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Wireless Energy Monitoring System using SCADA-A Review

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***Abstract*—Energy management and monitoring have always been unpredictable throughout India. This has led to the development of a straightforward yet insightful inquiry: "What is the new source of energy management?" The majority of our energy management-related concerns are resolved by this query. It has been observed generally across the nation that in order to monitor energy levels and provide a complete report about its use in kWh, an official must personally visit the user's home to verify historical meter readings before producing a chargeable report about the same. To show how a Smart Energy Meter (SEM) can generate an electricity bill while successfully decreasing errors. Methods: This SEM device blends contemporary technology with pre-existing electrical design, making it a low-cost solution suitable for the Indian setting. The suggested SEM just has a current sensor and a few related circuits. An Advanced Reduced Instruction Set Computer Machine (ARM7) microprocessor continuously monitors the system, and an integrated Android App makes the results available. A Wi-Fi module enables constant data updates and control over home equipment. Smart meter sensors are integrated into a PLC-equipped, PLC-controlled, and SCADA-monitored system. After connecting a wireless connection device, the system will collect observed data from the digital energy meter and transfer it to a server and the internet. Power theft will be discovered by a sensor, which will activate any time electricity is utilized improperly. A consumer utility grid will be automatically unplugged, and the customer's supply will be restored if there is a chance that it has been burglarized.**

Keywords—Energy meter, PLC, Data processing, SEMs, SCADA, Wi-Fi-module.

I. INTRODUCTION

According to a research by the Energy Information Administration, India is thought to squander almost three billion units of power annually (EIA). The main reason for this waste is inadequate power supply monitoring. The current situation calls for an automated method for generating electricity bills and proper monitoring of each appliance. Electronic energy meters and Internet of Things (IoT)-based Smart Energy Meters are just two examples of the technologies and methods that have been developed to measure power consumption more intelligently than conventional meters (Electro-Mechanical Induction Type). However, the proposed smart energy meters have been adversely affected in a number of ways. The proposed system sends an alert via mobile to the user to pay or recharge for an uninterrupted supply. The main disadvantage of this SEM is that power leakage may occur due to the usage of both current and voltage sensors for continuous monitoring of the electric devices. An IoT-based SEM using GSM fabricated by has implemented a system that used an Arduino Uno as a controller and a GSM module for sending information. This system collects information from the Arduino regarding the power consumption and the GSM module sends this information to the mobile device as a notification message. However, alerts regarding slab rates were not provided by these researchers. Slab rate alerts are important that could save a good amount of consumers' money. The proposed SEM utilizes a GSM architecture. This innovative system allows the electricity department to obtain regular meter readings without the need for manual readings. Additionally, the proposed smart meter features a prepaid billing system, efficient electricity management, and energy-saving capabilities. Furthermore, it also incorporates a mechanism to detect electricity theft. Nevertheless, as current and voltage sensors, as well as tampering and theft alarms, have been incorporated, power leakages are an issue that needs to be considered. Arduino-based SEM proposed by , uses a GSM shield module on a microcontroller to get her with an LDR sensor and relay. The system allows users to get energy consumption updates via SMS, as well as final bill creation and load re-configuration by SMS. But, the proposed SEM looks too complex, as it also has current, voltage sensors and other different periphery electronic components. The electricity sector is facing a major challenge in managing energy consumption due to the ever-increasing demand for energy, which has become an integral part of human life. Therefore, it is crucial to control and reduce household energy consumption to address this concern. The Energy Information Administration conducted study, and it is estimated that India wastes roughly three billion units of electricity each year(EIA). This waste primarily results from

insufficient power supply monitoring. Currently, it is necessary to generate electricity bills automatically and properly monitor each appliance. These are only two examples of the technologies and techniques that have been record different physiological parameters of human. The data is collected from the sensors and is analysed, computed using machine learning. The product outcome of the system would be an analysed and computed data, which plays an important role in the diagnosis. This is significant on the grounds that anybody could basically gain the software and start gathering information right away. Since a significant objective of the undertaking is to not meddle with the medical procedure being finished by utilizing muddled software, this is beneficial. Likewise, another benefit to the software comes as different data sources, and Bio Bench is fit for utilizing sixteen information channels.

II. LITERATURE SURVEY

A. Muhammad Usman et-a[3] proposed in this paper, an assertion of functions of the meter system: Load-Side Management, Data Recording and Alarming, Regular Metering and Precision, Bidirectional Communication. In comparison to conventional energy systems, smart metre technologies and other extensive applications made possible by SEMs have a number of notable advantages. Furthermore, it is getting easier to predict how REBN will advance. A compostable framework, in which the metre is constructed as an open structure with new capabilities, will make electricity metres intelligent and much more versatile. By including additional components, integrating Additionally, another alternative is installed in a SEM unit into other appliances in order to carry out the smartmetering function.

B. In this paper, Syufrijal, R. et-a [2] concluded on the fact that electrical energy usage can often be inefficient and wasteful due to the improper timing of its use, lack of awareness among the public to conserve energy, and the inability of consumers to directly monitor their usage. To address these issues, it would be beneficial to implement a system that can remotely and automatically monitor customers' electrical energy consumption. This paper also states that, The Internet of Things (IoT) can be used in this study to remotely and in real time monitor electrical energy use using a computer or smartphone. A microcontroller connected to the internet network and utilizing the MQTT (Message Queuing Telemetry Transport) protocol will transmit the power meter data to the cloud. In the meantime, Modbus protocol is used for communication between the microcontroller and the power meter

C. Devendra M Jaiswal et-a [1] in their paper titled "Modeling & designing of smart energy meter for smart grid applications" have proposed a mathematical approach for process design of the smart energy meter. Basically, a process-focused intelligent energy measuring system consisting of an Arduino coupled with Sim900 GSM Module and a LCD for showing readings directly to the user. It also explains delta modulation in frequency domain This study presents estimation of power and energy in terms of real, reactive, and apparent after performing mathematical modelling. Power and energy variables are estimated by an energy computing chip under sinusoidal settings. To prevent the aliasing effect, a low pass filter's role in the attenuation of higher frequency elements during the evaluation of the RMS value of the current is essential. For converting an analogue signal to a digital signal in a smart meter, a frequency domain model of a Sigma Delta Modulator is created.

D. Ghasan Fahim Huseien et-a [1] The author presented a smart meter system's 5G infrastructure in an urban setting, demonstrating that 5G networks can facilitate the Internet of Things (IoT) for the development of intelligent structures. Furthermore, the paper explores how smart energy and building management, which rely on artificial intelligence, can be implemented. In this discussion, the essential principles of utilizing AI, ML, and DRL methods in smart cities and their advancement through 5G technology have been examined. The integration of modern technologies in various aspects of daily life has created opportunities to enhance service performance in buildings, towns, and cities. Singapore has backed the 5G smart city technology as it has been implemented together with a variety of other technologies. A 5G-powered facade inspection system's workflow is increasingly being met with AI and drones.

E. R Amudhevalli et-a [1] proposed a SCADA based energy monitoring system occupying a PLC. This study presented an IoT-based smart energy metre reading and monitoring system using PLC and SCADA. The system has a number of crucial benefits, including wireless data transfer, remote monitoring and control, an anti-theft device, and cheaper costs. The procedure will offer a simple way to obtain the metre reading and spot a power supply theft, even without any human involvement. Using PLC with wireless communication systems improves the consistency of wireless data delivery

F. Giovanna Morelli et-a [3] purposed that the acievement of green recovery in aftermath of the COVID-19 pandemic necessititates the implementtation of long term commitments and regulations that impact both developed and developing countries. To achieve this goal, it is essential to restructure investment plans and fiscal policies to align with sustainable paradigm. The urgency of the adjustments required to combat climate change, whose effects are still unevenly distributed globally, is even more evident in the present circumstances. Design, energy demand, and built environments will all be strongly impacted by climate change. A meso-level is no longer feasible due to the growing emphasis placed by people and businesses on a green, sustainable culture. Energy-related smart grids are relatively new. Unfortunately, the main drawbacks of the presented analysis are around the absence of comprehensive statistical data. To evaluate the theoretical model aimed at promoting a common sustainable goal among governmental institutions, testing it could be beneficial. To promote social acceptance, politicians can aid smart meters by introducing education initiatives. This could involve imparting new skills related to green culture, providing detailed information about supplier changes, and implementing stringent data protection and privacy laws.

G. Waheb et-a [1] proposed that, for IoT monitoring of PV installations, a SEM based on LoRaWAN should be developed. Using the TTN platform and ATTM IoT server, The smart energy meter (SEM) is capable of real-time monitoring of various electrical and environmental factors such as voltage, current, power, energy, light intensity, temperature, and humidity. Additionally, it allows for monitoring of power billing statistics based on fixed tariffs. Smart Energy Meter (SEM) uses Arduino as the main controller to collect sensors data and send them to the LoRaWAN gateway for up load to the IoT cloud.In order to enhance its portability,solar systems are integrated into SEM. SEM for the solarPV system in LoRaWAN has been testedin various environments and has proved its ability to effectively monitor DC energy consumption and related parameters.TTN and ATTM dashboards on computing devices with Internet access can display the monitored data. DMM was used to validate the obtained electrical values, including current, voltage, and power. In order to ensure reliable wireless communication during actual deployment, a deterministic evaluation of the wireless channel was conducted, considering factors such as RSSI and SNR. The real-time measurements demonstrated that the use of SEM-LoRaWAN is feasible, as it showed good data reception and reliable communication links. More testing with heavier loads and longer timeframes with numerous systems rather than just one PV system are anticipated in future development. As an AC energy metre is attached to the DC/AC converter of the PV system to track the energy consumption of loads, further research will be done at greater levels of system integration.

H. Amir Ehsan Kianfar; The energy data information will be gathered via a monitoring system, which will also keep an eye on the mine's environmental conditions and the condition of the energy transmission network. Hazardous gases like methane and carbon monoxide, which represent a serious risk to the safety of miners, are of particular importance. Because methane is present, the entire monitoring system was created with explosion safety in mind and is working toward ATEX certification. The gathered information will be sent to Surface's main office, where a central database will be used to store it. There, the data can be further analysed, giving the mine operators insight into their operations for possible optimization and allowing them to recognise and respond to risks before they pose a threat.

I. Author G. Vani proposed that with the help of the suggested smart metering system, consumers can take the necessary safety steps to protect their electrical appliances by keeping an eye on various electrical energy characteristics like voltage, power factor, current, and energy consumption in kWh. By doing this, the consumer participates actively in energy management. During busy hours, the consumer can also keep an eye on the load. If more load is transferred to off-peak hours, peak demand will decrease as a result, which lowers the need for power output at peak times and lowers the cost of production. Customers become more cautious in controlling their electricity consumption since they stand to gain by restricting consumption during peak times.Therefore, both utility providers and consumers can benefit from the developed smart metering system. It is possible to develop and integrate a smart circuit into the system that can identify theft and emit a switching pulse when it does. The proposed smart metre design can incorporate circuitry for theft detection and an appropriate tariff scheme.

J. Nadeem Tariq Beigh proposed that his innovative system for metering and billing utilizes an Arduino and a GSM-enabled Smart Energy Meter capable of wireless data transmission via a GSM modem. The system effectively manages both the meter and the connection line. To make this project more dependable, higher-quality, and safer, more changes must be made. Due to problems with the network strength, the network coverage of the SIM used with the GSM module may be a little problematic.

K. Dr R Pawan Kumar Naidu; After examining a number of papers, the best smart energy metre based on IOT was selected due to its effectiveness and the fact that it can be used in both households and businesses to assess individual electrical appliance usage without affecting how the appliances are currently performing. Consumers can monitor and control how their data is used. With the help of this, consumers can evaluate the operating status of the appliances. Since users are informed of how the appliances work, they might reduce losses and so contribute to energy conservation. help protect energy for future generations.This type of smart energy metre based on the IOT can be used to achieve bidirectional communication, two-way metering and invoicing, home device control and monitoring, power extortion detection, management of demand and load, and more

II] Tables and Figures:

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TABLE I

Sr. No.	Authors	Paper Name	Components used	Remarks
1.	Mohammed Usman Haider, Faizal Mumtaz, Haseeb Hassan Khan, Mohammed Asif, Mohammed Shoaib Rashid, Shah Rukh Abbas and Mohammed Zeeshan.	Smart Energy meters in Renewable-Energy-based power networks	Wifi Smart switch ZMAi90 energy meter, smart grid infrastructure	The electricity meters have been made intelligent, and versatile as a result of portable framework with new functionalities incorporated by adding new modules.
2.	Syufrijal , R. Wicaksono, M. Rif'an , R. Anugerah	IoT Based Smart Energy Meter Using Modbus Protocol as Electricity Saving Effort	Modbus RTU, Microcontroller, PLC Siemens S7-1200, Power meter, Ethernet Module, Routers, Relay	IOT implanted to monitor electricity consumption remotely in real time.
3.	Devendra M. Jaiswal, Mohan P. Thakre	Modeling & designing of smart energy meter for smart grid applications	LCD, Arduino Uno, Energy Meter, Load, GSM Module SIM900	Mathematical modelling of power and energy is performed in terms of real, reactive and apparent power.
4.	Ghasan Fahim Hussein, Kwok Wei Shah	A review on 5G technology for smart energy management and smart buildings in Singapore	Drone, Remote Controller, Cloud server	Study of Singapore's smart city 5G technology
5.	R Amudhevalli and T Sivakumar	IoT Based Smart Energy Metering System for Monitoring the Domestic Load Using PLC and SCADA	Smart meter, PLC, Gateway, Server, SCADA, WebApp	Transfer of data without wires, remote observation and management, and security measures against theft.
6.	Shaista Hassan, Mir , Sahreen Ashruf , Sameena , Yasmeen Bhat and Nadeem Beigh	Review on Smart Electric Metering System Based on GSM/IOT	Arduino UNO, ESP8266 Wifi Module, GSM SIM900 Module, 16x2 LCD, LDR Sensor.	The system has the capability to wirelessly receive and transmit data using the GSM technology through a wireless protocol.

7.	1G.Vani, V.Usha Reddy	Application of Smart Energy Meter in Indian Energy Context	RS485, GSM, Ethernet, Smart Card Reader, Battery, Control unit, Energy metering IC.	Monitoring different parameters like voltage, current, power factor.

CONCLUSION

In conclusion, an Energy Monitoring system using SCADA is a powerful tool for organizations seeking to optimize their energy usage, reduce costs, and achieve their sustainability goals. By providing real-time data and insights into energy consumption patterns and inefficiencies, the system can help organizations to identify areas of waste and inefficiency, and to make data-driven decisions about how to improve their energy usage. The Energy Monitoring system can provide detailed information on energy usage by location, time, and type of equipment, enabling organizations to pinpoint areas of waste and inefficiency. The system can also provide alerts and alarms when energy usage exceeds predetermined thresholds, helping organizations to quickly identify and address issues such as equipment malfunctions or excessive energy usage during non-operational periods. Overall, the implementation of an Energy Monitoring system using SCADA can lead to significant cost savings, improved energy efficiency, and reduced carbon footprint. With the increasing focus on sustainability and energy efficiency in today's business environment, an Energy Monitoring system using SCADA is an essential tool for organizations seeking to stay competitive and achieve their environmental goals.

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