# A Household Energy Power Consumption Meter

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***Abstract*: - This work investigates the voltage monitoring and control feature for smart meters and identifies the impact of this feature on both power distribution and communication systems. Electricity saver is an android application which aims at reduction of electricity consumption in houses. Through this project we divide each room of house into different sections. The user is provided with options to enter the rate of electricity they would like to consume per month. Electricity saver then schedules limits for each day and for each room or section. Here for convenience, the Arduino circuit is considered to be a room. As per this project whenever the limit exceeds, a warning notification is given to the user. Electricity saver provides opportunity for the user to continue usage or discontinue usage.**

***Keywords: smart energy meter, internet of things, android application, ICT.***

## I. INTRODUCTION

In our everyday lives, electricity is a crucial resource. It is best to use electricity without causing damage or pollution. Humans would not be able to take advantage of modern convenience in the absence of electricity. Thus, the significance of electricity conservation is revealed. Every home should start saving. The goal of application is to reduce electricity use in order to create a better future. With a view to conserving money, the administrator of the house suggested that this application design a daily chart for the consumption of electricity. According to the blueprints, each sector (room) is given a certain restriction that is less than the admins suggested limit. If the usage exceeds the limit assigned, a warning notification will be given to the admin and the admin can turn off the appliance or can continue usage.

Data about the operation of any asset has become precious and tremendously useful in the era of distributed assets in smart electric distribution networks. It is possible to improve the management and control of electrical distribution systems through the integration of traditional electrical networks with current advancement in modern information and communication technologies (ICT), particularly with the introduction of connected devices to the internet of things (IOT). The electrical distribution system's reliability may enhance as a result of the increased communication with linked devices, which may also minimize energy losses and increase operational efficiency. These data are increasingly relevant and useful to system operators and energy sellers in the era of big data.

With 4.8% of the worldwide market, India surpassed China to become the third-largest electricity producer in the world. Renewable-energy made up around 28.43% of the total electricity generated while non-renewable energy made up about 71.57%. The essential element for living comfortably is electricity. It must be used and maintained properly. Currently, an electrical board employee makes a personal visit to the resident to collect energy meter readings and physically generate the bill for that month.

Energy metering has advanced significantly overtime. Thomas A Edison, a scientist and businessman, thought up the important implementation of billing the consumer for electricity consumption in the year 1881. Electric meter is a word that Edison first used in his U.S patent 25154 A. Elihu Thomson's motor meter and Aron's pendulum meter where later inventions. The "Induction-type Watt- hour meter". By Ferranti and Shallenberger, which utilized the paradise Electromagnetic Induction Principle and had a design that lasted more than a century, was the next most significant and ground-breaking electric meter.
Ferranti's rotating-disc Watt-hour meters were later replaced with meters that had no moving parts because of accuracy problems and power theft. The new meter included electrical components like a microcontroller, an analog-to-digital converter, a real-time clock, a lithium-ion battery, an LCD, and sensing tools like a current transformer (for neutral current sensing) and a shunt strip (for voltage sensing). Modern Watt-hour meters are made using high-tech techniques like "Ultrasonic Welding" of the base and cover, tamper-resistant hardware inside the meter, pressure-type tamper-proof seal on the outside of the meter, and inclusion of current-transformer between the neutral lines of supply and load to prevent power theft. The meters also adhere to the accuracy criteria established by that nation's Electricity Board.

The Internet of Things (IoT) is a network of physical devices and gadgets that are implanted with specific types of electronics that allow them to connect and communicate with one another by exchanging data. The "idea" of integrating the Internet of Things (IoT) with utility meters

dates back to 1996, when remote reading and data management systems for energy meters were combined. 'Near-Field Communication' for utility meters has now been added to the concept. This demonstrates that there are still chances for IoT to be expanded on a much greater scale. Typically, a household consumer expects the utility sector to provide a single phase AC service. Utility companies charge customers for their "energy" usage, which is measured by a unique, independent single phase AC static Watt-hour meter.

This work investigates the new voltage monitoring and control feature for smart meters, and identifies the impact of this feature on both power distribution and communication systems. Regarding the voltage monitoring, the intention work is to conserve energy by setting limits per user. Electricity saver is an android application which aims at reduction of electricity consumption in the houses. Notifications are passed to users at their exceeding usage limit and provides an option of continuing or off it. This reminder helps in the budget management of users. According to the plan, each room in the house can be set in accordance with the required limits and the admin has total control of this usage. That means, even before the usage limitation, the admin can turn off the electricity by the application. The big data is stored in an application which can be useful to revise the usage patterns. The smart meters adopt voltage and current transducers to measure energy consumption yielding an inherent voltage monitoring capacity which also allows a two-way communication, enabling sending and receiving control commands in real-time or near real-time

In India, where energy consumption is high, the IoT-based electricity monitoring system employing an android application can undoubtedly aid in the promotion of energy saving. Potentially, the proposed system may track how much energy is used in homes or workplaces and provide real-time data on energy use, enabling users to pinpoint areas where they can use less energy. This can be achieved by measuring energy consumption with sensors or smart meters, then sending the data for analysis to a central server or cloud platform. Users of the android application could have access to a user-friendly interface to examine their energy usage patterns, establish energy usage targets, and get alerts or notifications when their energy limitations are being approached or exceeded.

## II. CHALLENGES

The energy meters which are already installed at our houses are not replaced, but as a small modification on the already installed meters can change the existing meter into smart meters. Current reading with cost can be seen on application with automatic ON & OFF of meter is available. The unified approach for compressive sensing (CS) and authentication of empirically modeled signals over smart energy meter reading in advanced metering infrastructure (AMI). The wifi module used by the Arduino chip to transfer data through an android app. Therefore, an IoT-based monitoring system has the potential to improve energy efficiency, save costs, and promote sustainability in a range of contexts, including households, businesses, entire cities, and communities.

## III. RELATED WORKS

### *A. Smart Meter Infrastructure for Smart Grid IoT Applications. (Matteo Orlando et. al., 2022)*

In this paper, a low-cost smart meter architecture and a distributed software infrastructure for AMI were developed. These systems may gather network data, interact with other entities, and provide various functions to each actor connected to the network. Utilizing well-known IoT technology makes sure that it is very compatible with other devices and outside services. The capabilities of the infrastructure and the meter have both been evaluated using a digital real-time simulator (i.e., Opal-RT). According to the results of the experimental research, the latency caused by data transmission over the Internet complies with the restrictions given by the IEC 61850 standard. As a result, our architecture has no negative effects on the smart grid's ability to function, making it a workable option to support the introduction of new services

Merits: The 3 phase meter architecture is able to run multiple software applications, either onboard or distributed over the network, and to auto-update its status when required. This ensures high compatibility with other device management tools and communication protocols, such as DLMS/COSEM, SML, and IEC 61850, which could be added and treated as any other data processing algorithm.

Demerits: the proposed distributed software platform and the 3SMA need to be integrated in a wider distributed multimodal co-simulation environment. It is needed to unlock other possible scenarios and test additional multi energy services such as optimal management of RES. In addition, further optimization of algorithms and software running on 3SMA may improve their performances when implemented on embedded systems with reduced computation power.

### *B. A Novel IoT based Smart Energy Meter for Residential Energy Management in Smart Grid Infrastructure (Gitanjali Mehta et. al., 2021)*

Key Concepts:

Smart Electricity Energy Meters can be considered as the basic fundamental component of the future intelligent network or smart grid, measuring the energy flow and exchanging information on energy consumption between utilities and consumers and also monitoring and controlling home appliances and devices with consumer information. In this paper, the authors propose an IoT based Smart Energy Meter with Arduino and ESP8266 Wi-Fi unit which can provide information of electricity bill by SMS or E- mail and can also provide energy monitoring usage anytime and anywhere in the world.

Merits: The idea to send email notifications when energy crosses threshold value is 15 was successfully accomplished. With this we can regulate energy consumption with ease and

that too from anywhere in the world.

Demerits: Adafruit MQTT connection with Wi-Fi Adafruit IO Key can be unreliable.

***C. Preserving Privacy of Smart Meter Data in a Smart Grid Environment. (Matthew B. Gough, et. al., 2021)***

Key Concepts:

In this work, a cutting-edge Differential Privacy (DP) compatible algorithm is created to guarantee the security of consumer smart meter data. Not only from the perspective of a consumer's electricity bill, but also from the perspective of power systems, the consequences of this unique algorithm on the operation of the distribution grid are thoroughly explored. The system losses, power quality difficulties, and additional expenses that such a privacy-preserving technique can cause can all be empirically investigated using this method. Additionally, a number of cost allocation techniques based on cooperative game theory are employed to make sure that the extra expenses are distributed among the players in a fair, effective, and equitable way.

Merits: The novel algorithm presented in this paper addressed the concerns related to accessing consumer smart meter data by guaranteeing the privacy of the smart meter data without losing significant value derived from the data set, which is crucial.

Demerits: The use of the innovative DP algorithm increased the system costs by a maximum of 5.61%. Even though the DP algorithm will protect against the external adversary. The internal adversary is more difficult to protect against as they may be able to make inferences about the consumer's energy usage. The energy retailer may analyze the noisy smart meter data, but the amount of information that the energy retailer may infer remains bounded by the consumer's privacy level

## IV. RESEARCH GAP

The system should be designed to meet the existing standards. We now present the smart home energy consumption meter. The basic goal of a Smart Energy Meter (SEM) is to develop the necessary infrastructure for gathering data on the energy usage of home appliances, monitoring environmental indicators, and offering the necessary services to end users. Setting usage limits and interacting with customers and managing consumption across the network. Bill payment on a secured platform is also to be carefully studied. The economically friendly, safe with no compromises to the user's privacy is what is most concerning. Android application as well as alert messages helps to track the usage pattern well. Voltage controlling method has also to be considered in the hardware setting part. Every time a bill is generated by the server, it can be automatically mailed to the relevant user's email ID. To check if the system has failed or the energy meter has been tampered with, a server alert system can be set up. The server can be configured with an algorithm to track the user's energy usage.

## V. METHODOLOGY

The most prominent factor of this project is to put limitations on the usage of electrical appliances. Even though the limit exceeds there is privilege of using the most crucial appliances by the permission of the Administrator. The choice of continuation of usage after limitation completely relies on the system manager. The system brings smartness in terms of bilateral communication and controlling of load. Through the website or an Android app, the user may continuously monitor their energy consumption. As a result, the system is more convincing to the users and transparent. In accordance with the user's login privilege, the software unit inserts the data into a cloud database and displays it to the customer or the electricity board. Users who have entered into their consumer accounts can read information about their daily electricity consumption as well as more detailed information shown by a listed graph. The user can track their usage by looking at the graph, which shows the variation in consumption for each month. They can therefore concentrate on cutting their electricity use based on the consumption. The Android application also allows the user to set consumption restrictions. Separate areas for showing graphs are present in both user modules. Only the relevant user who is authorized to view the details can view the views because they are made under distinct privileges. Full design in accordance with the IoT standards and protocols.

### *A. USER CHARACTERISTICS*

- User Management
- Registration
- Scheduling
- Alert management

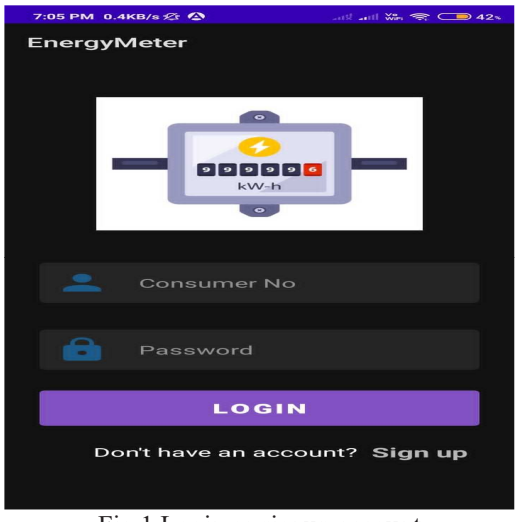


Fig.1 Login or signup account

### *B. SCHEDULING*

- The electricity consumption for each month is scheduled as well as it can also be reset.
- Limit for the month and number of rooms is given as input.
- Scheduling can be done for each day and for each room.

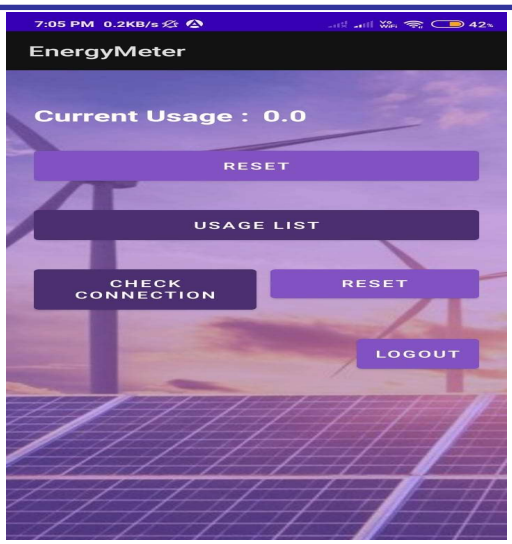


Fig.2 Limit reset option

### *C. ALERT SYSTEM*

- Over consumption of electricity is informed to the users.
- Increment in the usage than the limit entered by the user.
- System decides to send a warning to the user.
- User receives the notification indicating his or her over consumption.

### *D. PRE-INTIMATION SHUTDOWN*

The power outage is announced beforehand so that hospitals can be prepared or aware and take safety measures. Information about the power outage is transmitted via IoT from the admin web server to an Android application that has the customer's unique ID.

## VI. PROBLEM ANALYSIS AND DESIGN

The IoT real-time electricity monitoring system includes a Wi-Fi module (ESP8266), a toroidal current transformer (CT) sensor, a specialized energy meter, MySQL database, and a mobile application developed using Android Java on Android Studio.

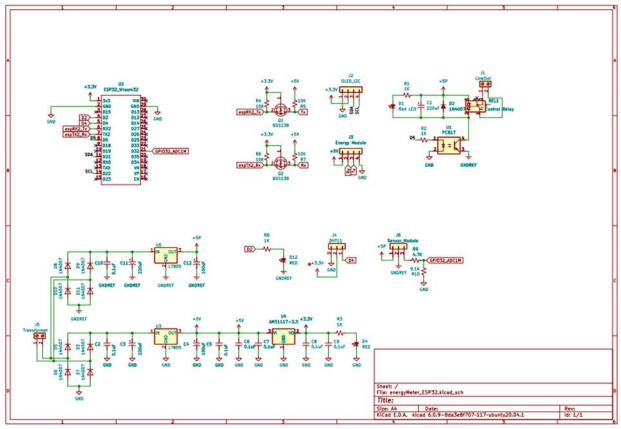

Fig.3 circuit diagram

Wi-Fi module: The ESP8266 is a great choice for a variety of IoT applications because it offers a practical and affordable method of wirelessly transmitting data to a database. The processed data is transmitted wirelessly over Wi-Fi by the ESP8266. The ESP8266 can be configured to deliver data via HTTP or MQTT protocols to a particular IP address or URL.

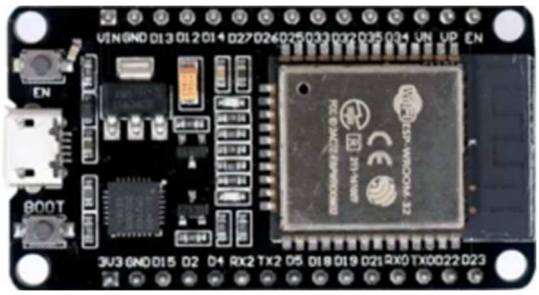

Fig.4 ESP8266

Toroidal current transformer (CT) sensor: In energy monitoring systems, the toroidal sensor is frequently utilized, connected to unique energy meters that convert the sensor's output current into a measurement of energy use in watt-hours (Wh).

## VII. RESULT AND PERFORMANCE ANALYSIS

The implementation of smart energy metering technology made it easier to assess electricity usage and to determine how much energy is used by the consumer on a daily basis once a threshold value is crossed. It is essential that the technique is economical and that the components meet all of the desired outputs in order to meet the aforementioned criteria.


Fig.5 power consumption details

## VIII. FUTURE SCOPE

The goal of this initiative is to reveal further potential outcomes and test other multi-energy services, such as the effective management of renewable energy sources (RES). We also intend to further improve the algorithms and software that operate on our smart energy system so that they work better when used on embedded systems with less processing power. We would like to specifically emphasize that the suggested distributed software platform and the smart energy meter will be integrated in a larger distributed multimodel co-simulation environment as potential future work. The big data is stored in an application which can be useful to revise the usage patterns. The consumer can receive monthly billing information for the energy used via the web server using the same mobile application. The web server is another method of payment.

Future potential is bright for the suggested system, which uses less energy and requires less manual labor. The solution can greatly eliminate the need for manual meter reading and improve energy efficiency by merging an energy meter with a mobile app to receive monthly statistics on energy consumption.

## IX. CONCLUSION

The study has expanded and refined previous work on the use of IoT technology for real-time monitoring and protection of a residential electricity supply. By automating the process, the system can provide real-time data and insights that can help users to make informed decisions and take action to save energy and reduce costs. The setting up of usage limit and resetting of the same, which also retains some power for emergency appliances is the major output for this work.

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