

Review Paper on Smart Energy Meter with GSM Billing & Control

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Abstract

Traditional electrical metering still depends on manual reading, delayed billing and limited visibility of real time power usage, leading to problems such as billing errors, electricity theft, energy wastage and increased workload for utility providers. The reviewed research papers highlight similar limitation in existing systems and emphasize the need for smart, automated and communication enabled metering solution. Many studies propose IoT, GSM, Wi-Fi and Zigbee based smart meters that provide real time monitoring, remote data transmission, prepaid billing option, theft detection, renewable energy integration and automated alerts.

Based on these finding, this project present a Smart Energy Meter with GSM Billing and Control that can continuously measure electricity consumption and send live usage update, billing information and notification directly to users through an android app. The system also supports remote load control for prepaid or unpaid billing situations, reducing manual intervention and improving billing accuracy. By offering real time access, automation and enough energy management, the proposed system benefits both consumers and electricity providers while contributing to a more modern, reliable and future ready power infrastructure

Keywords: Smart energy meter, IoT based power measurement, Wireless data transmission, Prepaid energy integration, Renewable energy compatibility

1. Introduction

Electricity metering in most places still depends on people checking meters manually, bills arriving late and users not knowing how much electricity they are using at the moment. Because of this, many problems occur wrong billing amounts, electricity theft, wasted power and more work for electricity companies. To solve these issues modern power systems are now moving towards smart, automatic and communication based metering methods.

Our smart energy meter with GSM billing and control project is developed as a step towards this modern approach. It uses an electronic energy meter along with Raspberry Pi or microcontroller and GSM module to create a system that works automatically and can be accessed from anywhere. The meter keeps track of electricity usage continuously that converts the readings into digital information and sends usage updates, billing details, reminders and alerts to users through SMS. This means there is no need for a person to visit and check the meter physically.

The system also includes relay that can control the power supply. If the user finishes the prepaid balance or does not pay the bill on time, the system can turn off the power and turn it back on once the payment is completed. This makes the system useful for prepaid billing and helps electricity companies reduce losses and protect revenue.

The system is also built in a way that allows more features to be added in the future. It can be connected to IoT platforms, online dashboards, home automation systems, tamper detection units and even renewable energy sources like solar power. With accurate readings, automation and secure data transfer, smart energy meter GSM becomes dependable and efficient solution for managing electricity for both users and electricity providers.

Along with improving efficiency, the system also helps save energy by giving users and providers clear information about how electricity is being used overtime. With access to usage reports and consumption trends, homes and businesses can plan how and when to use appliances more wisely. Real time data helps reduce wastage, manage power during busy hours and encourages responsible usage. For electricity companies, the system reduces manual work, lowers cost and increases billing accuracy and builds better trust with customers. The ability to detect usual electricity usage and control notes remotely also helps prevent overloads and keeps the power supply stable. As electricity needs grow and power system develop, smart metering becomes an important part of building and automated, reliable and modern electrical network. In the end, smart energy meter with GSM billing and control is an important step towards a transparent secure and future ready way of managing and distributing electricity.

Literature Review

In the first research paper, [1] we found that traditional electricity meters still need to be checked manually which is slow, inconvenient and often inaccurate. Users cannot see their electricity usage in real time and providers cannot monitor consumption or detect issues instantly. To improve this, the paper suggest using smart meters with Advanced Metering Infrastructure (AMI). These smart meters use communication technologies like GSM and Zigbee to send and receive data allowing two way communication and real time monitoring. This makes the metering system more accurate, automated and efficient.

The second research paper, [2] we found that existing smart metering systems still struggle with high setup costs, limited wireless range and lack of automation. Because of this, there is a need for low cost and easy to use smart energy meter that can monitor electricity wirelessly, prevent wastage and theft and let users check their uses instantly. The paper presents an IoT based energy meter that was tested using

60W bulb and heard 2000W water heater on earth 230V supply. The meter measured consumption accurately and sent the data to a web page through an ESP8266 Wi-Fi module. Users could view real time units and post a simple login and displayed data matched the serial monitor readings. The result showed that the system provides continuous updates, works without delays and removes the need for manual meter, reading human errors.

The third research paper, [3] we saw that traditional electricity meters are slow, inaccurate and unable to detect unusual or stolen electricity uses in real time. Because they rely on manual reading mistakes and delays are common which causes energy loss, financial loss and an unstable power supply. The paper suggests solving this problem with smart metering system that uses IoT and GSM. These smart meters monitor electricity continuously, detect abnormal usage such as theft and send the data wirelessly to electricity provider. This gives utilities instant access to information and allows them to respond quickly without needing manual meter checks.

The fourth research paper, [4] we learned that the current solar electricity setup uses to separate meters, one for measuring the power generation from solar panels and another bidirectional meter for measuring both imported and exported electricity. Billing is still done manually which can lead to mistakes and extra work. The paper proposes better system that combines both meters into a single smart meter that can calculate energy usage and generation automatically and send the details to the user's mobile through GSM. This allows customers to check the electricity information anytime and from anywhere. The system works with solar photovoltaic power, boost converter and an inverter to supply energy efficiently. It also uses Zigbee communication to send billing data to the power station. Overall the proposed system reduces human effort, avoids manual errors, provides quick access to billing information and supports renewable energy use in a smarter and more convenient way.

The fifth research paper, [5] we found Gaza faces a big electricity shortage, so many people depend on expensive private generators. Since there is no proper system to check where the electricity is coming from, consumer get confused and end up with high unexpected bills. To fix this problem, researchers have looked into low cost IoT energy monitoring methods. One system uses and ESP32 to collect energy data and send real time updates on voltage, current and power use through WhatsApp. Studies show that these system gives accurate readings and helps people understand their electricity usage better. Overall the research suggests that simple IoT tools can make energy management easier for households.

The sixth research paper, [6] we saw Smart meters are advanced energy metres that not only measures electricity use but also provide additional useful information compared to traditional meters. Different regions use different smart meter designs depending on the needs of consumers and utility companies. Research shows that an effective smart meter must include a secure and reliable communication system to ensure accurate billing. One proposed system uses a microcontroller that reads data from the energy meter through an opto-coupler and displays it on an LCD. The same data is also sent to the user through a GSM modem for easy monitoring. This approach helps consumers know exactly how much electricity load is using improving the inspiration and control over energy consumption.

The seventh research paper, [7] we saw energy meter industrial automation to identify power and energy consumption in terms of cost that would be economically suitable. To analyse the various odd

order harmonics present in the signal regarding samples and various electrical parameters for calculating energy consumption. IoT based smart energy meter sends real time energy consumption data to cloud platform using an ESP8266 Wi-Fi module. If the Internet is unavailable, GSM module (sim 900) sends the data via SMS using AT commands. The system can give alerts when energy use exceeds your set limit, schedule power usage and even cut off power when no one is home. The design helps monitor energy more efficiently with minimal delay.

The eighth research paper, [8] we observed to measure the global power consumption at homes and residential houses and monitor individual consumption of different systems in smart homes (light, heating, cooling and household appliances in general, etc.). The system, smart power meter is designed to accurately measure electrical parameters in real time. It uses a shunt resistor to sense current and a PZEM-004T module to measure voltage, current, power, energy and frequency.

We observed that in today's electricity meters still don't let users see how much power they are using at the moment, and billing depends on someone coming to read the meter manually. This process is slow, inconvenient and often leads to mistakes. People only get their bill at the end of the month, so they have no idea if they are using too much electricity until it's too late. Because of this, they cannot control their usage or reduce their expenses. On top of that, utility companies must send meter readers from house to house, which increases workload, cost and the chances of human error. To overcome these problems our project introduces a smart energy meter that provides real time monitoring and online billing through an android app. The meter constantly measures electricity usage and sends live updates to the user, removing the need for physical meter checking. This allows consumers to instantly see how much electricity they are using and manage it more wisely. At the same time, utility providers benefit from reduced manual effort, fewer errors and a modern automated billing process that makes the entire system faster, smarter and more efficient.

Conclusion

After reviewing all the research papers, we can clearly see that traditional meters are outdated and no longer meet the needs of consumers or utility providers. Most existing systems still rely on manual meter reading, delayed billing and have no real time visibility of electricity usage. This leads to problems such as high bills, power wastage, theft, human error and unnecessary labour. Even the improved systems discussed in the papers still struggle with issues like high cost, limited communication range, lack of automation and poor monitoring.

Across all studies one common message appears, there is a strong need for a smarter, faster and more user friendly energy metering solution. The research consistently shows that technologies like IoT, GSM, Wi-Fi, Zigbee and smart sensors can make electricity monitoring, prepaid billing, theft detection, renewable energy integration and mobile notification as key improvement.

Our project directly addresses these needs by providing a smart energy meter that offers real time monitoring, online billing and instant usage updates through an android app. This removes the need for

manual meter checks, reduces errors, helps users control their consumption and makes the entire system more efficient for both consumers and electricity providers. Overall, the conclusion from the research supports that smart metering with live tracking and digital billing is the future of energy management and our proposed system fits perfectly into this modern and necessary direction.

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