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Demand Side management of smart grid using IoT

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Abstract – *This paper focuses on demand side management (DSM) using smart grid using IoT technology. DSM is an important function in smart to manage electricity. DSM attains energy conservation and utilization, energy usage efficiency enrichment and saves cost through information technology. The main part of our work is fabrication of cost effective based on Demand side management using IoT technology smart grid which displays readings on OLED, Instant Power consumption from each user, sends and receive information from grid through cloud computing. The power consumption continuously monitored and recorded through webserver. A specific load will be provided to each user, if the load exceeds the particular limit, then it will record the readings on webserver and electricity for that specific user will be cut off. Domestic level Energy Management unit is designed for easy monitoring and control of house hold appliances.*

Key words: **Smart Grid, Demand Side Management (DSM), Cloud Computing.**

1. Introduction

Electricity is a vital element in today's economic development and national growth of the country. Over the past numerous decades, electric energy structure has encountered stressed circumstances because of ever growing energy demand, inefficient use of electric energy generation and transmission resources. Transmission line outage were a common motive of stress condition, which might be viable to occur throughout peak hours. This kind of events which will be the reason to supply limit situation where load shedding, cascading failures and blackouts are possible. Emerging challenges, such as old infrastructure, increase in demand and growing carbon emission are driving conventional power grid towards smart grid.[1]

1.1 Smart Grid

The smart grid is the technology which will incorporates information and communications methods will change the infrastructure, electricity generation, transmission and consumption. Today's centralised power system is smart grid like centralised electricity grid which will generate, distribute and regulate flow of electricity to each user.[2]

The Feedback loop of communication in fig-1 is a strength of smart grid.

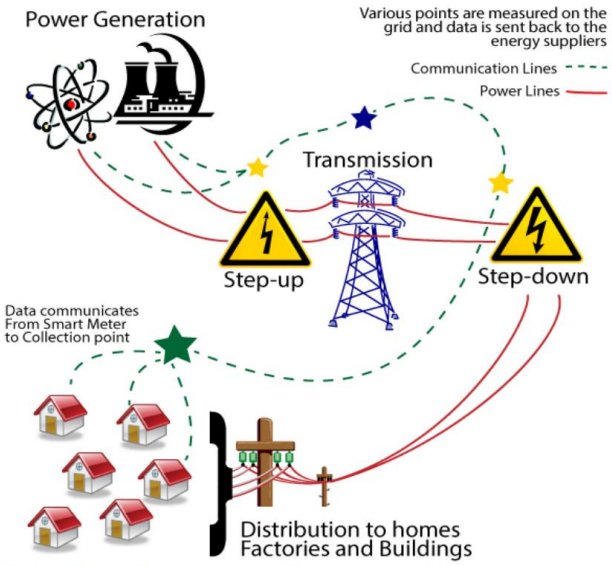

Fig-1- Smart grid

1.2 Demand Side Management

Demand- side Management (DSM) is an arising field in the energy industry. mileage companies are decreasingly espousing it as part of their sweats to control their costs and reduce the impact of energy dearth's on their nethermost lines. DSM is also effective in controlling the implicit adverse goods of power cuts during peak hours of the day and in case of high charges or traffic of electric grids. These factors can lead to advanced costs and vexation to the end- druggies, especially during weekends and at out- peak hours.

The complications in smart grid are partly tackled through demand side management (DSM). This method will bring down the pressure on grid along with electricity bills. DSM resource to the users to make desire concerning use of electricity that is when and how much to use. DSM has some regions of impact which are load shifting and load reduction.

Implementing DSM algorithm substantially relies on two-way communication among the utility and end user. The end user willingness to reduce/shift their power consumption. Power generation can be averted through shifting power usage from peak hours to off-peak hours so that cost of production gets reduced. [3-4]

There are six types of DSM technique methods for different users for load shaping and they are load shifting, valley filling, strategic conversation, peak clipping, strategic load growth and flexible load shape. Load shifting is nothing but the load shift from on peak to off peak hours and the advantage of load shifting is to lower the cost and peak demand. [5]

Electricity charge relates at the power consumption of the users. In electricity market, The DSM has the essential role. As demands increases the cost of electricity also increase. The increase in electricity cost will change the whole users in power system. By lowering the peak to average ratio, DSM regulates the power cost in electricity market. [6]

A DSM approach for domestic level users based on totally on load shifting approach is proposed here. The idea of behind this method is primarily based on users load precedence and comfort preferences. DSM allows in managing and controlling power consumption on the basis of electricity supply. [7]

1.3 Cloud Computing

Discussing about Cloud computing, it is nothing but the computer system resource which is available on demand of user. It is mainly used for data storage and power computing. They are distributed over different locations and each location has its own data centre. Cloud computing which consists Storage, server, databases, networking software which works over the internet. [8]

To use Clouds, first determine what kind of cloud needs to be used so there are three types of clouds according to their architecture and services that is public cloud, private cloud and Hybrid cloud and their services are like IaaS (Infrastructure as s service), PaaS (Platform as a service) and SaaS (Software as a service). [9-10]

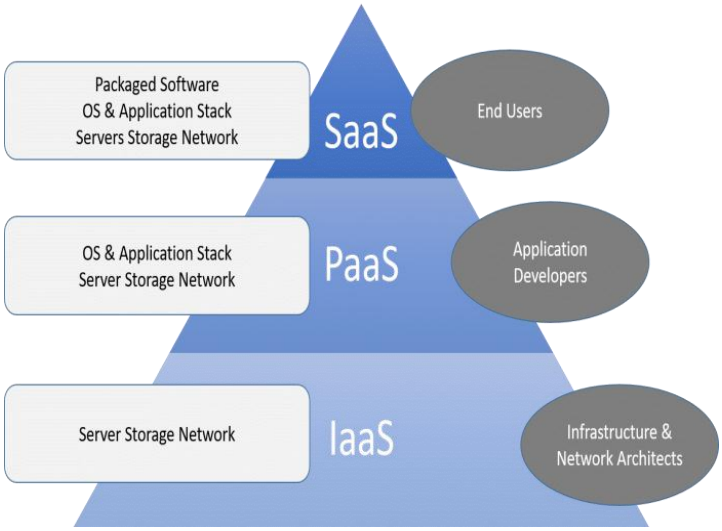

Fig-2- Cloud services model

2. Related Work

We have studied several research paper Based on Demand side managements in Electricity and smart grid and analysed different aspects.

A research paper based on a demand side management in smart grid based on ECC unit, we have pointed that ECC unit runs on a distributed algorithm which reduces peak load in by transferring shiftable loads from off-peak hours with on-peak hours [1].

Another research paper, we have studied about Intelligent demand side management in smart grid. This model is based on GUI (Graphical User Interface). GUI will be used to monitor, power consumption and calculate instantaneous cost of users [2].

Some research paper shows their impact on aspect such as overcome electric power stress through demand side management. This paper focuses the fabrication of the cost based on smart meters which displays reading on LCD and monitor power consumption then sends and receives information from grid using GSM module [3].

Demonstrated new scheme to stabilize power usage in smart grid. As Demand response management in smart grid is imperative which gives proper shape to the total load in demand side [4].

During this paper, we got to know few more benefits of smart grid and involvement of government in some countries. We also studied advance smart meters which record energy usage and provide it to the users [5].

In this paper, we studied about the path of the smart grid which involves challenges in smart grid and solution upon it which tells how to reduce cost of the consumption and stabilize the readings [6].

The part of this paper aims to provide energy systems so that researcher decision makers will get proper guidance to underlying drivers of consumers acceptance of the Smart grid and some steps for smart grid [7].

The Consumers can choose on-peaks hours for maximum use of power on residential purpose in way to reduce energy bills so that they can use power in those peak hours [8].

In the research paper on cloud computing tells that first cloud services were introduces by Amazon in 2006. Cloud computing it the life time dream of computing as a utility which has the capacity to convert a huge part of the IT company and making software even more attractive as a service and shaping the IT hardware is designed and purchased. Inventors with new invention ideas for new internet services no longer bear the huge capital expenses in tackle to emplace their service or mortal expenditure to operate it.

Cloud working out is the delivery of computing services such as servers, storage, database, networking, software, analytics, intelligence, and more, over the Cloud (Internet). The well-known Cloud services are Amazon web services, Google cloud platform and Microsoft Azure [9].

It aims to make and read sophisticated service terrain with important computing capabilities through an array of fairly low-cost computing reality, and using the advanced deployment models like SaaS (Software as a Service), PaaS (Platform as a Service), IaaS (Infrastructure as a Service), HaaS (Hardware as a Service) to distribute the important computing capacity to end-users. This paper will explore the background and service models and also presents the being exploration issues and counteraccusations in cloud computing such as security, reliability, sequestration, and so on [10].

3. Proposed Methodology

The idea behind this system is to design and implement the demand side management system with user friendly interface and control the functionalities for energy provider and load controllers that collects energy utilization data from the user and perform control based on webserver by using Energy sensor. The residential users do not have time to perform Demand response manually. So, the IoT based system plays a vital role in executing the automated demand response within an area. Each user's loads are used and the corresponding priority is adjusted based on the priority of the loads. Each load is connected through relays. Load curtailment request will be received by the relays, and they ensure the total power consumption below the specified demand limit. The proposed DSM system allows the home owner to use their loads when needed as long as the total domestic power consumption remains under the specified limit.

In proposed system, the Energy sensor, Webserver and data base view will be used to monitor and control appliances status and power consumption. To control the user's energy usage, Time of Use based pricing scheme is used here. The power consumed in the off-peak time costs less as compared to the peak hours. Power consumption cost per unit in peak hours is greater than the per unit price in off-peak hours.

The request power signal from each user is send through communication module. This communication module is used to fetch power consumption data from all the users and provide an interface for users to regain appliances status and review their power consumption. The Webserver contains data to monitor and control the power consumption.

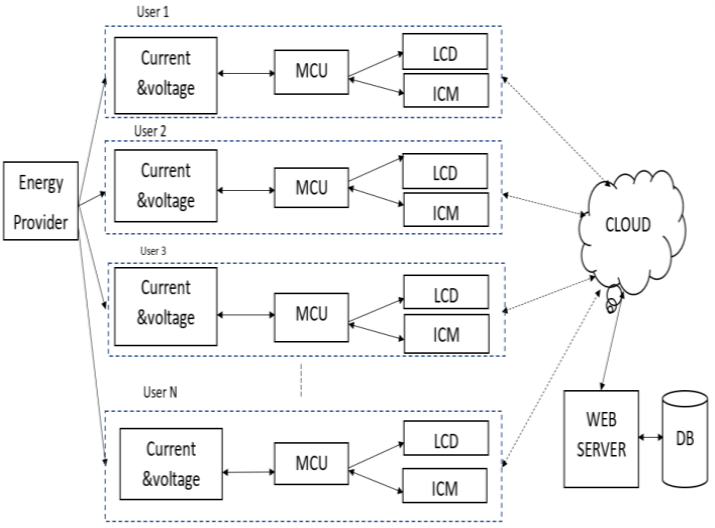

Fig- 3- Block Diagram

The main purpose of the system is to design and develop Demand side management system which will be user friendly and control energy provider and controller. The Electricity from Energy corporation will send to individual N Users according to their need and peak time. Energy sensor will measure Voltage, current and power being consumed by each user. User interface is used to Monitor and control user's status and power consumption.

The PZEM-004T Energy sensor will give voltage, Current and power value and ESP-32 Microcontroller will monitor Voltage and current and sends and received information on the Grid and to display data for each user OLED is used. The power transmission and consumption records for each user will be collected using Cloud computing. The request signal from user is send through communication module. This will collect electrical power consumption data from all the loads and providing an interface for users to regain appliances status and review their power consumption.

4. Algorithm

Demand Side Management Strategy developed to meet the capacity provided by the utility. The flowchart of the proposed strategy as shown in fig -3 First read the voltage, current and power of each user from Energy sensor and monitor it with the help of microcontroller and send it to the webserver's Data base. Then calculate the total power (P) of each user. The power consumption limit is given as decision value (Z). Then take the difference between decision value and absolute power. According to Value load control differences are possible.

The difference is above decision value then relays will turn of off along with that supply to extension will be cut off so that appliances value will not reach till energy sensor that means when value exceeds decision value the whole user will stop working because it is consuming more energy than required.

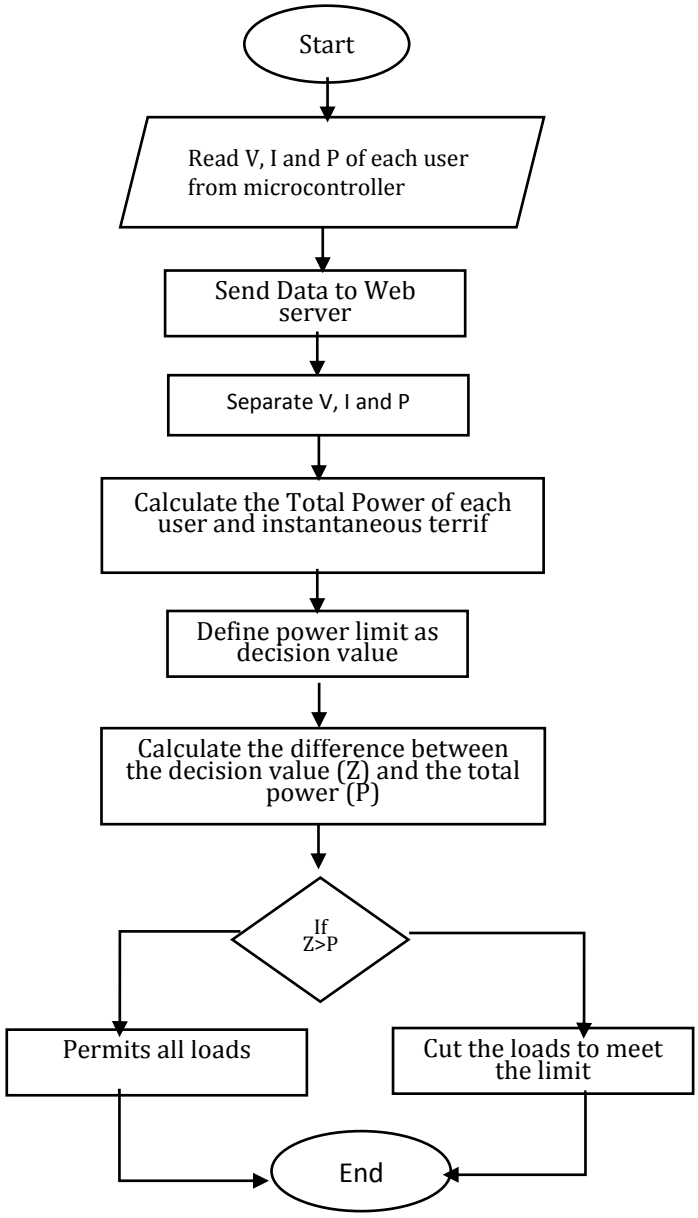

Fig-4- Flowchart

5. Result and Discussion

The Hardware result is discussed here as the input to each user will be provided with domestic level power. Energy sensor will calculate five parameters like voltage, Current, Power, Frequency and power factor for each user respectively.

The energy providers have some limit value which is taken as the decision value. With the help of ESP32 microcontroller and webserver total power will be calculated and get compared with decision value. When this decision value (Z) is less than the total power consumption of each user, then curtailment is done to

meet the decision value and that will be stored on webserver.

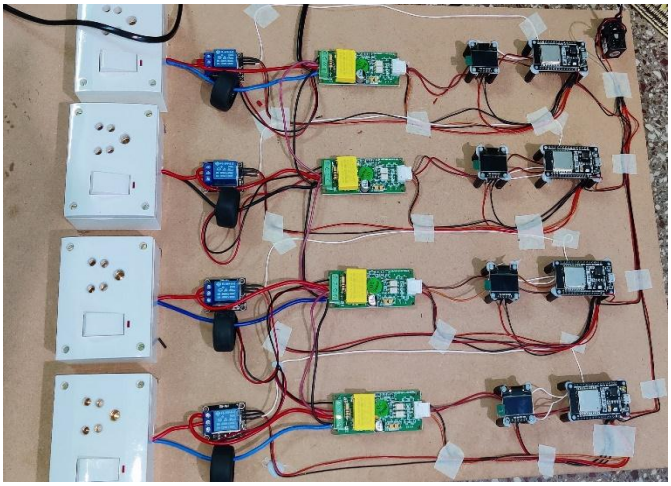

Fig 5- Hardware Implementation

Here two cases are considered.

Case 1: When Z < P

If power consumption by one of the users is greater than the decision value that times curtailment takes place.

Case 2: When Z > P

If power consumption by one of the users is lesser than the

decision value and if the decision value is greater, then there will be no curtailment will take place. The system allows all the loads.

6. Conclusion

The Demand side Management system with demand response plays a most vital role in effectively managing the wastage of power on the consumer side. This paper presents a better way to manage the power consumption of residential users. This Demand Side Management system for demand response applications might effectively manage and control the operation of assorted appliances to manage overall consumption below a threshold.

The proposed DSM takes under consideration each load priority and user preferences with IoT technology which is used for this method. Thus, the work provides an affordable, flexible, user-friendly, and very secure design for implementing a Demand side Management System. Hardware results indicate the effectiveness of the projected DSM Strategy and also the profit in their electricity bills.

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