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IOT Based Last Meter Smart Grid With Energy Theft Detection

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Abstract: As the need of energy is increasing day to day, we know that now a days each sector make use of electricity. From lighting a blub to charge an automobile we are using electricity. Because of the increasing demand of energy it's important to avoid the wastage of electricity. Here proposes some ways to control the usage of electricity and to detect the energy theft if occurs. By using a smart meter placed on home the daily consumption of electricity will be monitored and visualize to the consumer via mobile phone. Through this approach more customer participation takes place. Consumer can get full detail on his mobile including the monthly bill and respective consumption. It is also possible to switch off the equipments which consume more energy on peak time if our daily consumption crosses the normal limit. The details collected will also visualize to the distributor unit via web page. Hence the bill payment and disconnection procedures can be done through the IOT cloud. We may able to detect the energy theft location also in this proposed concept. The information regarding energy theft also gets passes to the distributor unit. It will help to control the energy usage of appliances remotely with an increased amount of accuracy and reduce the effort of human operator. There will be interaction from distributor side through a web page.

Keywords: Smart grid, internet of things, last-meter, cloud, theft.

I. INTRODUCTION

The LAST-METER smart grid is the portion of the smart grid closer to the home, and the one with which customers interact. It allows a two-way data flow between customers and electric utilities, transforming the "traditionally passive end-users into active players" in the energy market. Nontechnical customers need a simple way to control energy consumption and production, and to exchange power usage data at the proper level of granularity with energy providers or distributors. From the point of view of market acceptance and penetration, the last-meter smart grid is just one aspect of the broader concept of smart home and smart buildings. The consequence of this consideration is that one can hardly imagine a situation in which the consumer side of the smart grid and other smart home applications rely on different and separate infrastructures or platforms. However, smart-grid architectures proposed in the literature typically focus on the needs of power distributors to manage the complete power grid. They reach customer's premises with an ad-hoc network of smart meters connected by General Packet Radio

Service (GPRS) or sometimes, with a dedicated programmable logic controller (PLC) technology. They do not take into account the possibility that customers already have other smart home infrastructures. A smart grid is an electrical grid which includes a variety of an operational and energy measures including smart meters, smart appliances, renewable energy resources, and energy efficiency resources. Electronic energy conditioning and control of the fabrication and distribution of the electricity are the important facet of the smart grid. Smart meter is the portion of the smart grid nearer to the home and one in which customer interact. Traditional power system involves huge operational losses including the electricity theft. Electricity theft is a major concern in the distribution system. Advance Metering Infrastructure (AMI) in smart grid helps to reduce the risk of power theft by accurate monitoring capabilities.

IoT systems- a) Hardware section which includes the sensors, actuators and the communication sections. b) Middleware is used to analyze the data received from the sensors by doing necessary computations after storing it.

IoT is used in smart homes, to monitor the environmental and security conditions of home and to control home appliances automatically. It is also used in providing utilities like energy via smart grid and smart metering.

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A. Losses Due To Electricity Theft

Power theft is an illegal way of taking the energy for different uses, which tends to a huge loss for beneficial companies. There are almost 25 billion of losses annually in the world. Losses can be computed by measuring the energy supplied, subtracting the actual amount of energy billed/paid. Electricity theft can perform through various methods like stealing electricity through bypassing a meter, tampering meters for low meter reading, Billing irregularities and unpaid bills. Different technical and nontechnical methods were introduced in the past to identify electricity stealing. Nontechnical techniques include finding out of the customers with questionable load profile. The periodic inspection can help to reduce the theft, but such measure needs huge manpower and large labor. It fails in most cases due to the dishonesty of the staffs.

Another way of stealing electricity is meter tampering. Effect of such illegal activities will leads to shortage in energy as well as economy of the country. So many works have done to detect the electricity theft in smart meter. Electricity theft in smart meter can be detected but theft in grid line is undetectable. This means, it is not easy to locate the exact theft location when theft happens in the consumer line. Since the grid line is open to air and extended to a long distance, it will be easy to hack for bypassing the electricity. Power theft detection in distribution line is the major topic and researches are going on to detect and control such theft.

The smart homes are built by integrating three domains- the community domain, the home domain and the service domain. The community domain is the connected network of homes where the information from individual homes is disseminated. The home domain consists of a continuous real-time monitoring system to monitor the healthcare, security and environmental details. The service domain works as a call center which comprises of a communication device to communicate with trusted parties like medical team, fire or police department etc. The decisions are made on the basis of sensor data and the call is made to service provides or proper authorities through reliable communication channel.

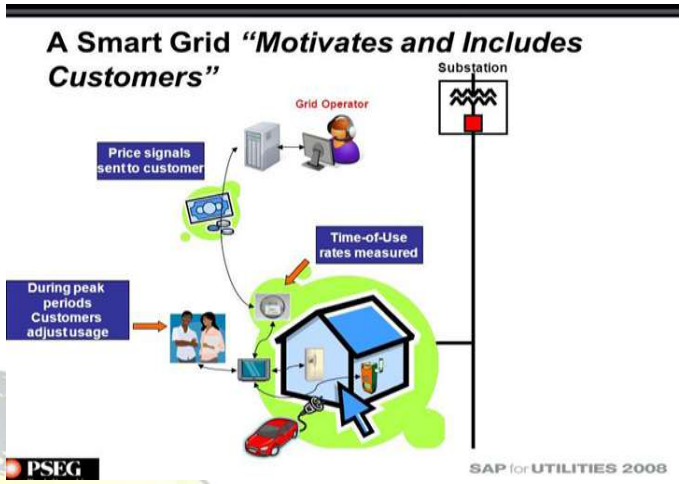

Fig.1: A High level approach on smart grid.[7]

Smart community framework consist the same, of any IoT systems. They are a) various sensors and things used in the network, b) the connection of things whether its wired or wireless, c) the digital data collected from the things or sensors, d) the processing, analysis of the data according to the application requirements, e) understanding the data and producing the findings, f) new services and actions are created based on those findings and g) based on those, the things respond through actuators.

The fundamental point of the Internet of Things is to empower things to be associated whenever, wherever, with anything and anybody in a perfect world utilizing any way/organize and any administration. Web of Things is another insurgency of the Internet. Items make themselves detectable and they acquire insight by settling on or empowering setting related choices, because of the way that they can convey data about themselves. They can get to data that has been amassed by different things, or they can be parts of complex administrations. The Internet Of Things (IOT) will convey a smarter grid to allow more information and connectivity throughout the infrastructure and to homes. Through the IOT, consumers, manufacturers and utility providers will uncover new ways to manage devices and ultimately conserve resources and save money by using smart meters, home gateways, smart plugs and connected appliances.

This paper organization is as follows: The related works done on smart grid is discussed in Section II. Section III put forward the proposed system architecture. Section IV describes about the system implementation of the system, it

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also evaluates the results provided by the implementation. The work is concluded in Section V.

II. BACKGROUND

Claudio Borean (1). This paper aims on the fact with improving the energy capacity of the whole home systems. The project enhances allocations of value-added services related on information exchange with energy usage, energy consumption and energy tariffs in the home area network (HAN).It enables users with information on household consumption directly on the display of an appliance itself, on a Smartphone, or on their own computer. It ensures that consumers will be able to use their appliances in a "smart" way by enhancing the energy efficiency of the entire home system. For instance, smart appliances can start functioning at non-peak times of day, in addition to Based Control and Monitoring of Smart Grid and energy Theft Detection cooperating to eliminate overloads.

S S Nagendra Kumar (2). Smart grid systems consisted of digitally based sensing, communications, and control technologies and field devices that function to coordinate different electric grid processes. When coming to power theft, in earlier day the energy meters are analog, so the consumers use two permanent magnets which are place to the meter so the disc is fixed and not able to make its rotation. This illegal way of theft can be reduced by using digital meters. This method will predict the power theft by identifying the area using smart meters and smart transformers. Smart transformer measure the total power consumed. The each consumer smart meter sent the power consumed by each consumer to the hub through zig-bee (P1, P2, P3….).The power from sending end should be equal to receiving end. The raspberry pi will do this calculation, if the equation is not equal on both sides, the location of that area is sent to the respective officer messaging that there is a power theft. The Raspberry Pi can be used to automate a smart grid at a relatively low cost. It works under IoT concept.

Don Carney Brown (3). Here it keep track of applications, which will differ significantly from typical business data processing. Here monitoring applications get their data from external sources rather than from humans issuing transactions. The aim of the DBMS in this theory is to warn humans when abnormal activity is estimated. Monitoring applications have data management that expands over some history of values reported in a stream. Most monitoring applications are trigger-based. Most monitoring applications have real-time requirements. Applications that monitor mobile sensors often have a low tolerance for data, making these applications effectively real time. The added stress on a DBMS that must serve real-time applications makes it imperative that the DBMS employ intelligent resource management and graceful degradation strategies during periods of high load.

Mitali Mahadev Raut (4). Smart grids are based on transmission between the provider and consumer. The grid becomes overburden during peak times or seasons. With the usage of smart grid technology consumer and owner gets daily electricity consumption reading and owner can cut electricity supply remotely through internet if bill is not paid. In case meter tempering is happened then owner and consumer is on micro switch is fitted in meter. This is to prevent meter tempering. The Internet of Things (IOT) will convey a smarter get message. Here consumer and provider can access their data through internet. The main part of this method is smart grid meter. Second feature of the smart grid to collect more information and connectivity to whole infrastructure and to homes. Through the IOT, consumers and producers can maintain resources and avoid the wastage of money.

Agustin Zaballos (5) the current power grid is defined as a system made of electrical generators, transformers, transmission, and distribution lines used to deliver electricity power to eventual users. Smart grid network control and monitoring are very important features in order to provide distributed generation and storage quality of service, and security. It is carried out at high voltage only. This communication paradigm achieves end-to-end integration of heterogeneous technologies by using the ubiquitous sensor network (USN) architecture and defining the interoperability with the next-generation network (NGN) as the smart grid backbone. Advanced metering infrastructure (AMI) consists of smart meters, data management, communication network and applications. A geographic information system (GIS) and a consumer information system (CIS) usually contribute with tools and important processes.

Shu Lei, Wu Xiaoling (6) Heterogeneous sensor networks which are physically deployed in different places sometimes need to be integrated over IP based wire/wireless networks into one virtual sensor networks to provide meaningful services for users. Pervasive network which is considered as the next generation of current networks requests us to integrate all kind of heterogeneous networks into one global network.

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III. PROPOSED METHOD

This paper develops a monitoring platform for IoT based smart grid system for three custom designed smart comes. In this section, system architecture for the proposed system is described along with a detailed description of the IoT communication protocol.

A. *System Architecture*

Here made planning for the last-meter smart grid that is implanted in a platform for the internet of things (IoT).It has four main advantages and elements with respect to the state of the artwork, each corresponding to the basic requirement of being "customer-centric" and ductile, in order to improve market acceptance and ease of deployment.

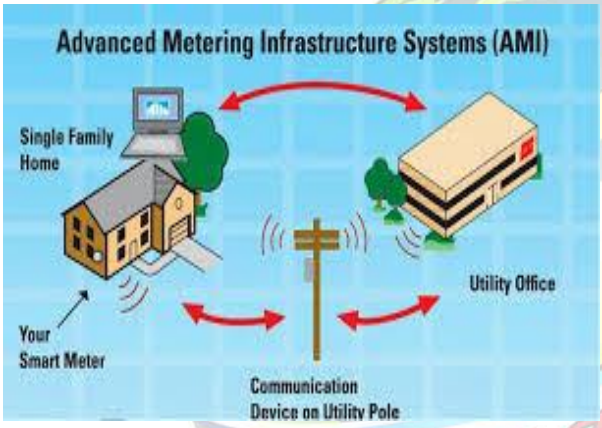

Fig. 2: The Proposed Smart grid Architecture.[8]

B. *Smart meter at home.*

Here it is implemented an in-home prototype on the IoT platform, building dedicated hardware and software. This first prototype only includes a data modem connected to the IoT server through a IP gateway. The sensors are smart plugs, placed between home appliances and a wall socket, and able to collect real-time power consumption data from the loads. Customers can have a visual feedback of their energy consumption and can remotely control each load. While technology in on the upgrading slopes, we should also note the increasing unethical activities. With a technical view, energy Theft is a non –ignorable crime that is highly prevented, and at the same time it directly affected the economy of a nation. Electricity theft is informal, so it has to be completely eliminated. Power consumption and losses have to be closely observed so that the generated energy is utilized in a most systematic manner. The system prevents the illegal usage of electricity.

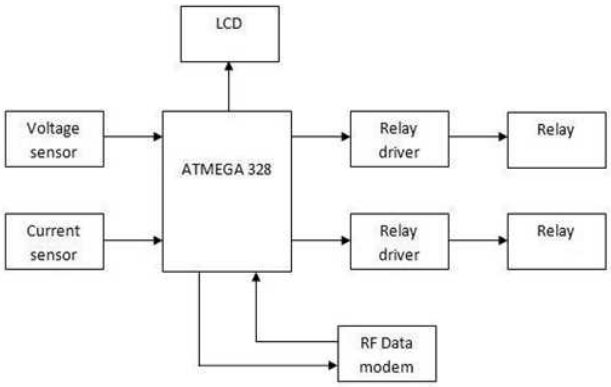

Fig.3.block diagram

Figure 3 represents the system block diagram on home unit. Voltage and current sensor is used for monitoring the energy consumption .data modem helps communicate between the distributor unit and home unit. For the peak time control relays and relay drivers are used.

C. *Energy theft*

Energy theft occurs mainly before the meter stages, with the help of smart grid we may able detect the energy theft by identifying the location. Smart transformer measure the total energy consumed i.e., total energy consumed at transformer (Ptot) by the consumer loads. The each consumer smart meter sent the power consumed by each consumer to the hub (P1, P2, P3….).The power from sending end should be equal to receiving end.

D.Web page at distribution center

Constructing an web page which should be displayed at the KSEB unit. This page should be displays the consumer number, unit used, amount to the authority. There may gave a choice to disconnect the electricity connection if the bill is not paid .Also the connection get replenished after the bill pays.

VI. IMPLEMENTATION AND RESULT

1. Hardware section

A. The power consumption unit

Aim of this power monitoring system is to measure the correct amount of power that is consumed by the customer each instant of time. The power measurement unit is connected on the consumer side as well as on the pole unit. Instrument transformers are used to measure the power. They are used for stepping down the current or voltage of a system to measurable values, such as 5A or 1A in the case of a current transformers or 110V or 100V in the case of a voltage transformer.

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ATMEGA 328 microcontroller,, sensors like voltage and current ,LCD display ,relay drivers and relays are used for this set up .the daily power consumption will monitored and sensed from each equipment and get stored in the microcontroller, later it will be displayed on the consumers mobile phone by a web page. Hence consumer can able to control the consumption of his energy.

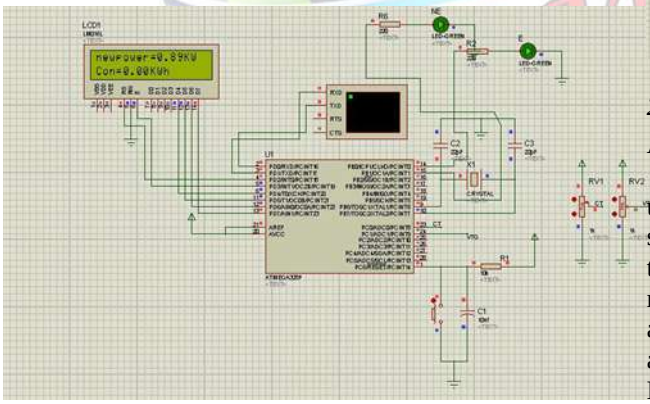
B. Energy theft.

By using transformers ,current sensors ,relays ,atmega328 ,setting up the model .the energy from transformer will be calculated by current sensor initially and later the consumed energy from each home get determined on comparing the results ,if we get equal value for both sides there didn't occur any theft otherwise there occur theft on the variation of the calculation. we may also able identify the location were the theft has been takes place. The theft message was informed to the distributor through GSM module attached in the unit.

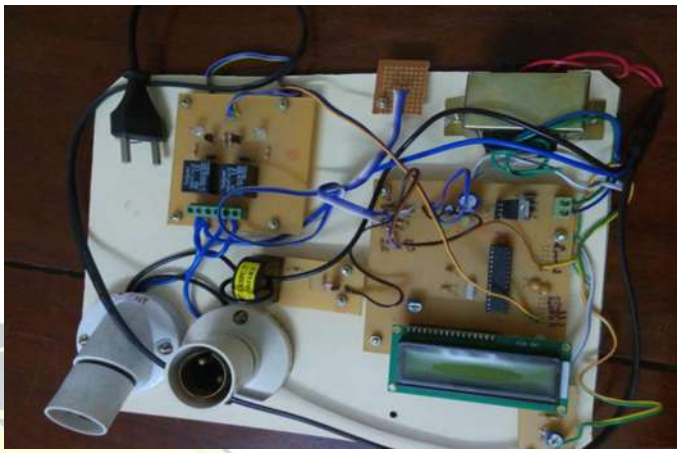
C .Web page.

A web page was displayed in the distributor unit; if the consumer didn't pay his electricity bill the authority can be able to disconnect his connection. After paying the bill the connection will be replenished. The connection and disconnection can be done through passing messages. Node Mcu unit is used to create the webpage. The message of disconnection will be passing through those modules and through a RF data modem the disconnection will occur.

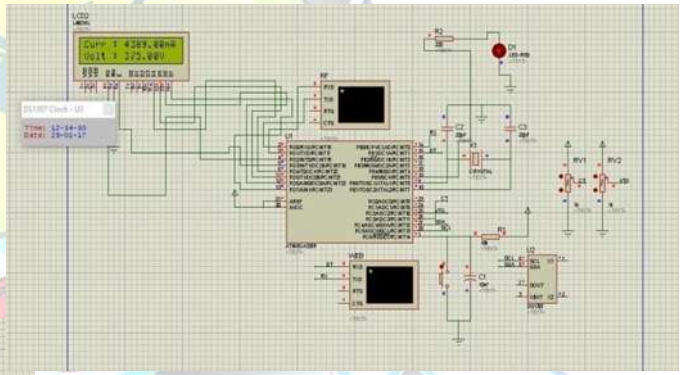
A.1..Simulation of power consumption



A.2 .Hardware section



B.1.simulation of power theft



2. Software section

A. *PROTEUS*

The Proteus Design Suite is a proprietary software tool used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards. Proteus is a tool that adds the environment simulation of electronic circuits, ISIS and the program to design printed circuit developed by English company LABCENTER electronics. The proteus design combines schematic capture, SPICE simulation circuits and PCB design to make a complete design of electronic system. Add to that the ability to simulate popular microcontrollers and run your current firmware and have a package that can dramatically reduce development time compared to a traditional design process.

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B. *ARDUINO*

Arduino is an open source PC equipment and programming organization, venture, and client group that plans and fabricates single-board microcontroller's ec and microcontroller packs for building advanced gadgets and intuitive articles that can detect and control questions in the physical world. The venture's items are circulated as open-source equipment and programming, which are authorized under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), allowing the produce of Arduino sheets and programming dissemination by anybody. Arduino sheets are accessible industrially in preassembled shape, or as do-it-without anyone's help (DIY) packs. Arduino board outlines utilize an assortment of microchips and controllers. The sheets are outfitted with sets of computerized and simple info/yield (I/O) sticks that might be interfaced to different extension sheets (shields) and different circuits. The sheets highlight serial interchanges interfaces, including Universal Serial Bus (USB) on a few models, which are additionally utilized for stacking programs from PCs. The microcontrollers are normally modified utilizing a vernacular of highlights from the programming dialects C and C++.

V. CONCLUSION

It was introduced an engineering, a usage, and an exhibit of the Customer Domain of the keen matrix, in light of a stage for the IoT that can have an expansive scope of brilliant home applications. Oddity in this field must be found in the structural idea, in the framework combination, and in the prioritization of necessities. In this sense, this proposition has one of a kind focal points and components of oddity regarding the best in class, it is client driven, it limits the arrangement of specific shrewd lattice framework, and it use perhaps accessible brilliant home applications, sensors, and systems. This is key for a far reaching acknowledgment of keen lattice applications and hardware to be sent at home.

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