

Role of Smart Metering System in Smart Grid

Dr.S.Sentamilselvan¹, Dr.R.Malathi², M.Kiranmai³, R.Akshaya⁴

¹ Associate Professor, SCSVMV University, Kanchipuram, India,

² Associate Professor, SCSVMV University, Kanchipuram, India,

^{3,4} UG Student, SCSVMV University, Kanchipuram, India.

Abstract: The proposed paper is regarding the importance of smart metering system in the smart grid and its implementation in India. The conventional energy meters have many disadvantages as compared to the smart meters. There is a huge increase in demand for power in India and the problem is that these demands have not been satisfied completely. There are over 200 million households in India out of which 40 million households are still living in darkness. Even if the demands are satisfied, numerous problems arise for pertaining to the loss of energy which in turn affects the economy of the nation. Crimes such as power thefts are also increasing day by day where the present scenario for the post-paid systems is also likely to fail. Hence, to solve the above problems, we propose a Smart Meter. A Smart Meter will not only measure energy but also exchange the information about power consumption between the utility companies and consumers. In the paper, we have proposed some solutions which could actually help in reducing the loss of electricity and also the advantages of smart meters. India is the place where most of the people can't afford to pay their bills of electricity and there exist some people who don't even have such connection. The deployment of Smart Meter in India will result in detection of power theft at a faster rate and also people don't have to wait in lines to pay their electricity bill as they can easily recharge their Smart Meter using prepaid mode. Hence, its significance and demand is increasing day by day. The architecture of smart meter, prepaid mode, post-paid mode and a way to detect power theft are explained below.

Keywords: Smart Meter, Smart Grid, Prepaid Mode, Post-paid Mode, Power Theft Detection.

I. INTRODUCTION

Nowadays, the consumption of electric power is increasing rapidly especially in urban areas. In the present scenario, the power sector of India is facing problems like AT & C losses, inefficient distribution, and transmission system.[3] It is because of the age-old power infrastructure. Moreover, Non-technical losses (NTL) like electricity theft, pending of bill payment by customers, etc. have worsened the condition.[4]

Generation and transmission costs are high due to operational losses which are exceeding by 30%. There are fluctuations of power cuts and voltage which are unscheduled and digital payments which are not acceptable in most of the cities. [5] Old equipment is being used which needs regular maintenance and are also have poor conductivity.[6]

The conventional energy meters were electromechanical meters which can't store the data and has one-way communication.[7] There is no memory element which can store the history of the consumption. Also, meter reading is done physically by the intervention of human.[8] An official visit door to door and note down the reading displayed on the meter and according to that, the electricity bill is generated. Estimated readings are shown and readings were rounded off to the nearest tens digit for the handy calculation.[9] Connections were done manually and no warning was given before the power cut for due payment. Hence, the smart meter concept came to light.[10]

The conventional billing system was slow, inaccurate due to the lack of reliability and flexibility. A Prepaid Energy Meter will empower utility centre to gather consumer's bill before its consumption.[11] The possibility of prepaid metering will be imperative for the new research fields of Smart Grid and is an unavoidable advance in making any grid smarter than it is currently. The metering industry is under the transformation these days. India has the majority of generation, transmission and distribution network in the world. The design of smart meter with theft detection has been proposed [1]. The effect of hybrid electric vehicles on the smart grid has huge impact [2]. The government has taken various initiatives like UDAY, Integrated power development scheme, Saubhagya scheme, etc [12]. The main objective of this is to install the 100 percent metering. India is likely to invest 45 billion rupees in smart meter distribution which in turn will help India to reduce 23 percent of transmission and distribution losses. The market of India is ₹ 2354 crores and is to be expected to grow at CAGR of 8-10 percent over the next 5 to 6 years.[13] The first step is to create an advanced metering infrastructure. Smart Meter National Program (SMNP) is on the verge of replacing 25 crores traditional meters with smart meters in India. The billing efficiency can be increased up to 75-100 percent. The revenues of utility will be increased by 1,38,100 crores. Many state governments have started introducing smart meters under the Indian government's Smart Cities Mission.[14] This program goes for urban reestablishment with the mission to make 100 smart cities across the nation.[15] For example, as of late, the Uttar Pradesh Electricity Regulatory Commission (UPERC) affirmed an appeal recorded by Uttar Pradesh Power Corporation Ltd. (UPPCL) with respect to the rollout of smart meters in the state. The UPPCL is focusing on 4 million customers over five distribution organizations (DISCOMs).

II. COMPARISON BETWEEN THE CONVENTIONAL GRID AND SMART GRID

The traditional power grid is the network of interconnections of generating stations, high voltage transmission lines and distribution lines. It is electromechanical in nature which implies that the infrastructure comprises of mechanical devices that are electrically operated. It works very slowly by default. It lacks flexibility in the power source, just as in the transmission system. There is one-way communication between electricity providers and customers. Generally, when a smart grid comes into action, it ensures the better connections, maintains the efficiency and reduces the environmental effects. Smart meter implementation can

handle the power demands efficiently. Smart meters consist of a digital display which can record the real and reactive power, energy, consumed. Smart grids have automated to bidirectional control. The smart energy meter includes the real-time clock (RTC), a data communication module, tamper detection, analog to digital converters and power management system.[16]

Table 1. Comparison between conventional and smart grid

Conventional Grid	Smart Grid
One way communication	Two way communication
Centralized Generator	Distributed Generator
Manual monitoring	Self monitoring
Manual control	Pervasive control
Electromechanical	Digital
Less sensors	More sensors

III. SMART METER

Smart Meter is a major part of a Smart Grid framework. The power consumption is measured at regular intervals. The saved information is sent to a central data management system through wired or wireless communication. They are fit for recording energy consumption information including frequency, voltage, current and power factor. [8] At the outset, Automatic Meter Reading (AMR) systems are familiar which lets the utilities to take the readings remotely. After this, electric suppliers place resources in Automatic Meter Infrastructure (AMI). It varies from AMR in a way that two-way communication is empowered between the utility companies and consumers. [6] Two-way communication alludes to the communication between electric providers and customers with the assistance of either wire or wireless communications. It is one of the vital features that separates smart meters from conventional meters.[20] Many smart meters have extremely valuable alert capacities, which can be set by the recorded information to help consumers to remember their energy usage. Moreover, it can detect power outage fast and restore at the same time. Additionally, the customers have a choice of a decision of selection of tariffs. [12] It can help in the discovery of power theft and hence, it upgrades the security.

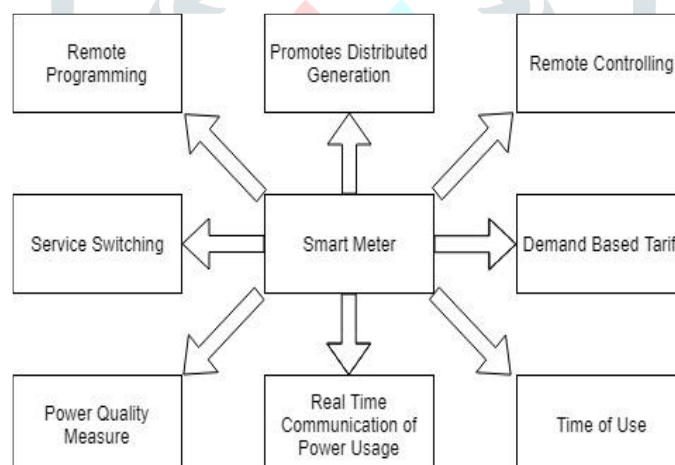


Figure1. Important functions of Smart Meters

IV. THE ARCHITECTURE OF SMART METER

The Consumer Premises refers to the residential or industrial areas where smart meters are installed to collect and record data. Smart Meter consists of two parts a) Analog Part b) Digital Part.

The Analog Part consists of Power supply, Anti-Aliasing Filter, Battery Charger, Real-Time Clock (RTC), Voltage and Current Measurement, Anti-Tampering Circuit, Sigma Delta ADC and Harmonics Analysis.

The Digital Part consists of a microcontroller unit (with register and RAM). The work of the microcontroller is to do all the calculations, to store all the values and to transmit the stored data. Communication Protocol establishes a connection or communication between the smart meter and MDMS.

The Meter Data Management System (MDMS) is where the data that enters the operation centre is collected from the concentrator. It is then processed and stored properly. The tools which are available at MDMS enable operations and management at different sections. It also does other work such as data communication and data processing.[10]

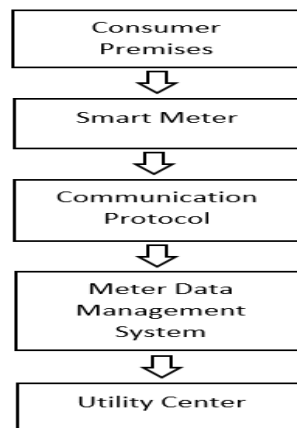


Figure 2. Architecture of Smart Meter

V. ADVANTAGES OF SMART METER

Application of smart meters in the power systems can produce various advantages for different stakeholders [13]. Advantages of Smart Meters for Utilities

- With the advanced monitoring technology and automated meter reading, the number of employees will be reduced.
- There will be a better use of power resources.
- The power system will offer dynamic pricing for the electricity market.
- The demand peaks will be less.[5]
- Smart Meters will monitor the electric systems fast.
- There will be less chance of power blackouts.
- Client premise safety will be improved.
- Interruptions and power theft will be detected easily.
- Operational costs will decrease.

Advantages of Smart Meters for Consumers

- It permits the customers to get more data about their energy utilization
- It allows the consumer to manage energy use in the best possible manner.
- It empowers the customers to shift to an off-peak time period to reduce the electric bills.
- It lets the consumer shift between conventional and renewable resources based on the tariff.
- The accuracy of the billing is improved as the bill is based on actual electricity consumption.
- The bill estimation is reduced.
- Outage restoration is improved.
- Data quality and power quality are improved.

Advantages of Smart Meters for Government

- Encouragement of renewable energy resources.
- Smart Meters will provide support for the Smart Grid initiatives.
- Smart Meters will provide better distribution and hence new power plants requirement becomes less thus reducing the pollution.
- Less emission of Greenhouse gases like CO₂.
- Better monitoring will result in the prevention of power outages.

VI. CHALLENGES

The advancement of the smart grid and smart metering framework in India isn't a simple undertaking as the Indian power sector represents various challenging issues such as the following: The capital and operational cost of the smart meter is high, thus many times the launching of the smart grid has been delayed.

- The data collected and processed by the smart meter should be verified.
- It is a new, complex and time-consuming project.
- There are still people who have no idea of how electricity is been delivered to their homes. Thus, people should be made aware of their electricity consumption, the advantages of using smart meters, etc.
- There is a health concern about the emission of the pulsed radiofrequency (RF) radiation from wireless smart meters.
- The utility employers should also be educated regarding smart meters.
- Conversion from existing technology to new technology takes time.
- There is a concern on the intrusion of privacy and security of individual consumption data. The information gathered from the consumption data could give a critical knowledge of customer's behavior. This important data could be abused if strict rules and regulations are not adhered to.

- Access to funds is one of the real barriers in the execution of Smart Grid. Policymakers need to make increasingly favourable guidelines so as to pull in an ever-increasing number of private users.

VII.CONCLUSION

As of today, the smart meter is still in the early stages as there is no large-scale execution of smart metering practices. The consumers should be benefited from the establishment of smart meters and its use. Though there are many other challenges in the implementation of smart meters, it has a bright future in India. The smart grid will upgrade the strength and unwavering quality of intensity frameworks using AMI innovations. The accurate billing, good monitoring of power flow, detection of power losses are some advantages of smart meters using AMI. The objective of this paper is to give the learning on the job of Smart Meter innovation in the Smart Grid. The smart meter is more advantageous than conventional meters as it has been discussed. It can not only be used in Demand Side Management but also in increasing the security of the building.

REFERENCES

- [1]. A.Aswin, Chidambaram.R, S.B.Kavin darshan, Abinav Soorya.N, S.Senthilmurugan “Design of Smart Energy Meter with power Theft detection and a novel of billing Payment” International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-7, Issue-6, March 2019.
- [2]. A Aswin and S Senthilmurugan “A survey on power levels of battery charging and infrastructure for plugin electric and hybrid vehicles”2018 IOP Conf. Ser.: Mater. Sci. Eng. 402 012154.
- [3]. Zanetti, Edgard Jamhour, Marcelo Pellenz, Manoel Penna, Voldi Zambenedetti, Ivan Chueiri,” A Tunable Fraud Detection System for Advanced Metering Infrastructure using Short-Lived Patterns”, IEEE Transactions on Smart Grid (Volume: 10, Issue: 1, Jan. 2019).
- [4]. Donghuan Yao, Mi Wen, Xiaohui Liang, Zipeng Fu, Kai Zhang, and Baojia Yang," Energy Theft Detection with Energy Privacy Preservation in the Smart Grid", IEEE Internet of Things Journal,2019.
- [5]. Pardeep Kumar, Yun Lin, Guangdong Bai, Andrew Pavard, Jin Song Dong, and Andrew Martin " Smart Grid Metering Networks: A Survey on Security, Privacy and Open Research Issues". IEEE Communications Surveys & Tutorials,2019.
- [6]. Grzegorz Dudek, Anna Gawlak, Mirosław Kornatka, Jerzy Szkutnik," Analysis of Smart Meter Data for Electricity Consumers", 15th International Conference on the European Energy Market (EEM),2018.
- [7]. Kumar Ask, Navneet Kumar Singh, Asheesh Kumar Singh, Dinesh Kumar Singh, and Kundan Anand, “Design and Simulation of Smart Prepaid-Postpaid Energy Meter with Alarm and Theft Control”,5 th IEEE Uttar Pradesh Section International Conference on Electrical, Electronics and Computer Engineering (UPCON),2018.
- [8]. R.Govindarajan, Dr.S.Meikandasivam and Dr.D.Vijayakumar, “Energy Monitoring System Using Zigbee and Arduino Controller”, International Journal of Engineering & Technology, Volume 07, Issue 04, pp.608-611, November 2018.
- [9]. Arvind Kumar Gupta, Ayan Mukherjee, Aurobinda Routray, Rajashree Biswas, “A novel power theft detection algorithm for low voltage distribution network”, IECON-2017 43rd Annual Conference of the IEEE Industrial Electronics Society,2017.
- [10]. R. Anand, G. R. Kanagachidambaresan, M. Balaji, K.S. Chandragupta Mauryan, “Design of Smart Meter for Smart Grid application through True Time-MATLAB”, International Conference on Electrical, Instrumentation, and Communication Engineering (ICEICE2017), 2017.
- [11]. R.Govindarajan, Dr.S.Meikandasivam and Dr.D.Vijayakumar, “Low Cost Arduino Based Smart Energy Monitoring System Using Internet of Things”, Journal of Engineering and Applied Sciences”, Volume 14, Issue 01, pp.170-177, January 2019.
- [12]. Stanislav Chren, Bruno Rossi and Tom a’s Pitner, “Smart Grids Deployments within EU Projects: The Role of Smart Meters “, Smart Cities Symposium Prague 2016.
- [13]. Gouri R. Barai, Sridhar Krishnan and Bala Venkatesh, “Smart Metering and Functionalities of Smart Meters in Smart Grid - A Review”, IEEE Electrical Power and Energy Conference (EPEC),2015
- [14]. Dr. Sarat Kumar Sahoo, Vikram K," Role of Smart Meters in Smart Grid", ElectricalIndia Magazine, June 2017.
- [15]. R.Govindarajan, Dr.S.Meikandasivam and Dr.D.Vijayakumar, “Cloud Computing Based Smart Energy Monitoring System”, International Journal of Scientific and Technology Research, Volume 08, Issue 10, pp. 886-890, October 2019.
- [16]. Swati Patel, Uday Kumar R.Y. and Prasanna Kumar B., "Role of smart meters in smart city development in India", IEEE 1st International Conference on Power Electronics, Intelligent Control, and Energy Systems (ICPEICES),2016.
- [17]. Qie Sun, Hailong Li, Zhanyu Ma, Chao Wang, Javier Campillo, Qi Zhang, Fredrik Wallin, and Jun Guo," A Comprehensive Review of Smart Energy Meters in Intelligent Energy Networks", IEEE Internet of Things Journal, Volume: 3, Issue: 4, 2016.
- [18]. Pooja Bansal, Ajmer Singh,” Smart metering in smart grid framework: A review”, Fourth International Conference on Parallel, Distributed and Grid Computing (PDGC),2016
- [19]. Dr.S.Thangalakshmi, G.Sangeetha Bharath, S.Muthu, ”Power Theft Prevention In Distribution System Using Smart Devices, International Journal of Applied Engineering Research, ISSN 0973-4562 Vol. 10 No.42 (2015).
- [20]. Paul, Shuva, Md Sajed Rabbani, Rippon Kumar Kundu, and Sikdar Mohammad Raihan Zaman. "A review of smart technology (Smart Grid) and its features", 1st International Conference on Non-Conventional Energy (ICONCE 2014), 2014.