang, Wu, Wang, Song, Hu, and Yu. We focus on monitoring electrical appliance states efficiently, leveraging power distribution network structures to minimize costs. Decomposing networks into mono-meter trees, we solve the NP-hard optimization problem with a 2-approximation ratio greedy algorithm. Extensive simulations across diverse power network structures validate the practicality and effectiveness of our approach.

The authors Priyadharshini and Subraman examine the growing global energy consumption in the literature review, highlighting the necessity of an efficient metering system. Their study focuses on developing a smart metering platform to track physical factors and patterns in energy usage, improving demand-side management. The paper addresses issues including data packet losses in the metering infrastructure and presents sophisticated LabVIEW and IoT-based monitoring tools.

The authors suggest a focus on the transformative impact of the Smart Grid (SG) in electricity delivery. They highlight SG's benefits, including precise energy tracking, clear

anomaly detection, and swift electricity restoration after disruptions, echoing the findings of Li and Yao (2010) and insights from EPRI (2020). Their review positions SG as crucial, enabling consumer adaptability and offering utility providers operational efficiencies and cost savings.

Authors Rosario Morello, Claudio De Capua, Gaetano Fulco, and Subhas Chandra Mukhopadhyay present a perspective on the development of a smart power meter for efficient energy monitoring in smart grids. The meter utilizes metrics from the IEEE Standard 1459-2010 to analyze voltage and current signals, providing crucial information on power consumption and quality. They emphasize the need for adaptive routing beyond traditional path shortening, considering specific criteria for energy flow. This smart meter aims to support the evolving smart power grid by responding to dynamic demands and quality considerations. In the context of the electric grid of the future, the authors highlight the crucial role of advanced sensing systems and IoT (Internet of Things) in achieving efficient energy monitoring among nodes in an electric network. Traditionally, energy flow in grids was guided by simple path shortening criteria. However, the changing dynamics of energy exchange now require a more adaptive approach. For instance, energy flow should consider factors such as quality standards when determining the most suitable route. The proposed smart power meter aims to support the evolving smart power grid by efficiently monitoring electricity among different nodes, adapting to changing needs and quality considerations.

In their research, authors Vamsi Sai, N. Thirupathi Rao, and Debnath Bhattacharyya meticulously engineer a smart electricity meter harnessing the computational prowess of microcomputers. Their primary objective centers on augmenting energy monitoring within smart grids, employing a light-dependent resistor (LDR) to tally pulses emitted by the electricity meter. This data is seamlessly transmitted to a Raspberry Pi connected to the internet, where it updates a database via the MEFN stack, enabling end-users to monitor their real-time electricity utilization with unprecedented convenience and accuracy. This innovative approach not only addresses the pressing need for efficient energy management but also empowers users by providing deep insights into their consumption patterns, ushering in a new era of intelligent electricity monitoring, and optimization.

In their paper on "Sustainable Communities with Smart Meters," Simona-Vasilica Oprea, Adela Bâra proposed a statistical measurement model, employing a first-order Confirmatory Factor Analyses (CFA), to discern factors influencing the changing attitudes of electricity consumers. Analyzing real questionnaire data from the Irish Commission for Energy Regulation (CER), the research revealed relevant relationships between socio-economic and

behavioral factors, showcasing an excellent fit of the models to the data based on performance indicators.

In the paper titled "Smart Metering Trends, Implications, and Necessities: A Policy Review," authors Javier Leiva, Alfonso Palacios, and José A. Aguado conduct a comprehensive exploration of the evolving landscape of smart metering infrastructures (SMI) within the context of modern electricity grids. The paper initiates with a scrutiny of energy policies aimed at implementing smart metering in Spain, Europe, and globally. It delves into the emerging trends in the energy sector, highlighting the growing prevalence of renewable generation, energy storage, electric vehicles, and energy management systems. The authors emphasize the imperative for innovation and the modernization of existing electricity infrastructure into smart grids, facilitated by the interaction between suppliers and consumers through control systems and smart metering. Recognizing the need for corresponding regulations, the paper addresses the technological capabilities of smart metering and user needs in the present and immediate future. It critically assesses the current status, potential, limitations, and implications of smart metering, concluding with recommendations for policy adaptations to effectively navigate the evolving energy landscape.

Milanpreet Kaur and her collaborators present a noteworthy contribution to the field of energy conservation in their study focusing on an IoT-based smart metering system. By employing Arduino Uno and Ethernet technologies, they underscore the importance of bidirectional communication for accurate energy measurement, timely data delivery, and enhanced customer services within the context of a smart grid. Published in the esteemed IOP Conference Series, their research provides a comprehensive examination of a robust system that offers reliable insights into Electrical Energy Management System (EMS) dynamics through the integration of Internet of Things (IoT) capabilities. This work serves as a valuable addition to the literature, offering insights and solutions crucial for the advancement of energy monitoring practices and sustainable energy management strategies.

The authors introduce an IoT-based Smart Electricity Monitoring and Control System (SMACS) utilizing Arduino UNO and ACS712 sensor. SMACS boasts a minimal 0.6% current error, outperforming existing Power Monitoring and Switching (PMAS) systems with a 7.8% error rate. Leveraging IoT technology, SMACS offers real-time monitoring and control, enhancing accuracy and efficiency in home energy management. Its integration potential with other smart home devices further facilitates seamless automation, empowering users to optimize electricity consumption effectively.

2.1 INFERENCES FROM LITERATURE SURVEY

1. Focus on Efficient Interfaces: The literature highlights the crucial role of efficient interfaces in smart meters to increase household awareness of energy consumption, addressing a communication gap between households and utility companies.

2. Advancements in Smart Metering Technology: Studies discuss advancements such as IoT integration, sensor technology, and real-time monitoring capabilities, offering improved accuracy and efficiency in energy management.

3. Empowerment Through Data: Smart metering systems empower users by providing real-time insights into energy consumption patterns, enabling informed decision-making and responsible usage behavior.

4. Challenges in Smart Grid Implementation: The literature identifies challenges such as regulatory frameworks, data analytics, and interoperability issues, underscoring the importance of policy adaptations and collaboration between stakeholders.

5. Opportunities for IoT Integration: Integration of IoT technology with smart metering systems offers opportunities for bidirectional communication, real-time data delivery, and enhanced customer services, facilitating seamless automation and optimization.

6. Importance of Energy Efficiency: Studies emphasize the importance of energy efficiency and conservation, aiming to optimize energy consumption and reduce environmental impact.

7. Societal and Economic Impact: The literature examines the societal and economic implications of smart metering systems, highlighting their potential to drive energy efficiency, reduce costs, and improve overall quality of life for consumers and communities.

8. Technological Innovations: Various technological innovations, including sensor integration and data analytics, are explored to enhance the accuracy, efficiency, and

convenience of energy management systems.

9. Consumer-Centric Approach: The proposed architectural proposals for a consumer-centric smart meter network aim to bridge the communication gap between utility providers and households, enhancing the effectiveness of energy-saving initiatives.

10. Potential for Sustainability: Smart metering systems offer potential for sustainability by enabling informed decision-making, optimizing energy consumption, and reducing carbon emissions in the context of evolving energy landscapes.

2.2 OPEN PROBLEMS IN EXISTING SYSTEM

Limited Data Granularity: Existing systems may lack granularity in data collection, providing only aggregated information at fixed intervals. This limitation hinders the ability to identify specific patterns or anomalies in power consumption.

Integration Challenges: Interoperability issues with various types of sensors, microcontrollers, or communication protocols may hinder seamless integration. This can result in incomplete or inaccurate data, affecting the reliability of the system.

User Engagement and Behavior: Many existing systems struggle to effectively engage users and encourage energy-efficient behavior. Finding ways to present data in a more user-friendly manner or incorporating gamification elements to motivate users is an ongoing challenge.

Cost Calculation Accuracy: The algorithms used for cost calculation may not accurately reflect dynamic pricing models, seasonal variations, or other factors influencing electricity costs. Improving the accuracy of cost predictions remains an open issue.

Remote Monitoring Challenges: Ensuring reliable and continuous remote monitoring, especially in areas with unstable network connectivity, is a persistent

problem. Addressing this issue is crucial for maintaining the effectiveness of the system.

Scalability Issues: Scalability challenges may arise when attempting to deploy the system in larger networks or across diverse geographical locations. Adapting the system to varying infrastructures and scales remains an open problem.

Energy Harvesting and Sustainability: Integrating sustainable power sources for the monitoring system itself, such as energy harvesting technologies, is an ongoing challenge. Enhancing the overall sustainability of the SEM is essential.

CHAPTER 3

REQUIREMENT ANALYSIS

3.1 FEASIBILITY STUDIES / RISK ANALYSIS OF THE PROJECT

The feasibility studies for the Smart Ecotricity Meter (SEM) project encompass critical assessments to ascertain its technical, operational, economic, legal, and scheduling viability. From a technical standpoint, rigorous evaluations are conducted to determine the accuracy and reliability of the chosen sensors for voltage and current measurements. This includes assessing their compatibility with the microcontroller and communication modules to ensure seamless real-time data acquisition. Operational feasibility examines user interfaces, considering ease of use, and the system's adaptability to diverse electrical infrastructures. Additionally, economic feasibility involves a thorough cost-benefit analysis, weighing the initial investment against anticipated benefits, such as energy savings and user cost reduction. Legal and regulatory considerations are paramount to ensure compliance with data privacy laws and electrical safety standards. Furthermore, a detailed schedule feasibility analysis identifies potential bottlenecks, dependencies, and resource requirements, ensuring a realistic and achievable project timeline.

Risk analysis plays a pivotal role in identifying potential impediments to the successful implementation of the Smart Ecotricity Meter (SEM) project. Key risks encompass technological challenges, budget constraints, regulatory hurdles, data security vulnerabilities, and unforeseen external factors like natural disasters or political instability. Each risk is meticulously assessed for its likelihood of occurrence and potential impact on the project's overarching objectives. This proactive and adaptive risk management approach ensures the resilience and sustainability of the Smart Ecotricity Meter project. By identifying, assessing, and mitigating potential obstacles with foresight, the project remains well-positioned to achieve its objectives, offering an innovative solution for energy monitoring and contributing to a more sustainable approach to electricity consumption.

3.2 SYSTEM REQUIREMENTS SPECIFICATION DOCUMENT

Arduino:

Arduino, an open-source electronics platform, plays a pivotal role in numerous projects across various domains. The Arduino ecosystem consists of microcontrollers, sensors, and actuators, providing a comprehensive solution for electronic prototyping and development. The platform's simplicity in programming and a vast community of developers contribute to its widespread adoption.



Fig 3.2.1 Arduino

Python:

Python is a user-friendly programming language used for various tasks like web development, data analysis, and artificial intelligence. It's popular because of its easy-to-read code and versatile applications. Python's large community means lots of support, making it a great choice for anyone learning to code or working on diverse projects. Its straightforward syntax and vast capabilities make it one of the most accessible languages for programmers of all levels.



Fig 3.2.2 Python

Flask:

Flask is a lightweight and versatile Python web framework that simplifies web application development. It provides essential tools and libraries for building robust, scalable, and secure web applications. Flask's modularity and simplicity make it an excellent choice for both beginners and experienced developers, enabling rapid prototyping and efficient development processes.

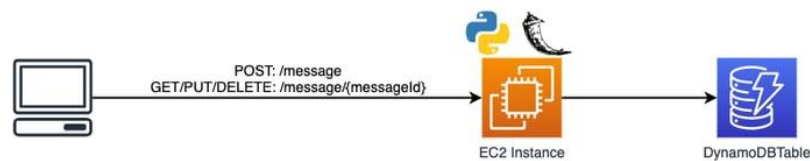


Fig 3.2.3 Flask

MongoDB:

MongoDB is an open-source NoSQL database system, classified as a document-oriented database. It stores data in flexible, JSON-like BSON documents, providing a dynamic schema for unstructured or semi-structured data. MongoDB is designed for scalability, allowing horizontal scaling across multiple servers through automatic sharding. With a powerful query language and support for indexing, it enables efficient data retrieval and analysis.

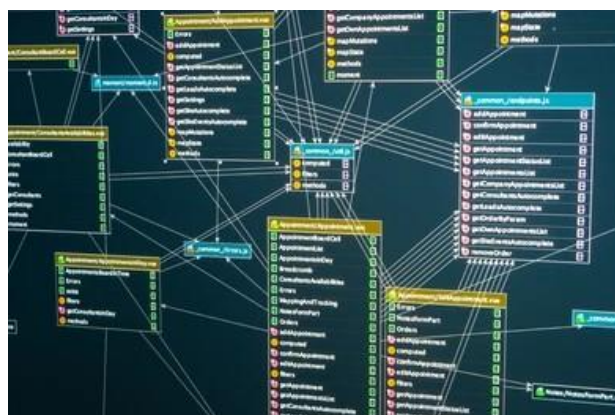


Fig 3.2.4 MongoDB

HTML:

HTML, or Hyper Text Markup Language, forms the backbone of virtually every webpage on the internet. It's a standard markup language that structures content on the web, defining elements like headings, paragraphs, links, and multimedia items. HTML documents are interpreted by web browsers to display web content, ensuring consistent formatting and layout across different devices



Fig 3.2.5 HTML

CSS:

CSS, or Cascading Style Sheets, is a fundamental technology in web design, enhancing the visual presentation and layout of HTML documents. It allows developers to control the colors, fonts, spacing, and overall look of a website across various devices and screen sizes. By separating content from presentation, CSS enables consistency and flexibility in web design, ensuring a seamless user experience.



Fig 3.2.6 CSS

Java Script:

JavaScript (JS) is a versatile, high-level programming language primarily known for its role in web development. It enables interactive and dynamic web content, making websites responsive and engaging for users. JS runs on web browsers, allowing real-time manipulation of webpage elements, data validation, and asynchronous communication, enhancing user experience.



Fig 3.2.7 Java Script

3.3 SOFTWARE REQUIREMENTS

Integrated Development Environment (IDE):

An Integrated Development Environment (IDE) is a software tool that simplifies the process of software development. It combines a code editor, debugger, and compiler, providing a unified platform for programmers. IDEs enhance efficiency by offering features like code completion and debugging tools, allowing developers to write, test, and debug code within one application.

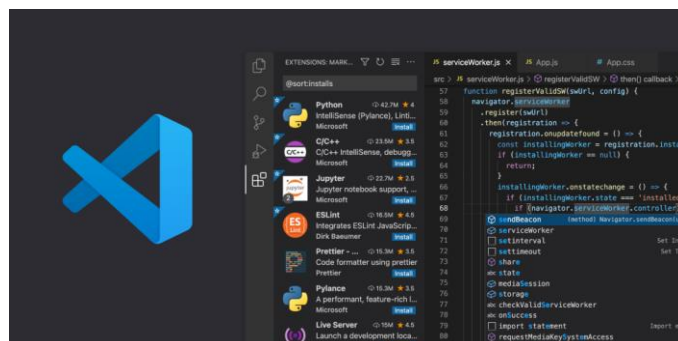


Fig 3.3.1 Visual Studio Code

Arduino IDE:

The Arduino Integrated Development Environment (IDE) is a user-friendly and versatile software tool for programming Arduino microcontrollers. Supporting the simplified Arduino programming language, it features an intuitive code editor, compiler, bootloader, and an efficient library management system for streamlined development. The IDE's serial monitor enables real-time communication, aiding in debugging and data monitoring. Its accessibility, cross-board compatibility, and strong community support make the Arduino IDE a valuable asset for professionals engaged in diverse electronic design projects.



Fig 3.3.2 Arduino IDE

Cloud Services:

Cloud services for hosting, exemplified by platforms like Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP), revolutionize the way businesses manage their online presence. These services offer scalable and flexible hosting solutions, allowing websites and applications to adapt seamlessly to fluctuating traffic demands.

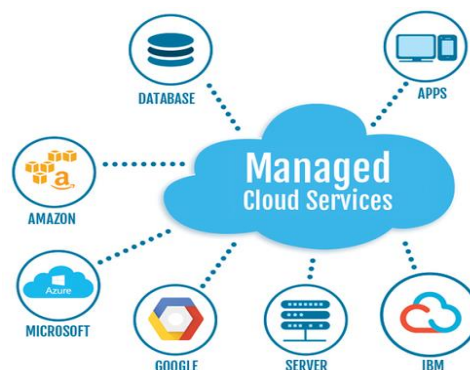


Fig 3.3.2 Cloud services

3.4 HARDWARE REQUIREMENTS:

Microcontroller (NodeMCU):

The NodeMCU is a versatile open-source microcontroller development board based on the ESP8266 Wi-Fi module. Featuring the Lua scripting language, it simplifies IoT (Internet of Things) development by providing built-in Wi-Fi connectivity and ease of programming. With its integrated USB-to-serial converter and a range of GPIO pins, NodeMCU is suitable for a variety of applications, including home automation, sensor networks, and IoT projects.



Fig 3.4.1 NodeMCU

Voltage Sensing Module:

A voltage sensing module is a component designed to measure and monitor voltage levels in electronic systems. Typically integrated with sensors or circuits, it provides an output that corresponds to the voltage being measured. These modules are crucial in various applications such as power supplies, battery monitoring, and energy management systems.

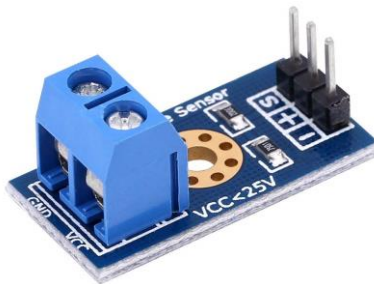


Fig 3.4.2 Voltage Sensing sensor

Current Sensing Module:

The ACS712 is a Hall effect-based current sensor by Allegro Microsystems, used for measuring AC and DC currents. It provides a linear output voltage proportional to the current passing through. The sensor offers selectable sensitivity options, low-noise operation, and comes in various models with specific current ratings. Its compact design and compatibility with microcontrollers make it popular in applications such as energy monitoring and motor control systems.

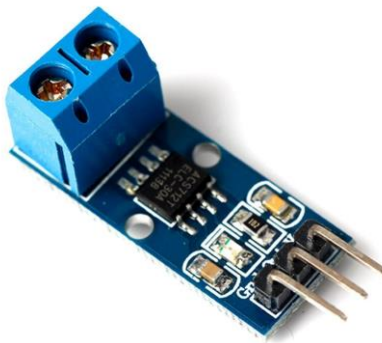


Fig 3.4.3 Current Sensing Module

Communication Module:

A communication module is a vital component in electronic systems, facilitating the exchange of data between devices. These modules, such as Wi-Fi, Bluetooth, or Ethernet interfaces, enable seamless connectivity. Selecting the appropriate communication module is essential for ensuring reliable data transfer. Compatibility with microcontrollers, data transfer speed, and range are key considerations. Communication modules play a crucial role in applications like smart home devices, industrial automation, and remote sensing systems.

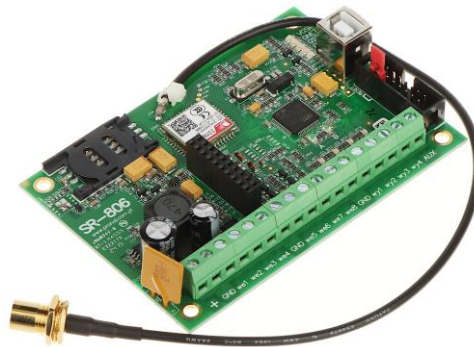


Fig 3.4.4 Communication Module

Temperature Sensor DS18B20:

Temperature sensors, exemplified by the DS18B20 digital sensor, play a crucial role in electronic applications by providing accurate and versatile temperature measurements. Its compact and waterproof design enhances adaptability, making it suitable for deployment in various environments. With precise and reliable digital readings over a wide temperature range, this sensor seamlessly integrates into microcontroller-based projects, finding applications in climate control, industrial automation, and weather monitoring.

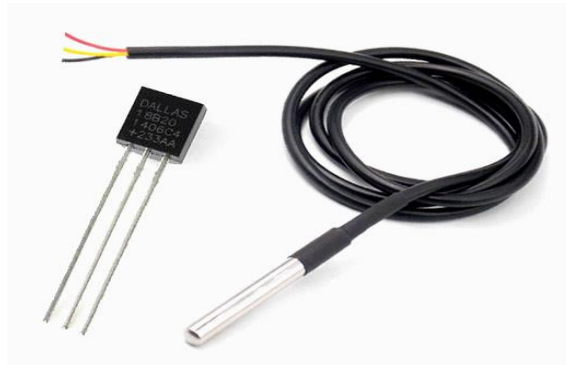


Fig 3.4.5 Temperature Sensor

Vertical LCD display:

The implementation of a vertical LCD display as a dashboard for a smart electricity meter represents a strategic enhancement in user interface design. This display provides a user-friendly and visually intuitive interface for monitoring and managing energy consumption. Through the vertical orientation, key parameters such as real-time energy usage, historical data, and system alerts are presented in a clear and organized manner, optimizing readability.



Fig 3.4.6 Vertical LCD Display

CHAPTER 4

DESCRIPTION OF THE PROPOSED SYSTEM

The SEM's impact transcends individual households, with significant implications for broader energy management initiatives. By aggregating data from multiple SEM installations, utility providers gain valuable insights into energy consumption patterns at the community or regional level. Armed with this information, they can devise targeted strategies to optimize energy distribution, alleviate strain on the grid during peak hours, and minimize wastage. Moreover, SEM's integration potential with renewable energy sources fosters a transition towards a greener energy landscape. By synchronizing with solar panels, wind turbines, or battery storage systems, SEM enables users to maximize self-consumption of renewable energy, reducing reliance on traditional fossil fuels and mitigating environmental impact.

Furthermore, the SEM's adaptability extends to commercial and industrial settings, where energy efficiency is paramount for operational sustainability and cost management. By providing granular insights into energy usage across different departments or production lines, SEM empowers businesses to identify inefficiencies, streamline processes, and optimize resource allocation. In conjunction with smart building management systems, SEM facilitates intelligent energy allocation, dynamically adjusting consumption in response to demand fluctuations and external factors such as time-of-use pricing. This holistic approach to energy management not only drives cost savings but also enhances operational resilience and environmental stewardship, aligning with corporate sustainability goals and regulatory requirements.

In essence, the SEM represents a paradigm shift in how we interact with and manage electricity consumption. Beyond mere data collection, it embodies a philosophy of empowerment, enabling users to take control of their energy usage, make informed decisions, and contribute to a more sustainable future. As society grapples with the challenges of climate change and resource scarcity, the SEM emerges as a beacon of innovation and progress, heralding a new era of energy consciousness and efficiency. Whether at the individual, community, or industrial level, the SEM's transformative potential holds promise for a brighter and more sustainable tomorrow.

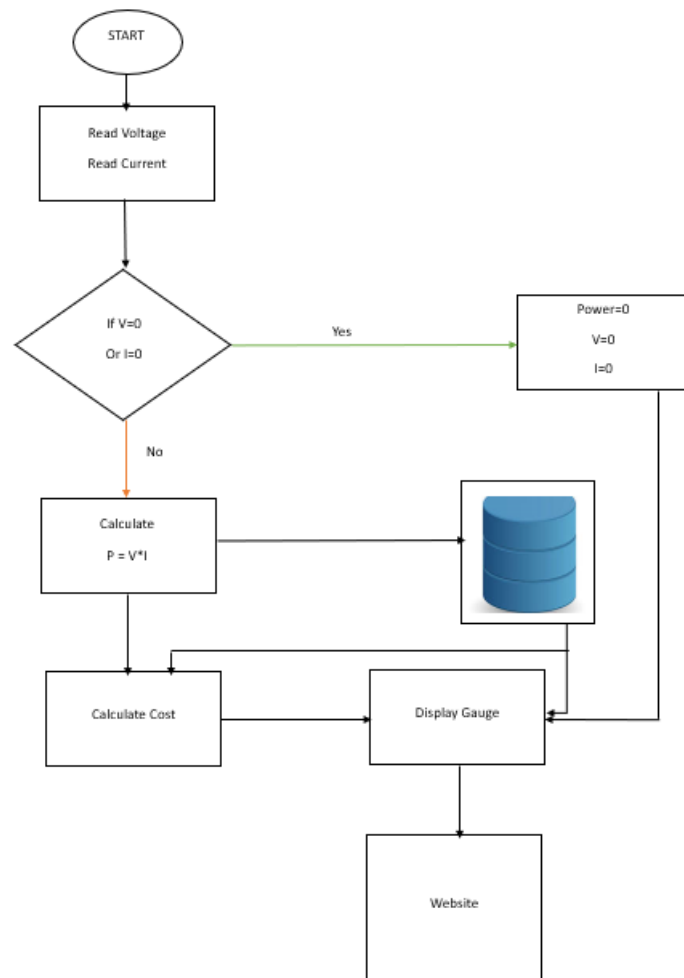


Fig 4.1: A Representation of a Smart Electricity Meter using Dataflow Diagram

4.1 ARCHITECTURE / OVERALL DESIGN OF PROPOSED SYSTEM

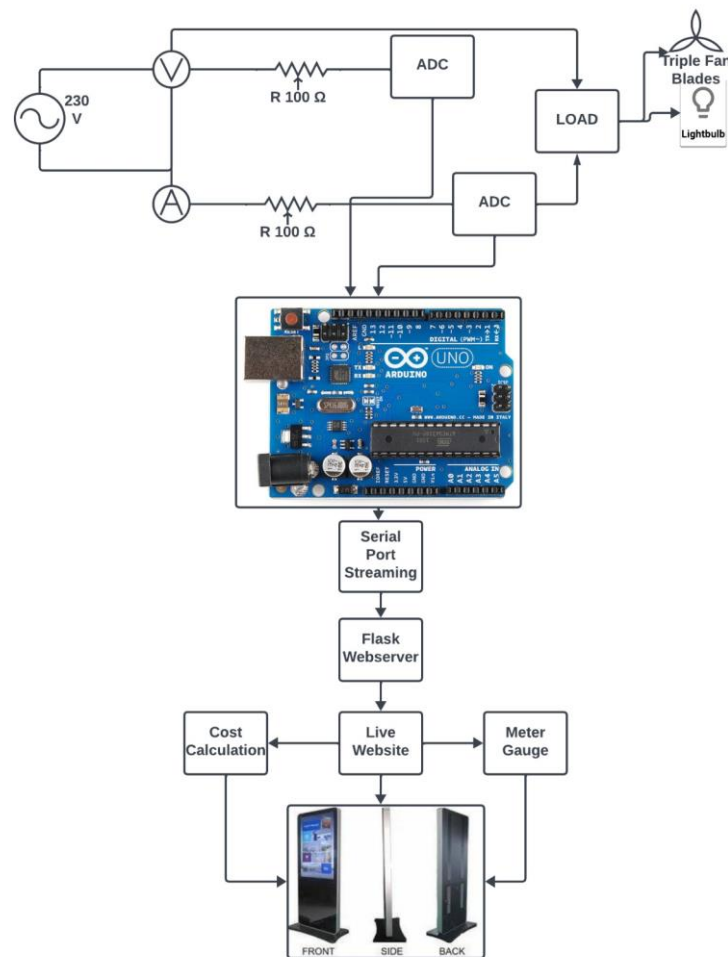


Fig 4.2: System Architecture for Smart Electricity Meter

In the proposed system, a 230V power supply is connected to a load, with a voltmeter and ammeter simultaneously measuring voltage (V) and current (I). These electrical parameters are then transmitted to an Arduino microcontroller, serving as a digital processing hub. The Arduino calculates instantaneous power consumption (P) using the formula $P = VI$. Subsequently, the processed data is transmitted through a serial communication interface to an external device with internet connectivity. Without specifying protocols, the external device relays the data to a dedicated website, where it is visually represented using a meter gauge or graphical display. This web-based presentation enhances real-time monitoring of power consumption, allowing users to make informed decisions about energy usage. The integration of the Arduino's digital interface with web-based visualization provides a user-friendly platform for effectively understanding and managing power consumption in the

connected load.

4.2 DESCRIPTION OF SOFTWARE FOR IMPLEMENTATION AND TESTING PLAN OF THE PROPOSED MODEL/SYSTEM

1. Programming Language:

The project will be implemented using the Arduino programming language for the ESP32 firmware. Python will be used on the server side to receive data from the ESP32 over a serial connection and store it in MongoDB.

2. Arduino Libraries:

ESP32-specific libraries for Arduino, including the ESP32 WiFi library and the Blynk library, will be utilized to enable seamless communication between the ESP32 and the Blynk app.

3. Communication Protocols:

The ESP32 will communicate with sensors (such as current and voltage sensors) to gather real-time electrical parameters. Data will be sent from the ESP32 to a Python server over a serial connection, and the Blynk app will communicate with the ESP32 over the internet using the Blynk platform.

4. Blynk App Integration:

The Blynk app will serve as the primary user interface, allowing users to monitor real-time energy consumption data and potentially control connected devices remotely.

5. Data Storage with Python and MongoDB:

A Python script running on a server will receive data from the ESP32 over the serial connection. The Python script will then use the pymongo library to connect to a MongoDB database and store the received data. This enables efficient storage and retrieval of both real-time and historical energy consumption data.

6. Security Considerations:

Security measures should be implemented in both the ESP32 firmware and the

Python script to ensure the confidentiality and integrity of the data being transmitted and stored.

Testing Plan for the Proposed Model/System:

1. Unit Testing:

- Verify the accuracy of voltage and current measurements individually.
- Test the functionality of the ESP32's communication with sensors and the Blynk app.
- Confirm the proper implementation of the data sending mechanism from ESP32 to the Python server.

2. Integration Testing:

- Validate the seamless integration between the ESP32 firmware, Blynk app, and Python server.
- Confirm the data flow from sensors through the ESP32 to the Python server and subsequent storage in MongoDB.
- Ensure that changes in data on the Blynk app are reflected in real-time on the ESP32.

3. Functional Testing:

- Test the real-time display of energy consumption data on the Blynk app.
- Validate the accuracy of power consumption calculations performed by the ESP32.
- Simulate various scenarios of energy consumption to ensure the dynamic adaptability of the system.
- Confirm the responsiveness of the Blynk app to user commands for remote control functionalities.

4. Performance Testing:

- Measure the system's response time for real-time data display on the Blynk app.
- Evaluate the ESP32's ability to handle different loads of incoming data.
- Assess the scalability of the system with varying numbers of connected devices.

5. Usability Testing:

- Evaluate the user interface of the Blynk app for intuitiveness and ease of use.
- Ensure that users can easily understand and interpret real-time energy consumption data.
- Gather feedback from potential users to identify areas for improvement in the Blynk app interface.

6. User Acceptance Testing (UAT):

- Involve end-users, including residents and utility authorities, to validate the system's effectiveness in monitoring and controlling energy consumption.
- Assess the Blynk app's user-friendliness and overall user satisfaction.
- Address user feedback and make necessary adjustments to enhance the user experience.

4.3 PROJECT MANAGEMENT PLAN

1. Requirement Analysis - 5 days
2. Hardware Setup (ESP32 and Sensors) - 7 days
3. ESP32 Firmware Development - 10 days
4. Blynk App Interface Design - 7 days
5. Integration of ESP32 with Blynk App - 5 days
6. Real-time Data Transmission Testing - 4 days
7. Blynk App User Interface Testing - 4 days
8. Data Storage Implementation (Python and MongoDB) - 8 days
9. End-to-End System Testing - 10 days
10. User Acceptance Testing (UAT) - 6 days

4.4 FINANCIAL REPORT ON ESTIMATED COSTING

1. ESP32 Microcontroller: ₹800 per unit
2. Current Sensor: ₹500 per sensor
3. Voltage Sensor: ₹400 per sensor
4. Blynk App Development: ₹5,000
5. Housing and Enclosure: ₹600 per unit

6. Power Supply Components: ₹200 per unit
7. Miscellaneous (wires, connectors, PCB): ₹500 per unit
8. Base cost for hosting: ₹2000 + Resources used

CHAPTER 5

IMPLEMENTATION DETAILS

5.1 DEVELOPMENT AND DEPLOYMENT SETUP

NodeMCU Integration:

The NodeMCU, an open-source IoT platform based on the ESP8266 WiFi module, is likely used for connecting the meter to the internet. It might handle data collection from ammeters and voltmeters and send this data to the central server.

Ammeter and Voltmeter Integration:

Ammeters and voltmeters are hardware components used for measuring current and voltage, respectively. Integration involves connecting these sensors to the NodeMCU, ensuring accurate readings.

Arduino IDE for NodeMCU Programming:

Arduino IDE is used for programming the NodeMCU, as it supports the ESP8266 platform. Developers would write firmware code to read sensor data, manage WiFi connectivity, and transmit data to the backend server.

VS Code for Backend Development:

Visual Studio Code (VS Code) is used for backend development. This might include writing Python code for the server-side logic and Flask web framework for handling HTTP requests and responses.

Python and Flask for Backend Logic:

Python is the programming language used for the backend, and Flask is the web framework chosen for creating the web application. Flask allows developers to define routes, handle requests, and interact with the database.

Serial Module for Communication:

The Serial module in Python is likely used to establish communication between the NodeMCU and the backend server. It facilitates the transfer of data from the microcontroller to the server over a serial connection.

MongoDB as the Backend Database:

MongoDB is employed as the backend database to store historical data and user information. The flexibility of a NoSQL database like MongoDB is suitable for handling time-series data and accommodating future expansions in data structure.

Real-time Data Processing with Python:

Python is used for real-time data processing on the server side. The backend logic includes algorithms to compute consumed units, related expenses, and other real-time metrics based on the incoming data from the NodeMCU.

Web Interface Development with Flask and HTML/CSS/JavaScript:

Flask, along with HTML, CSS, and JavaScript, is used for developing the user-friendly web interface. The frontend communicates with the backend to fetch and display real-time data, historical trends, and insights.

Database Integration:

The use of a scalable database like MongoDB and modular coding practices in both NodeMCU firmware and Flask backend supports scalability. A maintenance plan should include regular updates to address security vulnerabilities and improve functionality.

DEPLOYMENT PHASES**NodeMCU Firmware Deployment:**

- Compile and upload firmware code to the NodeMCU, configuring it for WiFi connection and backend communication. This step ensures the NodeMCU is ready to capture real-time electrical characteristics and transmit data to the backend on Render.

MongoDB Setup on Render:

- Set up a MongoDB instance on Render, configuring connection details. This establishes the backend database for storing and managing historical data captured by the NodeMCU.

Flask Application Deployment:

- Develop and test the Flask application locally, focusing on functionalities such as data processing, user interaction, and communication with the NodeMCU. Configure environment variables for sensitive information in the Render dashboard.

Version Control and Deployment:

- Connect the Render environment to the Git repository containing the Flask application code. Configure automatic deployment triggers on Git pushes, ensuring a streamlined and version-controlled deployment process.

Web Interface Deployment:

- Deploy frontend code (HTML, CSS, JavaScript) along with the Flask application on Render. Ensure a smooth and responsive web interface that seamlessly communicates with the backend, providing users with real-time insights into their power consumption.

Backup and Recovery Implementation:

- Establish a regular backup schedule for the MongoDB database on Render to prevent data loss. Additionally, define and test a recovery plan to address potential issues and ensure data integrity in the event of system failure or other unforeseen circumstances.

CHAPTER 6

RESULTS AND DISCUSSION

RESULTS:

The Smart Ecotricity Meter successfully integrates cutting-edge technology and environmentally friendly living by employing voltage and current sensors for precise real-time monitoring of electrical characteristics. The specialized online interface facilitates remote monitoring, allowing users to access energy usage trends from any location. Additionally, the meter provides a detailed breakdown of electricity spending, including computed consumed units and associated expenses. This comprehensive approach empowers users to make educated decisions about their energy consumption and promotes a more conscious and sustainable use of electricity.

DISCUSSION:

The Smart Ecotricity Meter's ability to offer real-time monitoring and detailed consumption breakdown aligns with the growing global emphasis on responsible resource management and sustainable living. By empowering users with insights into their energy usage patterns, the system encourages informed decision-making and contributes to a more environmentally conscious future. The user-friendly web platform not only enhances accessibility but also fosters engagement through historical data visualization, allowing users to identify trends and optimize their energy usage. This holistic approach positions the Smart Ecotricity Meter as a valuable tool in the transition towards a greener and more efficient electricity consumption model.

CHAPTER 7

CONCLUSION

7.1 CONCLUSION

In conclusion, the development and deployment of the Smart Ecotricity Meter represent a significant stride towards merging cutting-edge technology with environmentally conscious living. The successful integration of NodeMCU firmware, Flask backend, and MongoDB database enables real-time monitoring of power consumption and facilitates user engagement through a user-friendly web interface. Thorough testing, including integration, performance, security, and usability assessments, ensures the reliability and robustness of the system. As users gain access to detailed insights into their electricity usage patterns, the project not only empowers informed decision-making but also contributes to a broader global shift towards sustainable and responsible resource management. The scalable and secure architecture, coupled with periodic backups, establishes a foundation for the long-term reliability and resilience of the Smart Ecotricity Meter. Overall, the project serves as a testament to the possibilities of technology in fostering a greener and more environmentally conscious future.

7.2 FUTURE WORK

Future work for the SEM project holds exciting possibilities for enhancing its capabilities and expanding its impact. Incorporating smart learning features could empower users to predict and optimize their energy usage, fostering a more intuitive and personalized experience. Further integration with smart home devices would offer users increased control and convenience in managing their energy consumption. Exploring the incorporation of renewable energy sources aligns with the project's commitment to sustainability and could contribute to a more eco-friendly energy landscape. Enhancing data visualization techniques would provide users with clearer and more detailed insights, making the interface even more user-friendly. Collaboration with utility providers or government agencies could extend the positive effects of the project to broader community initiatives. Continuous updates to technology and security measures, coupled with a proactive approach to emerging trends, will be vital in ensuring the SEM remains adaptable and impactful in the evolving landscape of environmental monitoring and sustainable living.

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APPENDIX

A. SOURCE CODE:

PYTHON CODE:

```
from flask import Flask, render_template, Response
import serial
import time

app = Flask(name)

def readserial(comport, baudrate, timestamp=False):
    ser = serial.Serial(comport, baudrate, timeout=0.1)
    while True:
        data = ser.readline().decode().strip()
        if data and timestamp:
            voltage, current = data.split("/")
            # timestamp = time.strftime('%H:%M:%S')
            yield f'{voltage},{current}'
        elif data:
            yield f'{voltage},{current}'

@app.route('/')
def index():
    return render_template('index.html')

@app.route('/stream')
def stream():
    def generate():
        for data in readserial('COM3', 9600, True):
            yield f'data: {data}\n\n'
    return Response(generate(), mimetype='text/event-stream')

if name == 'main':
    app.run(debug=True, port=5000, host='0.0.0.0')
```

LOGIN PAGE

LOGIN.HTML

```
<!DOCTYPE html>
<html>
<head>
<link href='https://unpkg.com/boxicons@2.1.4/css/boxicons.min.css' rel='stylesheet'>
<link href="login.css" rel="stylesheet">
```

```

<style>
.hidden {
display: none;
}
</style>
</head>
<body>
<div id="loginForm" class="wrapper">
<form action="">
<h1>Login</h1>
<div class="input-box">
<input type="text" placeholder="Username" required>
<i class='bx bxs-user'></i>
</div>
<div class="input-box">
<input type="password" placeholder="password" required>
<i class='bx bxs-lock-alt'></i>
</div>
<div class="remember-forgot">
<label><input type="checkbox">Remember me
</label>
<!-- Removed the forgot password option -->
</div>
<button type="submit" class="btn">Login</button>
<div class="register-link">
<p>Don't have an account? <a href="#"
onclick="showRegisterForm()">Register</a></p>
</div>
</form>
</div>
<div id="registerForm" class="wrapper hidden">
<form action="">
<h1>Register</h1>
<div class="input-box">

```

```

<input type="text" placeholder="Name" required>
<i class='bx bxs-user'></i>
</div>
<div class="input-box">
<input type="text" placeholder="Mobile Number" required>
<i class='bx bxs-phone'></i>
</div>
<div class="input-box">
<input type="email" placeholder="Email" required>
<i class='bx bxs-envelope'></i>
</div>
<div class="input-box">
<input type="text" placeholder="Username" required>
<i class='bx bxs-user'></i>
</div>
<div class="input-box">
<input type="password" placeholder="Password" required>
<i class='bx bxs-lock-alt'></i>
</div>
<button type="submit" class="btn">Register</button>
<div class="register-link">
<p>Already have an account? <a href="#"
onclick="showLoginForm()">Login</a></p>
</div>
</form>
</div>
<script>
function showRegisterForm() {
document.getElementById('loginForm').style.display = 'none';
document.getElementById('registerForm').style.display = 'block';
}
function showLoginForm() {
document.getElementById('registerForm').style.display = 'none';
document.getElementById('loginForm').style.display = 'block';

```

```
}  
</script>  
</body>  
</html>
```

LOGIN.CSS

```
@import url('https://fonts.googleapis.com/css2?family=Poppins&display=swap');  
* {  
padding: 0;  
margin: 0;  
box-sizing: border-box;  
font-family: 'Poppins', sans-serif;  
}  
body {  
display: flex;  
justify-content: center;  
align-items: center;  
min-height: 100vh;  
background:url(sem2img.jpg);  
background-size: cover;  
background-position: center;  
}  
.wrapper {  
width: 420px;  
background: transparent;  
border:2px solid rgba(255, 255, 255, .2);  
backdrop-filter:blur(20px);  
box-shadow: 0 0 10px rgba(0 , 0 , 0 , .2);  
color: #fff;  
border-radius: 10px;  
padding: 30px 40px;  
}  
.wrapper h1 {  
font-size: 36px;
```

```

text-align: center;
}
.wrapper .input-box {
position: relative;
width: 100%;
height: 50px;
margin: 30px 0;
}
.input-box input {
width: 100%;
height: 100%;
background: transparent;
border: none;
outline: none;
border: 2px solid rgba(255, 255, 255, .2);
border-radius: 40px;
font-size: 16px;
color: #fff;
padding: 20px 45px 20px 20px;
}
.input-box input::placeholder {
color: #fff;
}
.input-box i {
position: absolute;
right: 20px;
top: 50%;
transform: translateY(-50%);
font-size: 20px;
}
.wrapper .remember-forgot {
display: flex;
justify-content: space-between;
font-size: 14.5px;

```

```

margin: -15px 0 15px;
}
.remember-forgot label input {
accent-color: #fff;
margin-right: 3px;
}
.remember-forgot a {
color: #fff;
text-decoration: none;
}
.remember-forgot a:hover {
text-decoration: underline;
}
.wrapper .btn {
width: 100%;
height: 45px;
border-radius: 40px;
border: none;
outline: none;
background: #fff;
box-shadow: 0 0 10px rgba(0 , 0 , 0 , .1);
cursor: pointer;
font-size: 16px;
color: #333;
font-weight: 600;
}
.wrapper .register-link {
text-align: center;
font-size: 14.5px;
margin: 20px 0 15px;
}
.register-link p a {
color: #fff;
text-decoration: none;

```

```
font-weight: 600;
}
.register-link p a:hover {
text-decoration: underline;
}
```

METER DASHBOARD

```
<!DOCTYPE html>
<html lang="en">
<head>
<meta charset="UTF-8">
<meta name="viewport" content="width=device-width, initial-scale=1.0">
<title>Usage Data</title>
<link href="https://stackpath.bootstrapcdn.com/bootstrap/4.5.0/css/bootstrap.min.css"
rel="stylesheet">
<script src="https://cdnjs.cloudflare.com/ajax/libs/raphael/2.1.4/raphael-
min.js"></script>
<script
src="https://cdnjs.cloudflare.com/ajax/libs/justgage/1.2.9/justgage.min.js"></script>
<style>
h2{
padding-top: 20px;
}
</style>
</head>
<body>
<div class="container">
<h1 class="text-center my-4">Usage Data</h1>
<div class="row">
<div id="voltage-gauge" class="col-md-6 border p-3">
<h2>Voltage</h2>
</div>
<div id="current-gauge" class="col-md-6 border p-3">
<h2>Current in mA</h2>
</div>
```

```

</div>
<div class="row" style="margin-top: 100px;">
<div id="power-gauge" class="col-md-6 border p-3">
<h2>Power</h2>
</div>
<div id="cost" class="col-md-6 border p-3">
<h2 style="margin-top: 100px;">Cost</h2>
<h3 id="cost-value"></h3>
</div>
</div>
</div>
<script src="https://code.jquery.com/jquery-3.5.1.min.js"></script>
<script>
$(document).ready(function() {
var source = new EventSource("/stream");
var totalPower = 0;
var voltageGauge = new JustGage({
id: "voltage-gauge",
value: 0,
min: 5,
max: 500,
title: "Voltage",
decimals:2
});
var currentGauge = new JustGage({
id: "current-gauge",
value: 0,
min: 0,
max: 200,
label:"A",
title: "Current in mA",
decimals:2
});
var powerGauge = new JustGage({

```

```

id: "power-gauge",
value: 0,
min: 0,
max: 600, // Adjust max power as needed
title: "Power",
decimals:2
});
source.onmessage = function(event) {
var data = event.data.split(",");
var voltage = parseFloat(data[0]);
var current = (parseFloat(data[1])*100)+0.3;
var power = voltage * current/100;
totalPower += power;
var cost = totalPower * 0.05;
voltageGauge.refresh(voltage.toFixed(2));
currentGauge.refresh(current.toFixed(2));
powerGauge.refresh(power.toFixed(2));
$('#cost-value').html('$' + cost.toFixed(2));
}
});
</script>
</body>
</html>

```

ARDUINO CODE

```

int adc_max = 728;

int adc_min = 297;

float volt_multi = 231;

float volt_multi_p;

float volt_multi_n;

```

```

#include <Filters.h>

#define ACS_Pin A0

float ACS_Value;

float testFrequency = 50;

float windowLength = 40.0/testFrequency;

float intercept = 0;

float slope = 0.0752;

float Amps_TRMS;

unsigned long printPeriod = 1000;

unsigned long previousMillis = 0;

void setup() {

    Serial.begin(9600);

    volt_multi_p = volt_multi * 1.4142;

    volt_multi_n = -volt_multi_p;

    Serial.begin( 9600 );

    pinMode(ACS_Pin,INPUT);

}

void loop() {

    RunningStatistics inputStats;

    inputStats.setWindowSecs( windowLength );

    while( true ) {

        ACS_Value = analogRead(ACS_Pin);

        inputStats.input(ACS_Value);

        if((unsigned long)(millis() - previousMillis) >= printPeriod) {

```

```

previousMillis = millis();

Amps_TRMS = intercept + slope * inputStats.sigma();

float volt_rms = get_voltage();

Serial.print("/");

Serial.println( Amps_TRMS );

}

}

}

float get_voltage() {

    float adc_sample;

    float volt_inst = 0;

    float sum = 0;

    float volt;

    long init_time = millis();

    int N = 0;

    while ((millis() - init_time) < 500) {

        adc_sample = analogRead(A1);

        volt_inst = map(adc_sample, adc_min, adc_max, volt_multi_n, volt_multi_p);

        sum += sq(volt_inst);

        N++;

        delay(1);

    }

    volt = sqrt(sum / N);

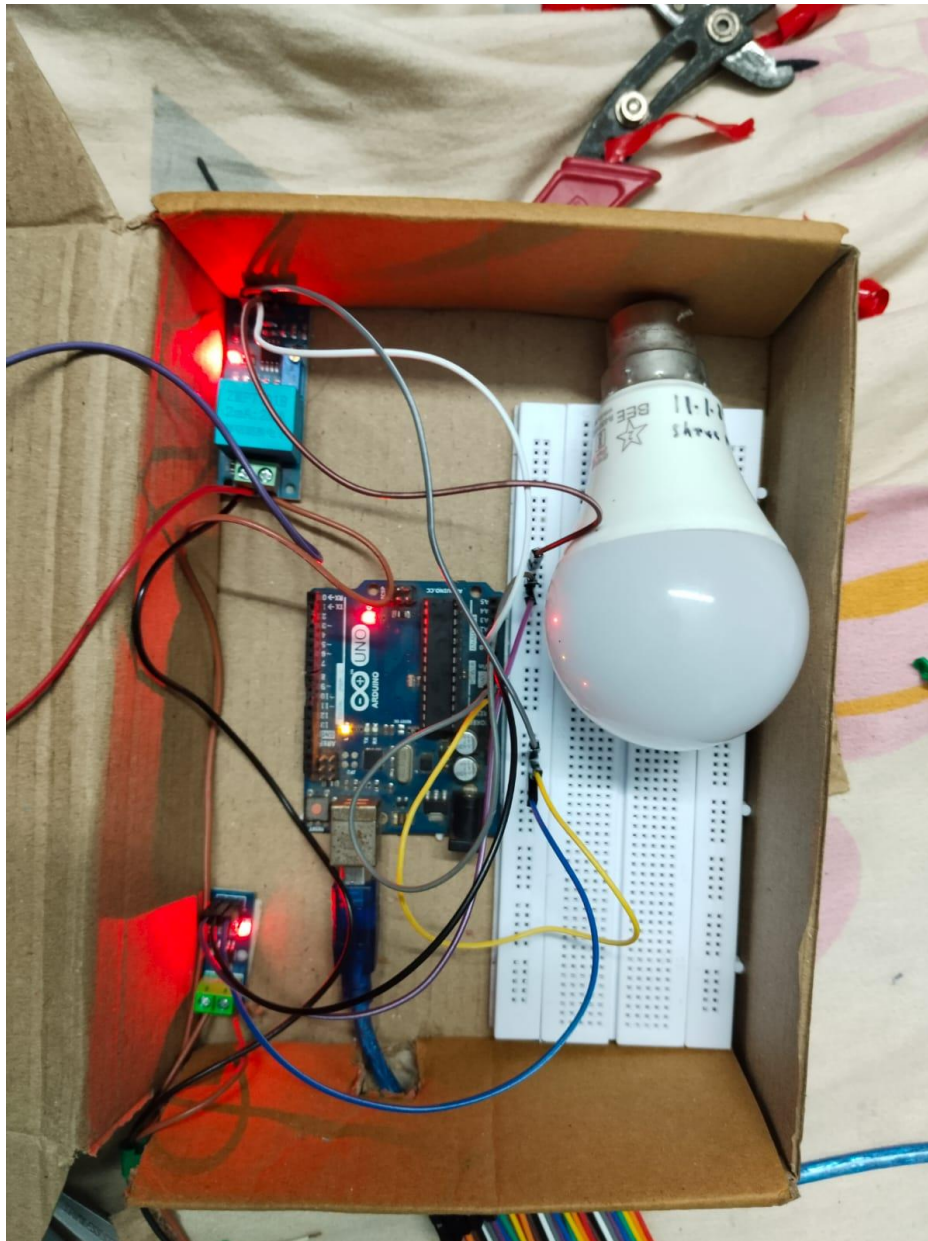
    return volt;

}

```

B.SCREENSHOTS:

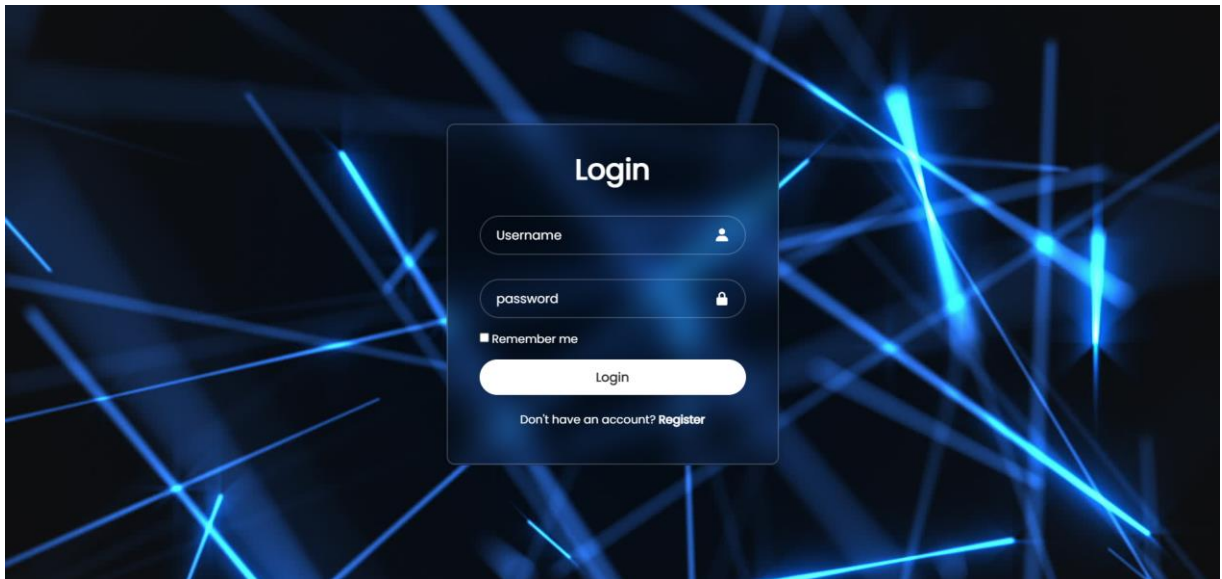
A. HARDWARE COMPONENTS OF THE PROJECT



B. WORKING OF PROJECT



C. LOGIN PAGE



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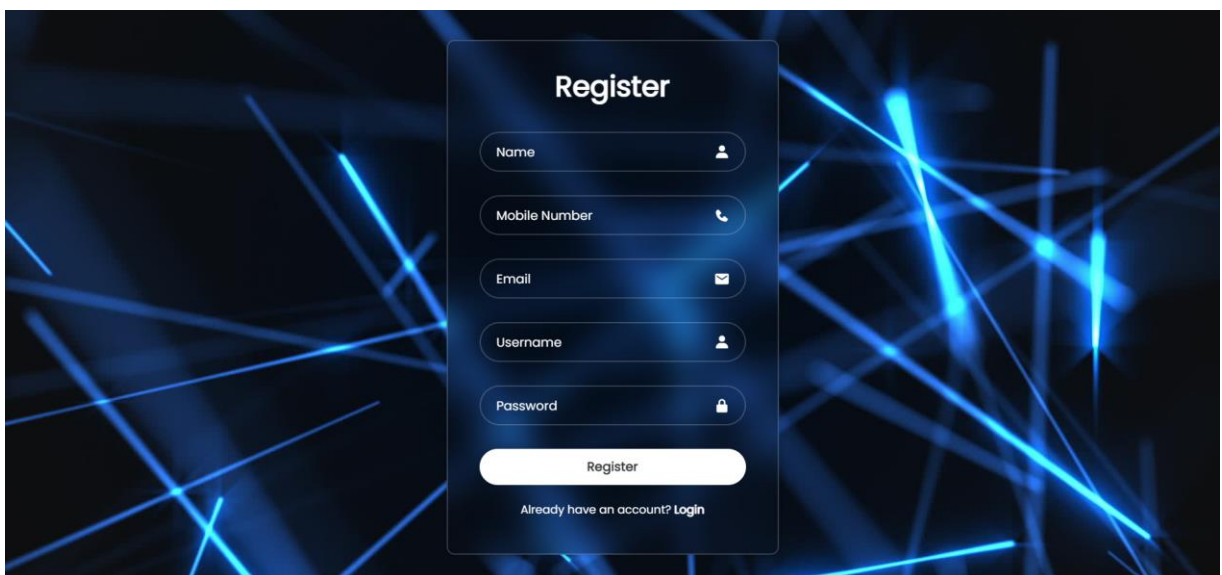
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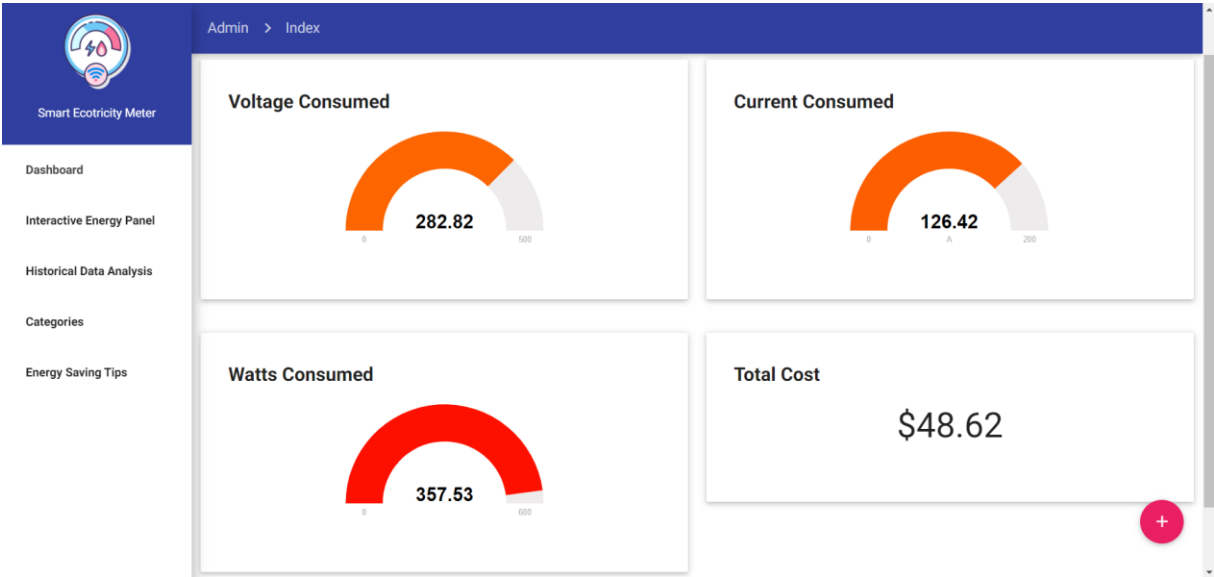
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D. OVERALL DASHBOARD



E. MOBILE VIEW

