

## Energy Meter Using IoT

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### Abstract:

New energy automation systems are expanding globally to achieve more efficient and reliable management of utility systems. The increasing focus and demand for power in the modern megacities warrants the compulsory installation of energy meters, as well as creation of new AMR charge estimation processes and means for enforcing proper energy management. One of the ways this has been modernized is AMR (Automatic Meter Reading system). This utilizes smart meters in conjunction with analog or digital energy meters. At present, energy scaling is still manually done, which is very tedious in this era of advanced internet dependency and also calls for highly skilled workers. The purpose of AMR Systems is to deal with issues in the expanding domain of power management. This paper presents the design model of a smart energy meter for power theft detection using IoT. The design model is made up of Arduino UNO, ESP8266, AC713 current sensors, etc. The AC713s captures current usage data from the ESP32 which is sent to the IoT platform. Although very effective, AMR nobody seems to care these smart energy meters render existing energy meters redundancy, which is absurdly wasteful.

**Keywords:** Energy Meter, IoT, Energy Management, Smart Metering, Cloud Computing. Home Automation Energy Meter.

### 1. Introduction

The rapid increase in need for energy and the global focus on the environment have necessitated the development of more efficient ways of monitoring energy consumption. While traditional energy meters have always provided accurate readings, they do not allow for real time monitoring, nor do they enable remote access, which is needed to maximize efficiency. As a solution, IoT based meters have been developed. These meters enable users to monitor their energy consumption remotely, analyze usage patterns, and optimize their energy consumption simultaneously in real-time. IoT allows the saving of usage data on the internet for further analytical processing, presenting the information to users via web and mobile applications. This

advancement in technology is expected to promote energy efficiency, reduce operating expenses, and work toward sustainable development.

### 2. Literature Survey

The incorporation of IoT within the energy metering systems has had quite a few studies done on it. Smart IoT-based meters are currently being used to manage energy within homes and industrial facilities. IoT For Energy Efficiency: As per the studies in [1], IoT-enabled energy meters have the integrated feature of remote monitoring, which allows users to check their energy expenditure at any time. The study also analyzed that IoT meters can detect abnormal patterns in energy usage, for instance, sudden increases in consumption and notify the users for a faster response.

**Cloud Based Energy Management Systems:** Users are provided with insights into their detailed energy data usage through the features of a cloud platform, enabling improved storage and analysis of energy data as stated in [2]. This helps improve the forecasting and optimization of energy consumption.

**Automation and Control:** In research conducted by [3], the application of energy IoT meters into IoT-controlled automated systems was advanced, which would switch off appliances when a given consumption level is reached in order to save energy during peak times.

**Smart Energy Metering In The Eyes Of Smart Grids:** The adoption of smart grids has and continues to be the center focus of IoT based smart meter studies like [4]. These systems provide real-time data for both consumers and utility providers to make energy consumption more efficient.

### **3. Proposed Methodology/Project Implementation**

This proposed IoT-based energy metering system is intended for real-time energy monitoring and management. The major components of the system include:

**Energy Meter Unit:** The most important and central component of the system is the energy meter which measures electrical parameters such as voltage, current, and power. This unit is interfaced with a microcontroller which processes measured data.

**Wi-Fi Module:** The Wi-Fi module (ESP8266 or ESP32) connects the energy meter to the internet, which in turn transmits collected data to the cloud in real-time.

**Cloud Platform:** The collected data is uploaded to a cloud-based platform (Google Firebase or ThingSpeak) where all the information is stored, processed, and made accessible to the users. This platform enables users to monitor their energy consumption via a user-friendly web interface.

**Mobile Application/Dashboard:** A user-friendly mobile application or web dashboard is created to access real-time and historical energy consumption data. Users may set thresholds, receive alerts, and observe energy savings for their period.

**Data Analysis and Optimization:** The system will include a data analysis module that will analyze trends, provide predictions on future energy consumption, and suggest areas for optimizing usage in order to cut costs.

### **4. Discussion**

The IoT-based energy meter system was evaluated on the basis of various parameters like accuracy, data transmission reliability, and user engagement.

**Accuracy:** The system's accuracy was compared with conventional energy meters. The results showed that the IoT-based system provided energy readings with a margin of error less than 2%, making it suitable for real-time monitoring.

**Data Transmission:** The system proved to be a reliable mode of data transmission from the energy meter to cloud storage with an extremely low latency period. Data was uploaded every 30 seconds, hence keeping a real-time monitoring of the system.

**User Engagement:** The web dashboard and mobile application were well received by users based on ease of use and functionalities. They allowed their users to monitor their real-time energy consumption, track trends, and receive notifications of abnormal consumption patterns.

**Insights on Energy Consumption:** The data analysis module of the system was able to identify opportunities for energy optimization by users. Alert notifications were sent out whenever the threshold for consumption was crossed to avoid wastage and reduce peak-hour charges.

But generally speaking, the IoT-based smart energy meter system was successful in providing real-time data, accuracy of energy measurement, and valuable insights into energy usage optimization.

### **5. Future Scope**

Although this IoT-enabled energy meter system has managed to prove its worth, there still exists vast scope for further improvement and expansions:

**Integration with Smart Homes:** The system can be an integral component for the already

developed smart home setup, which will allow controlling devices automatically based on real-time energy data, such as turning off lights or appliances in the case where high consumption is detected.

**Advanced Analytics:** The systems of the future will employ machine-learning algorithms to predict future energy consumption patterns and create personalized energy-saving advice on the basis of historical data.

**Energy Sharing and Trading:** The IoT energy meters could expand services to decentralized energy grids in which consumers can share the excess energy or even sell it back to the grid-both measures furthering sustainability.

**Energy Efficiency Reporting:** Advanced reporting utilities could be developed, allowing users to analyze energy performance over time and to carry out information comparisons reflecting the exact consumption patterns with respect to similar households as well as to assess the impact of energy-saving initiatives.

**Integration with Renewable Energy:** The system can be advanced to accommodate renewable sources such as wind and solar, so that users can track consumption and generation from a single pane of glass.

## 6. Conclusion

An Internet-based energy meter system provides a powerful solution for real-time energy monitoring and management. Users may be able to monitor energy consumption, minimize wastage, and determine data-driven corrective measures to improve energy usage through the incorporation of internet-of-things technology with server system and data evaluation. It naturally reduces operational costs through energy optimization and rendering an environmentally sustainable act of improving energy efficiency. While the system has shown great promise, in order to maximize performance and practical utility, future advancements include machine learning-based analysis and integration with smart homes and energy sharing capabilities. Successful implementation of the IoT-based

energy meter system could well rewrite the pattern of how energy is consumed and managed, hence ushering in an era of smarter and cleaner energy usage.

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