Second International Conference on Nexgen Technologies
Sengunthar Engineering College, Tiruchengode, Namakkal Dist. Tamilnadu (India)
8th - 9th March 2019 www.conferenceworld.in ISBN : 978-93-87793-75-0

# CONTROL AND MONITORING OF DOMESTIC LOAD USING ANDROID APPLICATION

**Dhinesh Kanna P[1], Mohamed Suhail M A[2], Prasannabalaji S[3]**

*[1-3]UG student, Department of EEE, Sri Krishna College of Technology, Coimbatore, Tamil Nadu (India)*

## ABSTRACT

*In future the electrical grid system in India will be termed as smart grid because of its smartness in decision making and resolving problems. The major objective of the smart grid is to provide quality uninterrupted power supply to consumers and establishing a good communication link between consumer and service provider. Our proposed system will monitor the domestic loads consumption of all consumer connection and categories the peak hour and non-peak hour based on the demand. The consumer will able to know the peak and non-peak hour using mobile application which will allow the users to schedule the loads in non-peak hour. Consumer will know about his consumption through this application, get notification for bill dues, over voltages, low voltages, scheduled power cuts by service provider. If any fault occurred in domestic side will immediately notified to the service provider. The domestic loads can be switched from remote. The smart meter in this system can operate in different modes of operation. Service provider can shut the supply to any domestic connection if the respective consumer didn't pay the bill dues. This system will increase the communication strength between the consumer and service provider and also will reduce the peak demand hence the electricity cost will be reduced.*

***Keywords: Smart Meter, Load Scheduling, Mobile application, peak demand, service provider, consumer.***

## I. INTRODUCTION

The smart grid is a collective network of smart meters, sensors and renewable energy resources. Smart grid provides a bidirectional communication between consumer and service provider, resulting in increased energy efficiency and power grid reliability. In smart grid, IOT plays a vital role, since internet is used as communication medium. Key aspects of metering process, challenges and opportunities arising due to the advent of big data and the increasing popularity of the cloud environments were discussed [1]. A smart energy meter is an electronic device that measures consumption of electric energy and communicates the information to the service provider as well as to consumers, as it will assist to optimize and manage the load usage remotely. There are many designs for Smart meters for efficient control and measuring of energy consumption. Concept of selection of meters based on sampling waveform [2] for smart meters utilizing voltage control. But the system response time is low due to the high sampling time. The voltage and energy are measured to regulate the voltage

at demand side by installing a smart meter at various region [3]-[4]. A cellular network based communication also used for smart meters [5] is limited to communication only through SMS, which cannot give UI and IoT experience to user.

Since the consumers are not aware about their consumption, this paper proposes a system for control and monitor the domestic loads by implementation of the software which can provide the knowledge about the amount of power consumed in the working and in the non-working days. As the load varies with time, it is difficult for the service provider to deliver the quality power throughout the day. The information about the quality of power and domestic energy consumption in several nodes of the electrical network is provided to the service provider by the smart meters integrated with the electric grid [6].The details of energy consumption at each buildings had send to service providers through a bidirectional communication link, to meet their demand [7]. To measure energy consumption hourly, energy lifestyle segmentation based clustering of loads are encoded as preprocessed dictionary [8]. Due to variations in the load demands and high peak demand, it is difficult for service provider to provide a quality power. To supply the demand future load demands are estimated. There are several methods to estimate the future load demands. Estimating the daily consumption of sample consumers by normalized load pattern to obtain Pseudo Load Profile of a consumer [9] had proposed frequency based clustering. Estimating all consumers based on some sample consumers will not give a closer demand estimation value for future demand. Similarly, monitoring the active and reactive load at the sample residential buildings [10]. To reduce the peak hour demand the load which can switch later are suggested to switch on during the non-peak hours, so that the peak hour demand can be reduced. But in conventional practice reducing the peak hour is not possible. To solve this problem the loads has to be shifted or scheduled during non-peak hours. Appliance level demand schedules are derived using aggregated energy consumption [11]. To give optimal energy cost, the tariff during peak and non-peak hours may vary. But the two tariff system may increase the calculation complexity [12]. A system with the day-ahead time dependent pricing scheme [13], with the renewable energy buying back scheme were implemented to reduce the peak time energy demand [14]. Different methods of load shifting and scheduling are used to reduce the peak time energy demand and to give optimal electricity cost to consumers. The randomized approach [15] which divide the loads into three categories as Thermostatically Controlled Device, Rechargeable Batteries and Successive Operation Device. Limitation of [15] is only thermostatically controlled devices were scheduled other devices were not scheduled. Similarly [16] the shift-able loads are scheduled to off-peak hours and the remaining curtailable loads are monitored and the energy consumption can be reduced. Thus shifting the load demand from the peak hours to the non-peak hour based on consumer preference is the major objective of this paper. It doesn't require any addition of sensor or the involvement of the consumer. The Smart Energy meter along with android application provides the features of Domestic Load Monitoring and control (DLMC) such as remote tariff plan setting, bill generation, remote connection and disconnection, fault detection, tampering protection, bypassing alerts and bill due alerts. Every information have been stored to the cloud through the smart energy meter. However scheduling gives the estimation of future energy demand and reduce the peak demand, there are some other problems for utility to consider is theft and fault detection. A Smart energy meter was designed to reduce the

meter tampering by the consumers. The system has a Current Transformer (CT) at the incoming line and n number of CTs were installed at each node of the electrical system of building where the smart energy meter was installed and compared, and reported to the utility. This requires huge capital cost and there exists a lot of practical difficulties [17]. Fault Detection is an important factor from service provider. An impedance based fault location identifying topology was designed and implemented with the smart energy meters to define the Low Voltage Zones (LVZ). This will result in the rough estimation of the fault location and not accurate [18]. If any fault is detected in the particular area the information is sent to both the consumers and the suppliers, if the problem is not rectified in the certain period of time then the problem will be forwarded to the higher officials in the hierarchical order automatically by the system. If any of the consumer tries to reduce the consumption reading it can be detected and the action can be taken by the service provider. Simultaneously the service connection will be disconnected. The various modes of controlling and monitoring the loads are proposed in this paper. The smart meter can operate in three modes of operation, Standard Mode, Scheduling Mode and Energy Saving Mode.

## II. METHODOLOGY

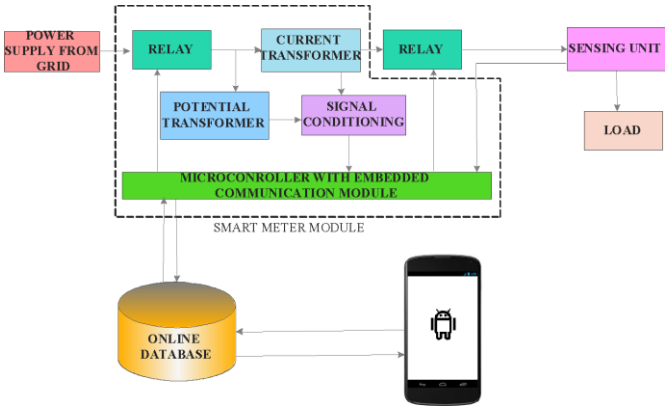


Fig1: Block Diagram of the Control and monitoring of Domestic Load Using Android application

The proposed system has two segments, Domestic side system and android application. The domestic side system has the smart meter. The smart meter comprises of measurement unit, microprocessor and load switching channel. The input line from the main supply is connected to the system through Relay and then measurement unit. The measured values are processed by the microcontroller which in turn transfer the data to the cloud database. The smart meters are able to operate in three modes of operations:

1. Scheduling Mode.
2. Standard Mode.
3. Energy Saving Mode.

### 1.1 Scheduling Mode

In this mode smart meter is allowed to operate at its fullest features like scheduling, monitoring and bill generation, meter tampering, switching the loads and Report to consumer's forum where consumers can send their problems to their service provider. This is the default mode of operation.

1.2 Standard Mode.

This mode has limited features, load scheduling is not allowed in this mode. This mode allows the system to troubleshoot itself and will be report to the consumer if any error occurs while troubleshooting. The consumers are allowed to switch the loads and monitor their current consumption but history of consumption is limited. The consumers are notified for all situations said earlier.

1.3 Energy Saving Mode.

This is a special mode, the user can make their smart meter to operate in this mode, when they are going for long trips. In this mode, consumers are asked to choose the loads as mandatory loads and can schedule when the load should on and off. All other loads are not allowed to switch on. The features like notification for voltage variation, bill dues, meter tampering and consumer's forum.

The smart meters are able to communicate with android application through online database. The loads are switched and scheduled from remote using the android application. The android application is synchronized with the consumer's smart meter, which allows the user to schedule the loads on non-peak hours. The users are come to know their peak and non-peak hours through the android application. All the users of android application are required to register initially then login to access their features. Each users are given with individual id number and password to login after successful registration. The service provider will login using their employee id and password whereas consumer will be login using their email id and password. If a consumer has many service connections, all connections are controlled by single login but by selecting one active meter at a time. Though, notifications for non-active meters also be received. Scheduling is the important feature of this android application. This will be the better solution to reduce the peak demand and allows the user to set the time for any loads which should be switch on later nor immediately like washing machine, air conditioner, rice cooker, microwave oven and even motor pump also. The consumer must enable the loads which have to be scheduled in non-peak hours.

To provide the better communication between the consumer and service provider is a major objective of this proposed system. In case of any scheduled power cut, it will be intimated to the consumers as a notification along with the date and time. If any other faults occurs or else if there is an unexpected power cut at domestic side, it will be reported to the service provider's employee automatically with time and date. If the problem was not responded within a time limit then the problem will be forwarded to their higher officials. The consumers are allowed to post their quires to their service provider using this android application.

## III. RESULT AND DISCUSSION

The proposed system brings more awareness to the consumers about their grid system. The meter is installed in prototype model with linear electrical loads and its measurement accuracy is comparatively equal to the traditional meter. The smart meter was stable in all three modes of operation. The loads are scheduled as per consumer's preference and the loads are switched as per scheduling time. The peak demand value has reduced and service provider able to know his power quality through this application.

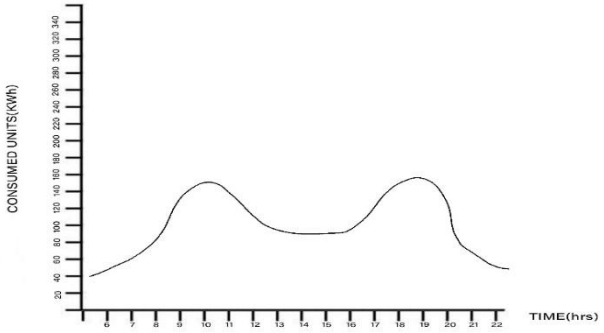


Fig2. Demand with respect to time before implementing the proposed system.

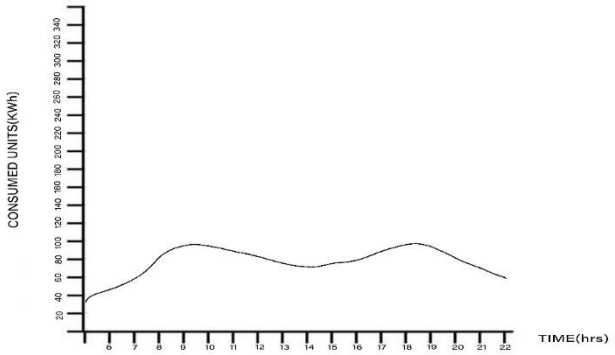


Fig3. Demand with respect to time after implementing the proposed system.

The consumer and service provider are given alert for unexpected power failure, hence service provider can resolve the problem immediately. The loads are switched remotely by consumer application. The main supply is able to turn on or off by the service provider.

## IV. CONCLUSION

The consumers are now aware about their consumption, and consumers also responsible to reduce the peak demand since consumer preferred load scheduling is implemented. Even though the heart of the system is hardware, IoT and Android application has a vital role in this system. As consumers are now being alerted for the scheduled power cuts by the service provider, so they can switch their loads accordingly. The dynamic pricing brings awareness about the peak demand among the consumers hence load scheduling is used efficiently. The consumers are notified for any voltage variations which might affect the sensitive devices. The consumers are reminded to pay the bills to avoid auto disconnection of supply due to unpaid bills. The consumers can monitor their meters whenever they are required.

**REFERENCE**

[1] Damminda Alahakoon ; Xinghuo Yu, *"Smart Electricity Meter Data Intelligence for Future Energy Systems: A Survey"*, IEEE Transactions on Industrial Informatics, Volume: 12 , Issue: 1, 425 – 436,2016.

[2] Yoshihito Kinoshita ; Kazunori Iwabuchi ; Yasuyuki Miyazaki, *"Distribution voltage monitoring and control utilising smart meters"*, Volume: 2017 , Issue: 1, 1043 – 1047,2017

[3] Zhenyu Guo ; Z. Jane Wang ; Ali Kashani, *"Home Appliance Load Modeling From Aggregated Smart Meter Data"*, IEEE Transactions on Power Systems, Volume: 30 , Issue: 1, 254 – 262,2015.

[4] Carlo Muscas ; Marco Pau ; Paolo Attilio Pegoraro ; Sara Sulis, *"Smart electric energy measurements in power distribution grids"*, IEEE Instrumentation & Measurement Magazine, Volume: 18 , Issue: 1,17-21,2015.

[5] Labib Labib ; Masum Billah ; G.M. Sultan Mahmud Rana ; Md. Nazmus Sadat ; Md.Golam Kibria ; Md. Rafiqul Islam, *"Design and implementation of low cost universal smart energy meter with demand sideload management"*, IET Generation, Transmission & Distribution,Volume: 11,Issue: 16,3938 – 3945,2017.

[6] Rosario Morello ; Claudio De Capua ; Gaetano Fulco ; Subhas Chandra Mukhopadhyay, *"A Smart Power Meter to Monitor Energy Flow in Smart Grids: The Role of Advanced Sensing and IoT in the Electric Grid of the Future"*, IEEE Sensors Journal,Volume: 17 , Issue: 23, 7828 – 7837,2017.

[7] Tianshu Wei ; Qi Zhu ; Nanpeng Yu, *"Proactive Demand Participation of Smart Buildings in Smart Grid"*, IEEE Transactions on Computers, Volume: 65 , Issue: 5, 1392 – 1406,2016.

[8] Jungsuk Kwac ; June Flora ; Ram Rajagopal," Household Energy Consumption Segmentation Using Hourly Data", IEEE Transactions on Smart Grid, Volume: 5 , Issue: 1, 420 – 430,2014.

[9] Y. Raeisi Gahrooei, A.Khodabakhshian ; Rahmat-Allah Hooshmand, *"A New Pseudo Load Profile Determination Approach in Low Voltage Distribution Networks"*, IEEE Transactions on Power Systems, Volume: 33 , Issue: 1, 463 – 472,2018.

[10] Jelena Ponoćko ; Jovica V. Milanović, *"Smart meter-driven estimation of residential load flexibility"*, CIRED - Open Access Proceedings Journal, Volume: 2017 , Issue: 1,1993 – 1997,2017.

[11] S. N. Akshay Uttama Nambi ; R. Venkatesha Prasad ; Antonio R. Lua, *"Decentralized Energy Demand Regulation in Smart Homes"*, IEEE Transactions on Green Communications and Networking, Volume: 1 , Issue: 3, 372 – 380,2017

[12] Nsilulu T. Mbungu ; Raj Naidoo ; Ramesh C. Bansal ; Minnesh Bipath, *"Optimal single phase smart meter design*", The Journal of Engineering, Volume: 2017 , Issue: 13,1220 – 1224,2017.

[13] Amir Safdarian ; Mahmud Fotuhi-Firuzabad ; Matti Lehtonen, *"A Distributed Algorithm for Managing Residential Demand Response in Smart Grids"*, IEEE Transactions on Industrial Informatics, Volume: 10 , Issue: 4, 2385 – 2393,2014.

[14] Te-Chuan Chiu ; Yuan-Yao Shih ; Ai-Chun Pang ; Che-Wei Pai, *"Optimized Day-Ahead Pricing With Renewable Energy Demand-Side Management for Smart Grids"*, IEEE Internet of Things Journal, Volume: 4 , Issue: 2,374 – 383,2017.

[15] Endong Liu ; Peng Cheng, "Achieving Privacy Protection Using Distributed Load Scheduling: A Randomized Approach", IEEE Transactions on Smart Grid,Issue:2016, DOI 10.1109/TSG.2017.2703400

[16] Fan-Lin Meng ; Xiao-Jun Zeng, *"A Profit Maximization Approach to Demand Response Management with Customers Behavior Learning in Smart Grid"*, IEEE Transactions on Smart Grid, Volume: 7 , Issue: 3, 1516 – 1529,2016.

[17] Wessam Mesbah, *"Securing Smart Electricity Meters Against Customer Attacks"*, IEEE Internet of Things Journal, Volume: 9 , Issue: 1, 101 – 110,2018.

[18] Fernanda C. L. Trindade ; Walmir Freitas, *"Low Voltage Zones to Support Fault Location in Distribution Systems With Smart Meters"*, IEEE Transactions on Smart Grid ,Volume: 8 , Issue: 6,2765 – 2774,2017.