

Smart Energy Grid System Based On Internet Of Things- A Conceptual Framework

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Abstract: - Smart energy grid is the energy management system of the progressive new era. The development of new cities accentuates the need of using smart energy grids. A smart grid is a system by which monitoring and management of the whole system can be done from a single point. Smart Grid and Internet of Things are two technologies that have become vastly developed recently. In the perspective of energy saving, smart grid is an outstanding solution to optimize the energy consumption and Internet of Things can be a key that offers consumers the ease of having a real-time technique to systematize and manage energy usage. It is like a non-stop communication between the customer and the electricity board. Present day energy grids are outdated and hence less efficient. Theft of electricity, a very common occurrence in the present-day grid system ultimately decreases the efficiency and loss of revenue and energy takes place. In today's world, we can't afford loss of energy specifically, with the rapid rate of mitigating resources. To alleviate these problems, smart grids come as a respite. In this paper the authors propose the development of smart grid system design based on Internet of Things for smart power supply through grid and beside that smart energy meter is also developed which provides notification of meter tampering and energy consumption. The system also provides alert on electricity theft detection. The planning of the proposed protocols to be used, the working of the system, and the problems in the system design are analyzed so that the proposed design can develop the optimization of the system Smart grid.

Keywords—Smart grid; Internet of Things; energy meter; theft management

I. INTRODUCTION

Internet of Things (IOT) is an approach and a prototype which enables us to form a whole new system using universal things/objects of the environment and controlling them in an organized manner which ultimately gives the desired result. These systems can be wired or wireless but the main goal of IOT is to enable the things to be connected with the system on the real-time basis. The data obtained through the Internet of Things is stored and displayed on a platform making it available always. Internet of Things has witnessed huge growth in every sector, from the medical field to the field of cars and roads to smart grids for energy management. When the topic of energy management is introduced, Smart energy grid is the first topic of discussion.

Internet of Things plays a major role in designing a smart grid which helps in saving a lot of energy which can be utilized somewhere else.

IOT enabled smart grids are more about the energy efficiency and the management of energy consumption at the lowest cost. The Internet of Things will deliver a smarter grid to facilitate more information and connectivity throughout the infrastructure, and to homes. Through the IOT, consumers, manufacturers and utility providers will unearth new techniques to control devices and eventually conserve resources and save money by using smart meters, home gateways, smart plugs, and connected appliances.

II. WHAT IS A SMART GRID?

Smart grid is an energy network that can reasonably integrate the actions of all the connected equipment, all the equipments are monitored for efficient working of all the components. Smart grid has a two-way flow of information unlike the old traditional power grid.

III. NEED OF SMART GRID

- Smart grids have a high efficiency than the old traditional grid.
- We all accepted that there are limitations that we face as many methods are not there, at present to use. Energy loss used to take place in traditional grids but not in smart grids.
- Unlike in traditional grids where it was not economical for the consumers to enjoy comfortable lifestyle, but with smart grid all the facilities can be enjoyed at a very reasonable cost.
- No one wants to pay extra for their energy bills which sometimes are generate very high as compared to the actual usage due to electricity theft. This can be regulated using the electricity theft detection technology.

IV. FEATURES OF SMART GRID

- Continuous power supply: - In a smart grid uninterrupted energy supply is provided to the consumers and for this a secondary energy line is made available so that in case of any fault the load will be transferred to the other energy line giving an uninterrupted supply.

- Operates against both physical and cyber attacks:- In smart grid if there is any attack, the whole grid keep a check on the circuit and if at all any strange incident take place then an instant message will be sent to the officials. This feature makes a grid very safe and secure.
- Real-time bill calculation: - Consumption done by each and every user is kept in check and bill calculation is done in real time basis. Total billing can be accessed by the concerned authorities via IOT platform.
- Theft detection and meter tampering:- If any unauthorized load is added on the circuit then message will be dropped to the operator, similarly if a case of meter tampering has happened then message will again be sent to the consumer and the operator.

V. HARDWARE SPECIFICATION

The major components required for the grid prototype to be completed are as follows:-

- Power Supply- It is the most important component of the grid as if there is no energy to flow through the grid then the grid itself is of no use. 220 Volts is taken and by the use of step down transformer the voltage is reduced to 5 Volts on which all the components will be working, all the current energy will be changed into direct current from alternate current, so that components can function.
- Internal Load- This is the allotted load on the system, any load other than this will be unauthorised and theft will be detected by the system.
- External Load-The unauthorised load will be shown using this load and also in case of theft this load will be used.
- Energy Meter- Through the meter, monitoring of the consumption done by the user will be done. All the data stored will be presented on the platform for the personal consideration. In General bill, generation will be done automatically by taking the consumption into the account of each and every consumer.
- Optocoupler- An optocoupler is a component that consists of a photo detector and an LED. Here it will be used with the energy meter to send the signals from meter to the microcontroller.
- Atmega Microcontroller- When connected with a 16 Kilohertz (KHz) crystal oscillator and two 22 picofarad (pf) capacitor, it acts as the brain for the whole circuit. It is the duty of the microcontroller to collect data from all the parts of the circuit and accordingly make the circuit behave. Pins 3 to 8 are connected to LCD screen to display the data on the screen while sending it to the platform, online.

- Wi-Fi Module- This is used to connect the circuit to the online platform where all the data is stored as well as presented to be accessed by the concerned authorities. If there is any fault in the power line or incidents like theft and meter tampering, these incidents will be shown on the platform as well. The Wi-Fi Module used in the circuit has a model number ESP8266.
- GSM/GPRS Modem- The main purpose of a GSM modem in the circuit is to send a warning message whenever incidents of theft, meter tampering or fault in the circuit takes place. The model number of the GSM/GPRS Modem is RS232; it is built with a dual band GSM/GPRS engine-SIM900A. This Modem operates on frequencies 900/1800 MHz.
- LCD Screen-It is used just to display important information and messages. All the data is being presented online or through SMS, data information should also be represented at the circuit level. The LCD used, is a 16x2 intelligent alphanumeric dot matrix display.

VI. BASIC BLOCK DIAGRAM

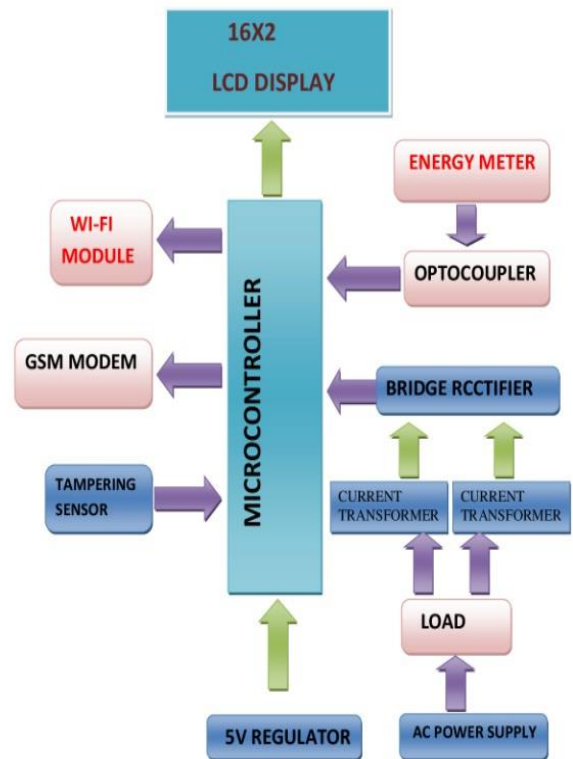


Fig 1. Block diagram of Smart Energy Grid System

VII. CIRCUIT DIAGRAM

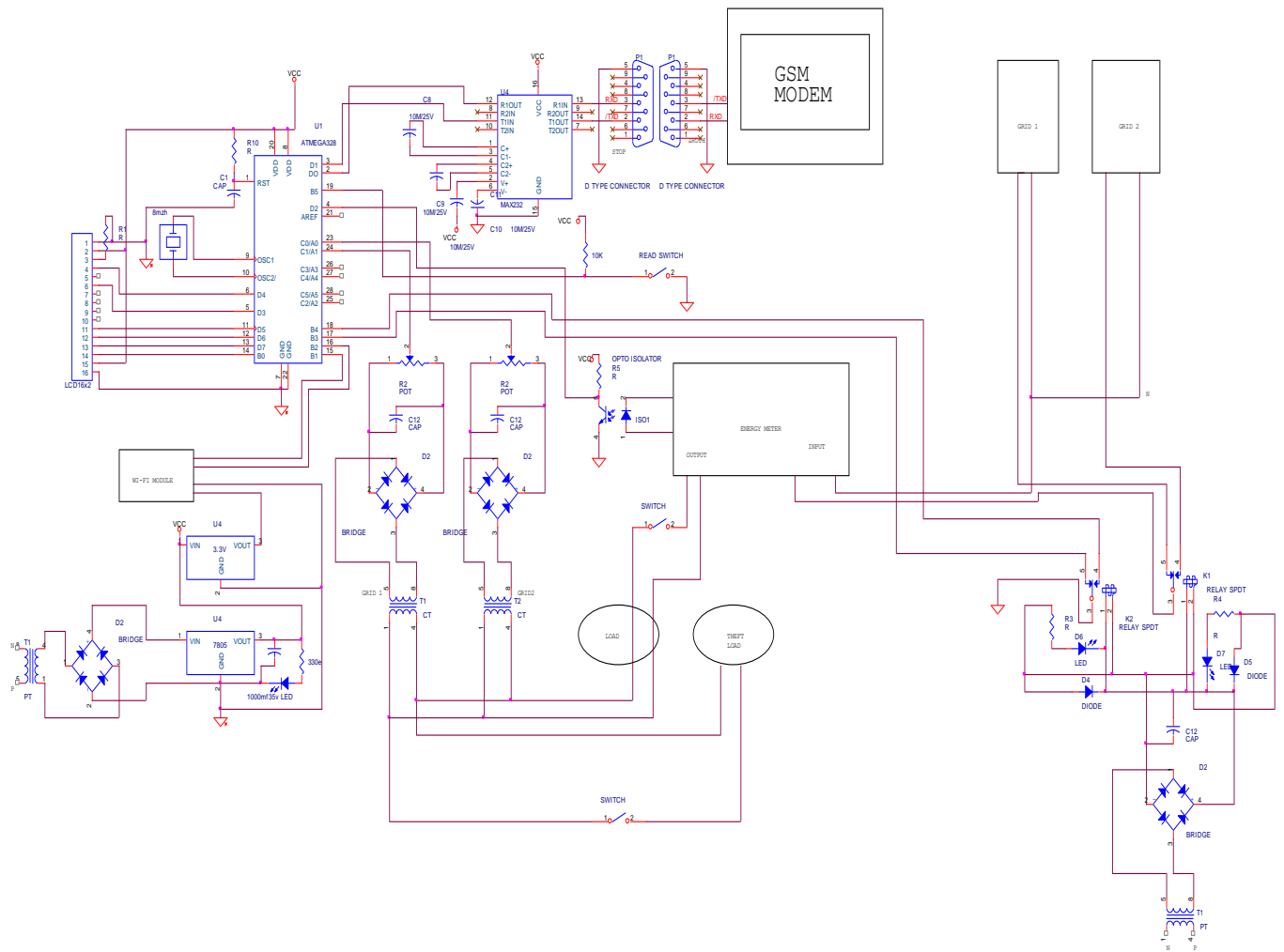


Fig 2.Circuit diagram of the proposed model of Smart Energy Grid System

The description of the above given circuit is as follows: -

All the main components of the circuits work on 5V of electricity. The power input is taken as 220V which is then brought down to 5V by using a step down transformer. Two loads are taken one is authorized and another is unauthorized. Whenever a fault comes on the primary line of power then automatically load is being transferred to the secondary line and for this a relay is used to make the switch between the power lines. Theft of electricity is detected by using control transformers in the line. Whenever any unauthorized load is detected by the control transformers then it gets notified by the variation in voltage at the microcontroller. For detecting energy meter tampering, a magnetic switch is used which is attached to the meter covering so that whenever there is a tampering in meter, the switch is open and the circuit breaks. This sends a low voltage signal to the microcontroller. The total process is controlled by the Atmega microcontroller; this microcontroller keeps a track of all the activities taking place in the circuit and performs accordingly. Another microcontroller is also used MAX232 in the circuit which is

there to control the GSM and Wi-Fi module. If there is a case of theft of power from the circuit then Atmega microcontroller will give command to MAX232 microcontroller to send a message to the owner and update the same onto the platform to be accessed by valid officials. Here we have used an open source IOT platform thingspeak.com which will send and receive all the valid data of a consumer on a single page, data like consumption, billing, meter tampering, etc. All of this data can be accessed by the consumer as well as by the owner. In case of meter tampering taking place, a message will be sent to the consumer and the owner so that required action can be taken to prevent it. At the circuit level all the data is displayed through a 16x2 LCD display. When all these features work at their full potential and are maintained regularly then the overall efficiency of the system reaches a whole different level, due to this new sector of power conservation opens up for research which will help humanity to grow and become prosperous.

VIII. ADVANTAGES AND DISADVANTAGES

Advantages:-

- Transmission of electricity becomes more efficient.
- In case of power disturbances, quick restoration of electricity is facilitated.
- It is very economical for the user as well as for the owner, cost of managing the whole infrastructure is very economical and it is user-friendly as the bill amount is reduced.
- No power theft can take place; cases of meter tampering also go down in huge numbers.
- Technology used is a time saving one as monitoring and managing of the whole circuit can be done from a single point and in real time.

Disadvantages:-

- One of the major drawbacks this system has is leakage of sensitive customer data, as the whole database is created online the stored data is always in a danger of getting hacked by some external source. Work is being put in to make it more secure and reliable but it's still a long way to be covered.
- Meters without the top security can be tampered easily without getting onto the radar.

IX. CONCLUSION

Smart grid is a revolution underway in the energy domain. The technology used is very user friendly. Daily consumption can be checked by the user from anywhere, at anytime using internet. Owner also can monitor the consumer's meter from a control unit. It is one of the most promising and prominent applications of Internet of Things. Reduced operations and management costs for utilities, and lower power costs for consumers are desirable outcomes. It is a Time saving technology, which can help keep a check on incidents like Meter tampering, theft, etc. It is a full-proof technology which is garnering a positive response from the targeted demographics resulting in the dawn of a new era.

ACKNOWLEDGMENT

This research was supported by SRM Institute of Science and Technology. We thank our batch mates as well as our professors from SRM Institute who provided insight and expertise that greatly assisted the research.

We like to give thanks to Mr. Saptarshi Gupta, Assistant Professor for assistance with all the major and minute details of the project circuit and assembling, and we are also very grateful for his comments that greatly improved the manuscript and the overall project.

We would also like to show our gratitude to Mr. Arun Kumar, Assistant Professor and Mrs. Rupali Singh, Assistant Professor for sharing their pearls of wisdom with us during the course of this research. We are also immensely grateful to all the reputed professors for their comments on an earlier version of the manuscript, although any error is our own and should not tarnish the reputation of these esteemed persons.

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