International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 07 | July 2020 www.irjet.net p-ISSN: 2395-0072

IoT Enabled Energy Management Meter

Aiswarya Ajay[1], Akhil Mohan[2], Mekha Nair M I[3], Vrinda A R[4], Ms. Shilpa George[5](Asst. Prof)

[1-4] Department of Electrical and Electronics Engineering, Mar Baselios of College of Engineering and Technology, Thiruvananthapuram, Kerala, India

---

Abstract - *Efficient energy utilization plays an important role for the development of smart grid in power system. Hence, monitoring and controlling of energy consumption is the main priority of the smart grid. The existing energy metering system has many problems associated with it. One of the key problem is that, there is no two-way communication. To solve this problem, an IoT based energy management meter is proposed. Based on the Internet of Things (IoT), the proposed smart energy meter controls and calculates the consumption of energy, this removes human involvement in meter readings and bill generation thereby reducing the error that usually causes chaos and energy related corruption. It is made using a GSM module, microcontroller, current sensors etc. along with pre-paid/post-paid scheme. The proposed scheme is to send the data to consumer via GSM module. RTC provides delay and acts as an interrupt. The system includes a provision of sending an SMS to user for update on energy consumption along with final bill generation via SMS. The disconnection of power supply on demand or due to pending dues was implemented using a relay. Therefore, energy analyzation by the consumer becomes much easier and controllable. This system also helps in detecting power theft. Thus, this smart meter helps in home automation using IoT and enabling wireless communication which is a great step towards Digital India.*

Key Words: GSM, MQTT, NodeMCU, Arduino Uno, Opto-coupler etc

1. INTRODUCTION

Planning and the operation of energy production and the energy consumption units are the major concept in energy management. Energy management is important for each organization in different ways. In fact, it's the worldwide goal to save energy and cut the operational cost which successively, affects tons of other areas. They have objectives like conservation of resources, climate protection and price savings when still the users have permanent access to the energy withheld. However, the physical energy meter reading is an outdated concept as it is inefficient, prone to errors and leads to a lot of wastage of manpower. Also they're not bi directional hence it's unable to regulate the non-technical losses occurring at consumer premises. This system also becomes a burden to the consumers since the energy companies needs to invest on the cost of physically reading the meters to the consumers. Energy usage pattern and details are neither considered nor given an alert or a warning so the people are unaware of the energy they use and they get to know that only through their electricity bills.

2. LITERATURE REVIEW

The history and evolution of energy meter started back in the 1880s. With the discovery and high consumption of electricity more efficient types of lamps were being introduced. For measuring the consumption amount new methods had to be discovered. A variety of meters were introduced over time. For the advanced billing and metering billing system [1] the proposed energy meter with micro controller and GSM modem to transmit the info such as electricity used which is generated in kWh, security services (line Cut/On) over GSM mobile network like data are often then fed and integrated into existing energy management systems located at power companies or organizations to supply the services among the purchasers without man-power. The newly designed AMR based on based on micro-controller Atmega328P to identify and control the meter from theft of power and solving it by distinctly connecting and reconnecting the lines of a certain consumer. An SMS will be sent automatically to the utility central server through GSM module [2] whenever unauthorized activities detected and a separate message will send back to the micro-controller in order to disconnect the unauthorized supply. Above mentioned systems had some disadvantages.In this system the relays can automatically connect and disconnect the main system as well individual devices if they cut the preset threshold level. The system uses the frequency of LED present on the meter with help of LDR, which blinks at a frequency proportional to the power consumed by conventional meters. It also uses ESP8266-12e to compute the power of load. Also our system has two modes of payment and it also helps in the proper management of energy.

3. PROPOSED METHOD

In the present system, the main issues include lack of energy management facilities, knowledge of energy usage, minimal information etc. Hence our project focuses to rectify these issues. IoT enabled smart energy management meter includes a prepaid or post-paid system which lets the users choose their mode of payment. Both focuses on using the energy wisely i.e. alert messages are sent besides bills. Customers are updated about their

additional energy consumption by the alert messages and the IoT functions lets them control their appliances or save energy even when they are far away. Current sensors are used to identify the devices that consume more power. Then alert messages are sent to the user's phones, which informs them of the additional usage, thereby allowing them to cut off the respective devices instantly from anywhere. Human efforts are reduced as automated relays are used. Connection, reconnection and billing will be done automatically. As the billing systems are automated there are less chances of faults.

4. IMPLEMENTATION

4.1. Block Diagram and Working

The alert messages are sent to the mobile phones of the consumers once the usage exceeds every 50%, 90% and 100% of the consumption of the average threshold of every month. The consumers are hence able to identify their usage pattern and do the needful. In addition to this, they can also monitor if a device is left unused through the MQTT platform and disconnect the devices from Our project mainly aims to help the consumers and utility with the difficulties they face while using the normal or the conventional energy meters. The IoT enabled Energy Management Meter mainly consists of Arduino UNO, GSM modem, Wi-Fi module or NodeMCU, automatic relays, current sensor, RTC etc. Arduino Uno is connected to the energy meter by an opto coupler. The opto coupler or opto-isolator is an electronic device that is used to transfer electric signals between two isolated circuits by using light. It prevents high voltages from affecting the circuit. The Arduino UNO programmed such as to send alert messages once the energy usage exceeds the preset threshold, select the schemes of payment i.e. prepaid or post-paid, IoT online communication, GSM communication etc. Current sensors are devices that senses current and generates a voltage signal proportional to the current. The signal could be analog or digital. Here, ACS712 current sensor is utilised with which the current is measured. The generated signal or the measured value can be displayed on an ammeter or can be stored for further analysis or for control purpose. The measured value is converted in to a proportional voltage signal which can be further read by a microcontroller. The value thus obtained is compared with the pre-set threshold. This helps in the identification of appliances using excessive energy which in order helps to send the alert messages via IoT. For an open source IoT platform we use NodeMCU. It includes a firmware which runs on ESP8266 Wi-Fi System on the chip. A simple and powerful LUA programming language can be used to program the ESP8266 Wi-Fi module with help of the NodeMCU and hence we are able to send and receive alerts and instructions via MQTT (Message Queuing Telemetry Transform) platform. Therefore, the appliances can be controlled as required i.e. while receiving alerts or identifying the equipment that uses excessive energy. 12v single channel automated relay are connected individually to each appliance as well as to the supply inlet that helps in disconnecting the very appliance as required and also the supply as a whole. RTC keeps the track of the real time and also provides a delay.

The proposed energy meter works with more efficiency and additional features compared to the conventional energy meters. There are a number of new characteristics that are incorporated in the IoT enabled energy management meter. Unlike the conventional energy meters that perform just the calculation, the following functions are also done in our meter. They include:

- Two types of payment methods i.e., Post-paid and Prepaid
- Generation of bills automatically
- Bills are sent to the consumers mobiles, both online and offline
- As the calculations are automatic, accuracy and precision are maintained
- Less prone to errors
- Reduced time consumption
- Reduced human efforts as billing, connection, and re-connection of supply is done automatically
- Alert messages are sent for excessive energy usage, unnoticed working of appliances, energy wastage etc.
- As RTC is being used customers are aware of their usage in real time.
- Controlling of devices from a distance using IoT.

IoT enabled energy Management Meter comes with two payment schemes, i.e. Post-paid and Prepaid schemes. The consumers can use the toggle switch that is provided in the meter itself to select between the two.

1)Post-paid working

In this scheme the amount is paid after the usage of energy in a span of 2 months as the conventional meters. But in the IoT enabled energy management meter unlike the conventional energy meters the bill is generated automatically after every two months without any human intervention. The generated bill is sent to the consumers. The supply will be disconnected after the last date of the bill payment automatically and will be reconnected once the amount is paid. The main advantage of the IoT enabled energy management meter is that it sends alert messages and makes the consumer aware of their usage, and helps them in energy management. The customers are aware of their usage in Post-paid systems in different ways:

i. When the consumer exceeds the threshold energy
ii. When a device is on and unused
iii. Usage alert is sent every month besides the electricity bills

iv. Electricity bills are sent every 2 months

2) Pre-paid working

In the prepaid scheme, consumers should pay for the electricity beforehand. The main advantage of this scheme is that it helps to keep an account of total energy available and used. The alert messaging system in this is based on the percentage of the total energy used i.e. alerts will be send for 50%, 90% and 100% of the total energy after which the supply will be disconnected. Due to this alert message consumers will be cautious about the usage of electricity and thereby wastage will be less. The main advantage of this system is that energy wastage will be controlled to a great extent. People as they are cautious of their usage they'll start conserving and hence leading to sustainable usage.

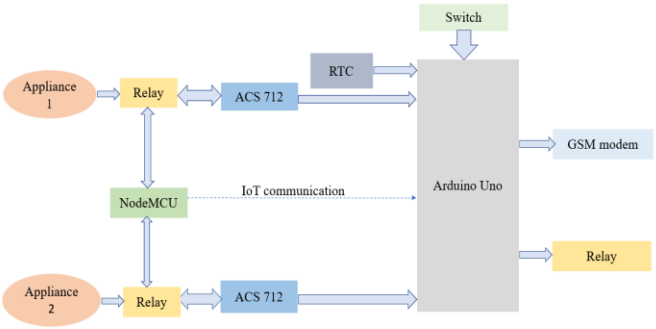

Fig -1: Block Diagram

5. HARDWARE SETUP

Fig 2. shows the final hardware setup of the proposed system.

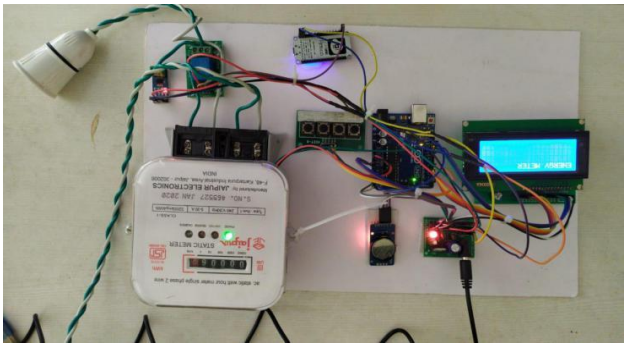

Fig -2: Hardware setup

The switch provided is a button type switch which allows the consumer to toggle between the pre-paid and post-paid connections according to his or her choice. The entire system is controlled by the microcontroller which is the Arduino Uno. All the programs are fed to this microcontroller and thus it controls the entire system. The Real Time Clock (RTC), is given to provide delay and act as an interrupt. As we are providing IoT control methods in our product we require a Wi-Fi module. The module we are using is the NodeMCU ESP8266. SIM 800 GSM modem is used for offline communication purpose. We have provided ACS 712 current sensors to identify any high-power consuming or faulty appliances. Relays are provided to each appliance so that they can be controlled via IoT. An automated relay is used as the main relay which serves the purpose of disconnection and re-connection of the main supply.

6. RESULT

Energy consumption is a rising crisis now a day. In most of the cases lack of knowledge or information regarding their usage lead to the wastage of electricity. People are unaware of their usage pattern and need of consuming energy sustainably which in turn paves way for increased billing amounts, load shedding, under production of electricity etc. Our project sees through all the main issues faced by the utility as well as the consumers. The IoT Enabled Energy Management Meter helps in using energy sustainably by making consumers aware of their usage through alert messages. The alert messages are sent via the MQTT platform, using which distant control of appliances are also possible. In the current scenario the real time monitoring of the appliances helps to recognize devices left unnoticed or of no use, so that can be controlled i.e. switched ON or OFF.The alert messages are sent for both Post-paid and prepaid schemes. For Post-paid, it's for the 50%, 90% and 100% of the threshold that is pre-set. On the other hand, for the prepaid alerts are for every 50%, 90% and 100% of the recharged energy. The bills are processed every two months and are sent to the consumers via their phones. The supply is disconnected if the amount is not remitted before the deadline and will only be reconnected after the payment is processed.

Fig -3: Starting up of meter

Fig -4: Mode selection

Fig -5: No load output

7. CONCLUSION

The proposed model can be used to measure voltage, current and calculate the power consumption of a household. This data is used as a feedback to monitor the energy consumption and make the user aware when the load exceeds. Provision of remote switching of appliances is also provided. Keeping in view the expensive IP addressable appliances the smart switching using relays provides a viable option to stick to the conventional appliances. Further research can be carried out on the network architecture, communication technology and dedicated mobile application for data analysis. The appliances can be easily accessed through platforms like MQTT and the notification can be sent using SMS. Supply relays can be turned ON and OFF automatically once a user exhausts its prepaid threshold value. Individual relays with the appliances also have a number of advantages i.e. the devices can be individually disconnected if not needed then, even from a distance and can be reconnected automatically. This device helps in the sustainable usage of energy and saves or reduces any additional billing charges as the consumers are aware of their usage at real time. Hence energy management is carried out and therefore saving generations.

REFERENCES

[1] Md. Masudur Rahman, Noor-E-Jannat, Mohd. Ohidul Islam, Md. Serazus Salakin, "Arduino and GSM Based Smart Energy Meter for Advanced Metering and Billing System", 2nd Int'l Conf. On Electrical Engineering and Information & Communication Technology (ICEEICT),2017

[2] S.Visalatchi, K Kamal Sandeep, "Smart energy metering and power theft control using Arduino and GSM", Institute of Electrical and Electronics Engineers (IEEE),2017

[3] WJ Li, DHK Tsang, "Smart home energy management systems based on non-intrusive load monitoring," 2015 IEEE International Conference on Smart Grid Communications, pp. 885-890, November 2015.

[4] Gobhinath.S, Gunasundari.N and Gowthami.P, "Internet of Things (IoT) Based Energy Meter", International Research Journal of Engineering and Technology (IRJET), 2016.