

# IoT Enabled Automatic Electricity Monitoring and Billing

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In recent years, automated meter reading systems (AMR) are being utilized in most developed countries. The advantages these electric metering system offers make it a more accurate measuring device than the conventional electromechanical meter reading system. AMRs capacity to automatically transmit data real-time increases the reliability of this metering system, unlike electromechanical meters which occasionally make use of previous readings as a basis of the consumer's current billing.

## I. OVERVIEW

Over the years, the need for electricity has grown in rapid proportions. Electric meters are devices responsible for determining these billing charges, usually on a monthly basis and are computed in kilowatt-hours. The conventional metering system is done manually. An employee of the Electricity Board will be coming to take the reading and enter in the card. There are more chances of manual error, delay in processing, tampering of the meter and misuse of the Electricity by other sources.

The objective of the work is to monitor the electricity usage by residential and commercial buildings and make the prevailing electricity billing system simpler and efficient. The system continuously acquires data from sensor and uploads data to cloud.

The idea is implemented through the usage of sensor that is available today. The sensor counts

Impressions per kWh (3600/kWh). The main component include microcontroller for processing data received from sensor and calculates units consumed. Through Wi-Fi interface module this data will be uploaded to cloud. Later at Electricity board Electricity Bill will be generated based on data stored in cloud and bill is messaged to consumer.

Further this system can be incorporated into each electronic device to monitoring and control energy consumed by each devices.

## II. INNOVATIONS TO BE PRESENTED

- Measure units of electricity consumed using LDR sensor, which reads Cal (Impressions per kWh) LED counts of meter.
- Upload units consumed per day to cloud.
- Visualize energy consumption trends (daily, weekly, seasonal, operational...)
- Generate Bill at electricity office based on data stored in cloud.
- Message Electricity bill to consumer mobiles.
- Manage and observe how changes to relevant driving factors impact Electricity.

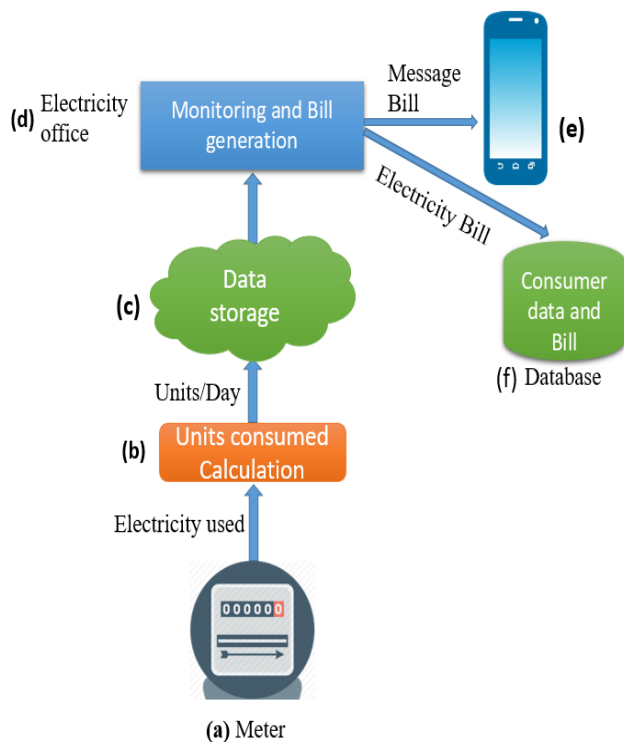
## III. FRAMEWORK

The electricity monitoring and automated billing has the purpose of reducing manual work of issuing monthly bills and effective usage of electricity. This purpose is achieved by first

measuring electricity units consumed per day by reading Cal LED count (Impressions per kWh) using LDR sensor. Uploading daily usage details to cloud. Finally, the data from cloud is extracted for monthly bills calculation.

The units consumed per day will be displayed to consumer. This purpose is achieved by sending data from transmitter ZigBee interface connected to microcontroller to Receiver ZigBee interface. Receiver ZigBee is connected to second microcontroller and data is send to LCD display. This helps consumer to monitor and control electricity usage.

The proposed system is shown in figure 1



**Figure 1 Proposed System**

#### IV. EARLY STAGE IDEAS FOR RESEARCH PAPER

The working principle of the proposed model is

- a) Usage of electricity estimation is done through LDR sensor.

- b) Calculate units consumed per day and send data to LCD display using ZigBee module for user monitoring.
- c) Upload units consumed per day to cloud using Wi-Fi module.
- d) A web application is designed to manage consumer data.  
Extract energy consumption data of particular consumer (customer) from cloud and generate Electricity bill.
- e) Message monthly bill to customer mobiles.
- f) Store and Maintain customer details, monthly bills and payment details in database.

The following features are considered during implementation.

1. **Usage Calculation:** Electricity usage by various household appliances is calculated by reading Cal (Impressions per kWh) LED of meter.

$$1 \text{ Unit} = 3600 \text{ Imp/kWh}$$

2. **Bill Generation:** Bill generation for various sectors.

(a) Commercial tariffs

Commercial-LT- Rs.6.45/unit (Urban)

Rs.5.95/unit (Rural)

Commercial-HT- Rs.6.45/unit (Urban)

Rs.5.95/unit (Rural)

(b) Industrial tariffs

Industrial-HT- Rs.5.65 /unit (Urban)

(b) Rs.5.35 /unit (Rural)

(c) Domestic tariffs

Domestic-LT-

Rs.2.50/unit up to 30units (Urban)

Rs.2.40/unit up to 30 units (Rural)

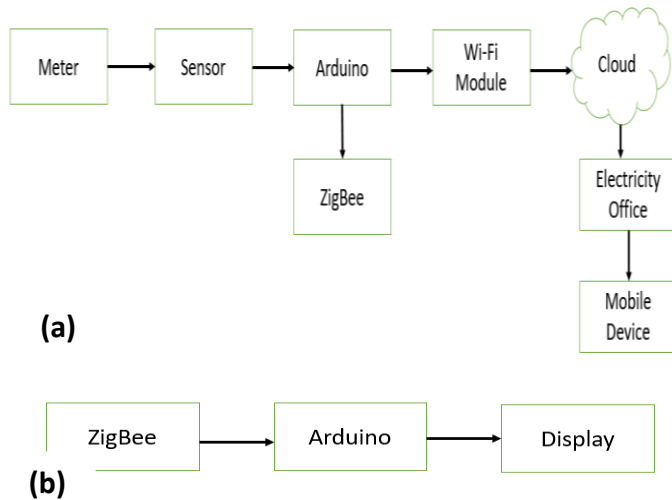
Rs.3.70/unit up to 30units (Urban)

Rs.3.40/unit up to 30 units (Rural)

## V. THEORY FRAMEWORK, MODELLING AND EXPERIMENTATION

### A) MODELLING

Electricity monitoring system block diagram is shown in figure 2.



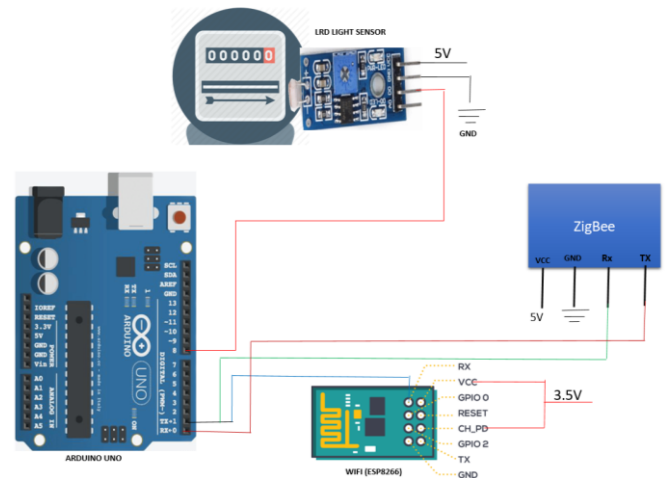
**Figure 2 Block Diagram of Energy monitoring system**

- LDR light Sensor is placed in positions near Cal (Impressions per kWh) led of meter.
- LDR output is sent to microcontroller (Arduino) which functions as data acquisition and calculation node.
- Units of electricity consumed per day is calculated in microcontroller.
- Calculated data is sent to cloud (IOT web service) using a Wi-Fi interface module connected to the microcontroller.
- Data is also sent to LCD display using ZigBee interface module for user monitoring of units consumed.

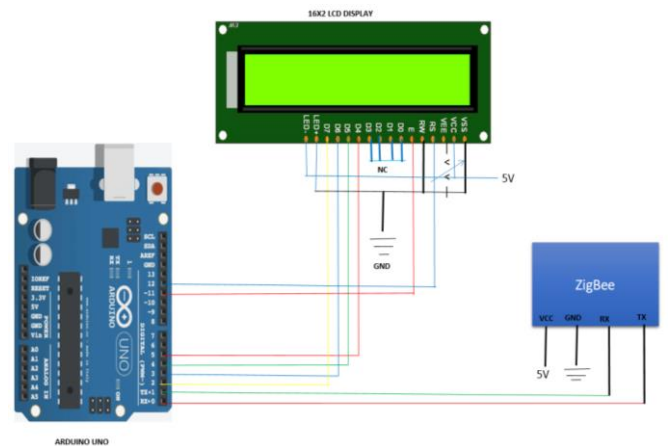
- Data present in the cloud is extracted and Monthly bill is generated by web application at Electricity office.
- Monthly Bills and other usage information are messaged to consumer mobile.

### B) EXPERIMENTATION

The energy monitoring system will be analysed to measure units consumed and accuracy with Bill generation. Connection between different components is tested under various conditions.



**(a) Reading meter readings and calculating energy consumed units**



**(b) Displaying units consumed using LCD and ZigBee**

### **Figure 3 Circuit Diagram of Energy monitoring system**

Problems encountered during testing are

- a) Problem in wireless transmission of data in Wi-Fi interface network
- b) Extracting data from cloud for bill generation.

### **VI. CONCLUSIONS AND VALIDATIONS**

The proposed Smart Electricity Metering is an approach to automatic meter reading that collects data remotely for an effective management of the energy consumed and automatic monthly Bill generation. Indoor energy monitoring system is implemented to keep check on energy usage. The data is collected at a central data collecting node and sent to cloud. The data on cloud is used by Electricity office members through website for monitoring energy usage, bill generation and bill payment details. Bills are messaged to respective consumer mobiles.