



Smart Electricity Meters for Smart Living

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ABSTRACT: Electricity meters are the ones used to measure the consumption of electricity at the premises where they are installed. Such meters notify customers about the right readings, charges they have to pay for electricity consumption, and much more. But when it comes to stealing electricity, or to retailers manipulating readings for their own benefits, the traditional metering system is a matter of concern. Therefore, the concept of smart meters was introduced by using big data analytics. Smart meters possess features such as prepaid installations, monitors to know how much energy one uses and at what particular time. Thereby managing energy efficiency, accuracy, and costs. This paper will illustrate the need for smart electricity meters and perform a comparative study between traditional and smart electricity meters. In some countries, smart metering systems have already been installed, and India needs to be one of them, too. This concept will be accomplished soon, as said by India's Finance Minister. With the installation of smart electricity meters, consumers will be able to know how much energy is used, at what time of day energy is used, monitor usage during peak hours, get accurate readings in an easy to understand format on any hand-held device.

KEYWORDS: smart electricity meter, data analytics.

I. INTRODUCTION

Evolving energy consumption nowadays gives rise to the involvement of technology for advancing energy efficiency. So, to manage electrical energy consumption in the most effective way, smart electricity meters are the right choice. Smart electricity meters operate in an atmosphere of real-time, which is perhaps the key benefit in this modern smart world. It is an electronic device that monitors electricity consumption at a particular time of the day and notifies consumers and suppliers accordingly. It is not a new idea, it has been applied over the years globally. In the UK more than 2.9 million and in the US more than 70 million smart meters are already installed according to the 2016 survey [1]. The smart electricity meter is not only for billing purposes, rather it is two-way communication between the meter and the central system. The communication can be wired or wireless like Power Line Carrier(wired), Wi-Fi, ZigBee(wireless), etc. In accordance, retailers and consumers are putting more emphasis on making the retail industry more competitive. A prevalent topic now is how to handle huge smart meter data. Considerable big data analytics technology now plays a major role not only in managing massive smart meter data but also in knowing the status of the electricity grid. Lack of the idea of data analytics in traditional metering systems is due to the processing of small amounts of data only for billing purposes which can be collected manually. But because of two-way communication, smart electricity meters need advanced data analytics to extract relevant information. Thus, smart meters can take advantage of the advancement of communication and data processing technologies over conventional meters such as handling vast quantities of data, improving performance, and evaluating quickly. Figure 1 represents the traditional meter and figure 2 represents smart meter. This paper is to discuss the need for smart electricity meters, the concept of big data analytics in smart meters, and applications for the same.



Fig 1. Traditional Meter



Fig 2. Smart Meter

This paper comprises various sections. Section 2 defines the era of electricity without a cloud, which means a world of traditional electricity meters. Section 3 explains smart electricity meters in detail, which further explains the importance of big data over the cloud and the benefits of smart electricity meters. Section 4 shows a survey that shows global trends of smart meters. Finally, Section 5 explains why one should prefer a smart electricity meter over tradition alones.

II. THE ERA OF ELECTRICITY METER WITHOUT CLOUD

As technological developments are growing globally, measuring energy consumption is the most significant feature. The energy was consumed in huge amounts, so the problem was unsystematic billing criteria. For example, customers receiving more or less power or suppliers receiving more or less pay. Therefore, the invention of the traditional electricity meter was a vital accomplishment. The traditional electricity meter measures energy consumed by a customer and generates a billing report for the same on a monthly, quarterly, or annual basis. It was essentially designed solely to gather basic electricity consumption data manually and then make bills from the readings. But now, as more features are getting developed for consumer’s convenience day by day, more information and large volumes of data need to be managed. For example, monitoring readings at regular intervals or finding peak levels for electricity consumption, suggesting more efficient use of power resources, and many more. Therefore, the concept of cloud came into existence. With the growth of big data and cloud computing, analysis of the actions behind electricity consumption is more convenient [2]. Smart meters provide data on cloud by remote data collection and then we can apply big data analysis on that data.

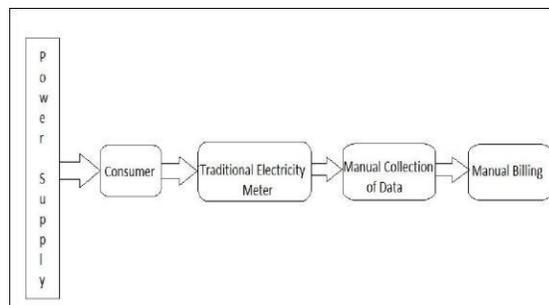


Fig 3. Flow Chart for Traditional Electricity Meter

III. SMART ELECTRICITY METER: A PRESTIGE FOR THE SMARTWORLD

Smart meters give real-time data which is in huge demand worldwide. Smart meter resolves almost many issues that were observed in traditional metering systems. One of the main issues was that we were able to read total readings only

through that meter and not through the computer system and any handheld unit. Smart electricity meters provide data on our connected devices such as mobile phones, computers, or any other handheld device from which both customers and retailers can draw. This feature of smart meter reduces the chances of stealing electricity to a great extent. Because we can see the total energy consumed on an hourly basis on any device. One of the most important goals of smart metering in buildings is to suggest optimal schedules of electrical loads to meet targets like save energy, fulfill the demand, forecasting peaks duration of energy consumption [3]. Due to increased energy consumption day by day, large volumes of data need to be managed. So, smart electricity meters are designed to analyze and handle these large volumes of data. The concept that was used to handle this vast amount of data was big data and cloud.

A. BIG DATA IN SMART METER

Big Data provides us a large volume of data and large velocity of data that are quite difficult to manage and analyze in traditional database systems. Big Data can be categorized into four dimensions, called four V's. Four V's of Big Data are:

- **Volume:** Volume plays a very important role in big data. A large amount of data is generated by big corporations and organizations on a daily basis which constitutes bigdata.
- **Velocity:** Velocity means the speed of piling up data and the speed at which data is moving around. But the important thing is how rapidly data is being processed.
- **Variety:** It refers to a variety of data, which means whether the data is structured or unstructured. There should be no duplicate entry.
- **Veracity:** This simply refers to the accuracy or certainty of data. Huge quantities of data are difficult to manage which can result in noisy output.

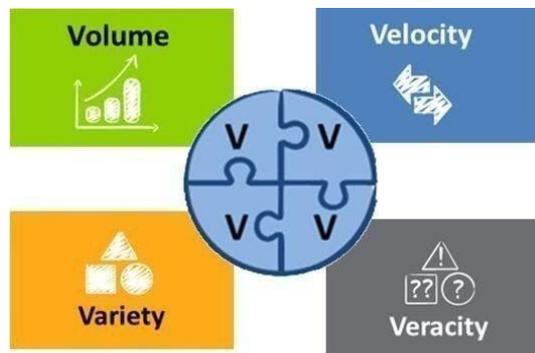


Fig 4. Four V's of Big Data

If we see the idea of big data in accordance with electricity consumption, these four V's are found important to consider. The main benefit is, going from one meter of reading per month to smart meter readings every 30 minutes turns 48 million readings per million consumers into vast amounts of data to manage [4]. So, electricity consumption on a large scale produces a vast amount of data which can only be handled by a smart electricity meter. Also, because of the increase in energy consumption, data multiplies minute by minute and second by second. Now, with such a large amount of data, there can be errors due to mistakes in data transmission or device failure, which is a major concern. This big data resides in the cloud. Now, let us understand what cloud really is.

B. BIG DATA AND THE CLOUD: AN ESSENTIALMATCH

As the name suggests, Big Data consists of data in huge amounts. So, the cloud offers a platform for big data so that it can be stored, analyzed, and processed in a fast and efficient way. Smart meters on the Cloud can allow remote data collection and analysis capability, advanced metering infrastructure (AMI), remote diagnosis, and load management of equipment, failure analysis, off-peak / peak load monitoring. All the data that is received from the smart meter regarding

energy consumption can be stored and analyzed on the cloud without any direct investment. So, a flow chart shows how a smart meter actually works.

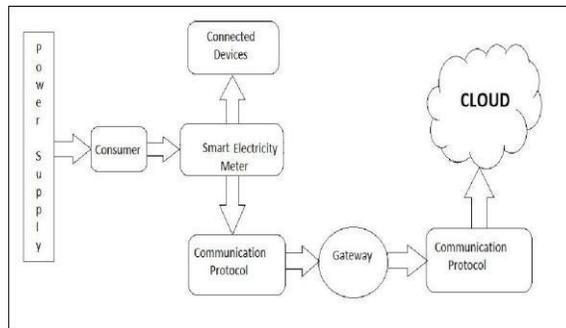


Figure 5. Flow Chart for Smart Electricity Meter

Figure 5 shows how smart electricity meter actually works. As we can see in the flowchart, the consumer uses electricity and the corresponding meter calculates readings for the same. Now, on the one hand, a smart meter is connected to devices that display readings, and on the other, it provides data to the communication protocol or the interface which in turn links the data in the cloud through the gateway. In this way, smart electricity meters are able to store huge amounts of data.

C. WHY SMART METERS?

Based on the previous review, Smart Electricity meters are providing rich information to the consumers. So, there must be some of the benefits of smart meters that make them so useful. The benefit of smart meters in energy networks can bring many benefits for different stakeholders [5]. Figure 6 shows the benefit of using smart meters.

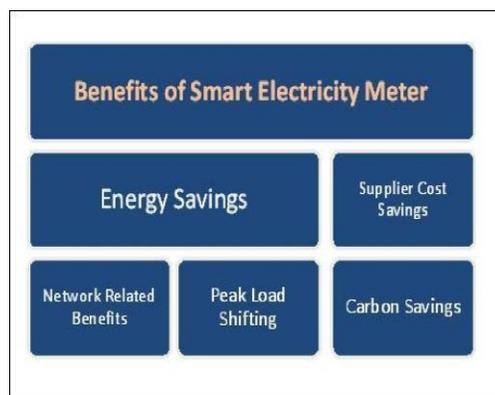


Fig 6. Benefits of Smart Electricity Meters

IV. GLOBAL TREND OF SMART METERING SYSTEM

While demands for energy saving and environmental protection continue to rise and are driven by the advancement of digital technologies, smart metering has been introduced rapidly during this period of time [5]. The deployment of smart meters is rising worldwide at a faster pace. Figure 7 represents the evolution of smart electricity meters worldwide until now. Below Pie Chart shows meters deployed in Billions in different countries. North America tops the list by deploying 1.6 Billion Smart Electricity meters till now. Other countries are also in the race to make themselves smart for better energy efficiency. India is not yet part of this smart metering system. Indian economy is one of the fastest-growing economies but due to not availability of sufficient electricity, its industrial growth gets limited [6]. But as said by India's Finance Minister, Nirmala Sitharaman in Budget 2020 that all electricity meters will be converted into smart electricity

meters till 2022-23, India will be in the race soon.

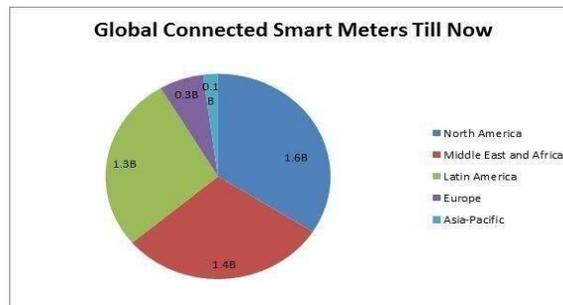


Fig 7. Globally Connected Smart Meters till Now

A. Challenges for India in Implementation of Smart Electricity Meters

It is not that India has so far made no effort in implementing smart electricity meters across the country. Back in November 2015, the Indian Government launched a scheme, named UDAY,

abbreviation of Ujwal Discom Assurance Yojana for installation of smart electricity meters. Its main aim was to track data accurately and efficiently. Under this scheme, smart meters for consumption of above 500 units and smart meters for consumption of above 200 units were installed. But despite many measures, anticipated results were not seen. For example, if seen on one of the scenarios from that time, in Karnataka - Of the 137,456 consumers targeted in the category of 500 units/month, only 610 have smart meters (0.4 percent) installed. Similarly, only 1,876 of 2,91,650 consumers (0.6 percent) have installed smart meters in the consumer category of 200 units/month. When observed closely, reasons found for the problem were high implementation cost, lack of qualified manpower and interoperability issues. Also, studies reveal that challenges lie in the implementation plan itself. So, for the programme to be executed properly, India has to come up with a much smarter planning and smarter execution. In accordance with the problems encountered in the UDAY scheme, India may face some more challenges. Some are listed below-

- **Security Threats:** Smart meters create security issues at a greater extent. As all the data and signals are transmitted via a network, customer's personal information may be targeted. Smart meters have to deal with a huge amount of data on a daily basis, so securing the data can be a quite difficult task. Also, some utility companies do not pay much attention to the maintenance of their communication system which probably affects the security of data. So, in order to make a smart meter secure, confidentiality, integrity, authenticity should be taken into consideration.
- **Skilled Manpower:** Smart meter is a kind of complex meter design. Various kinds of technologies, dedicated hardware, and software are required for the implementation of the system. Deep knowledge of all these things is mandatory to achieve expected results. Therefore, skilled manpower and experts will be needed so that dealing with upcoming problems can be done easily. So, it is quite a challenge because people in interesting areas will need to be trained because of a lack of experience in the Indian environment.
- **Deciding the budget:** In India, the smart meter project is still a new concept and is in development mode. So deciding the budget to be spent on smart meters and also maintaining other services too is a big challenge. Finding investors is one of the main who could invest in this project is a difficult task too. Arranging the contractors, laborers, and providing their salaries, then purchasing different types of tools and parts that could be costly too.



V.DIFFERENCE BETWEEN TRADITIONAL AND SMART ELECTRICITYMETER

Table 1: Traditional vs Manual Electric Meter

Traditional Electricity Meter	Smart Electricity Meter
The traditional meter system measures energy consumption monthly.	The smart metering system provides real-time data and then enables us to extract data at any time of the day.
Only manual billing could be done. Customers need to be present at the site.	No need for manual billing due to the facility of remote data collection.
Electricity theft was a major concern.	Reduces chances of theft due to prepayment meters.
This system was unable to manage large volumes of data.	This system can manage a huge amount of data due to cloud facilities.
Traditional meters can give errors due to noisy data.	The smart meters are less prone to error. The consumers and service companies get correct readings [7].

VI.CONCLUSION

In this paper, a review of smart metering systems and traditional metering systems, their functionalities, and the benefits of smart electricity meters over traditional have shown. Smart meters are gaining popularity worldwide due to vast features they are providing which can result in reducing carbon emissions and improving energy efficiency. This paper shows how smart electricity meters can handle large volumes of data which is increasing globally day by day due to an increase in energy consumption. A smart metering system benefits everyone such as consumers, retailers, society, and a lot more which is seen to be the most important part. The Intelligent Meter is a new euphemism. Many countries have already been taking advantage of this wide area concept. India will also be one of them in recent coming years.

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