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Design and Implementation IOT Based Energy Monitoring & Controlling System

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Abstract: To design and implement an IoT-based system for real-time monitoring and control of electrical energy consumption to improve efficiency, reduce wastage, and enable remote management. The aim of this project is to develop an Internet of Things (IoT) based Energy Monitoring System to reduce energy waste and cutting down energy cost. Therefore, it needs a system which provide efficient energy consumption management. For the starting of designing an IoT-based Energy Monitoring System, different sensor and calculated AC measurement methods were studied. The development of this system is to integrate each of the sensor, energy measuring device and IoT system into one complete module.

The device that transfers the data or information from the energy monitoring device to the cloud storage is the ESP8266 Wi-Fi module. The output is the energy consumption that has been used according to the real-time data measurement. Lastly, the data that is transmitted to the cloud can be monitored through the mobile application Thing View. In conclusion, this system is necessary because it can control and manage energy consumption to avoid wastage and promote energy conservation.

I. INTRODUCTION

India is the fourth largest energy consumer in the world, the primary energy requirement in India has grown from about 450 million tons of oil equivalent in 2000 to 770 million TOE (Tone Equivalent of Oil) in 2012 as shown in Figure 1. This is expected to grow to about 1500 million TOE in 2030. India suffers from a massive electricity deficit with large swathes of country undergoing power cuts on a regular basis, but with ever increase in the demand for energy it is very difficult for Indian electric utilities to supply required energy. Hence, energy management and saving becomes very important.

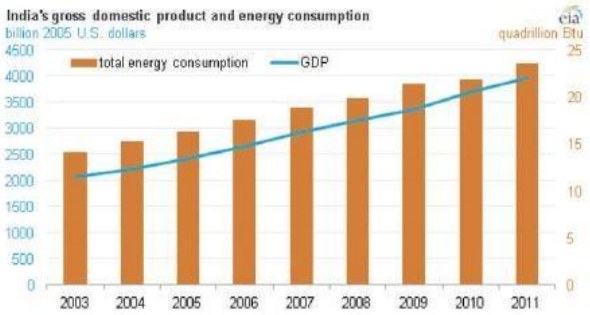

Figure 1. India's Gross Domestic Product and Energy Consumption (Source: https://www.eia.gov/todayinenergy/detail.php)

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Therefore, it is essential to switch to new and better options like smart grid, smart metering, and zero energy buildings that will help reduce dependency on these reserves by reducing energy consumption and increasing the performance and efficiency of the existing energy management infrastructure. Energy Management Systems (EMS) are essential as a comprehensive offering that combines energy and process optimization and, where appropriate, incorporates the solution into online advanced control and optimization strategies. An Energy Management System is a series of policies, processes and procedures to manage energy usage, Energy, in the context of organizational use, can be defined as the direct or indirect consumption of fuel required to perform the organizational functions. It is a strategy of adjusting and optimizing energy, using systems and procedures to reduce energy usage.

What is IoT-Based Energy Monitoring?

Monitoring energy through IoT is done with the help of a bunch of connected devices. It involves smart meters, sensors and cloud platforms to track and analyze overall energy consumption in real time. These devices work to collect data from different electrical systems and appliances, send it over the internet and present it on the apps/dashboard in a very user-friendly format that's simple to understand.

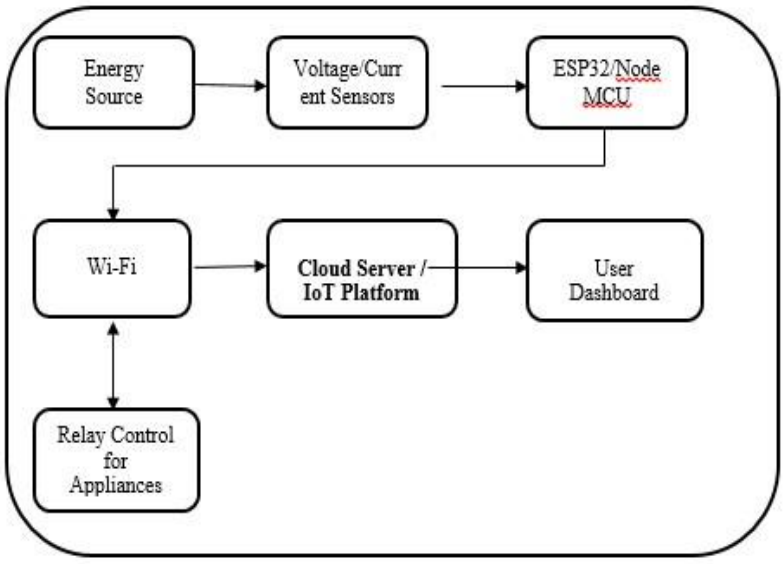
It could be a small office, a residential building or a full-fledged manufacturing plant, an IOT energy monitoring system makes it possible to know how, when and where electricity is being used. This is how businesses can know inefficiencies, learn if there are any unusual patterns and come up with energy saving strategies.

II. OBJECTIVE

- To measure energy usage (voltage, current, power) using smart sensors.
- To transmit data to a cloud server via IoT protocols (e.g., MQTT/HTTP).
- To provide real-time energy consumption reports on a web/mobile dashboard.
- To implement control features (e.g., turning appliances ON/OFF remotely).
- To analyse data for detecting over-consumption and suggest energy-saving measures.

III. METHODOLOGY

- **Sensors & Measurement:** Current Sensor (ACS712) and Voltage Sensor measure real-time parameters.
- **Microcontroller:** Node MCU / ESP32 processes data and connects to Wi-Fi.
- **Cloud Platform:** Data is uploaded to platforms like **Things Board, Blynk, or Thing Speak**.
- **User Interface:** A mobile/web app displays energy usage graphs and allows remote switching.
- **Control System:** Relay modules control appliances based on user commands or threshold values.
- **Data Analytics**: Usage trends analysed for identifying energy wastage.



Block Diagram

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IV. CONCLUSION

The IoT-based system was successfully designed using **ESP32/Node MCU**, **ACS712 current sensor**, and **relay modules**.

Real-time energy parameters (voltage, current, power, energy consumption) were measured and uploaded to the cloud platform (Thing Speak).

A user-friendly **dashboard** was developed to display graphs of energy consumption, daily/weekly usage, and device status.

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