Smart Meter Data Analysis- Karnataka Perspective

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Abstract— The technological developments have led to invention of many smart devices and hence an increase in power demands. The utilities are facing a huge challenge to match supply with demand. Smart grids establish a two way communication between the utilities and consumers in order to achieve an optimum value of Demand and supply. Demand side Management is an integral part of smart Grid and Advanced Metering Infrastructure plays a key factor in the effective implementation of DSM. The standard electricity meters have the ability to record the power consumption of a home or business; smart meters can record energy usage in 15-minute intervals or a minimum of hourly and transmit the information to the utilities. Most significantly, smart meters establish a two-way communication with the utility and therefore the home/business. In this paper, an analysis of smart meter data obtained from a small region of Mysore in Karnataka is presented to carry out further research on Demand side management strategies that can be adopted in order to reduce energy consumption during peak hours and flatten the load curve.

Keywords— Demand side Management, Advanced Metering Infrastructure (AMI), Tariff, Low tension.

I. INTRODUCTION

Traditional energy meters were used to supply electricity in the early stages of household technology. These meters are crucial for determining how much electricity is used in individual households, industries and commercial sectors. With the advent in technology, the use of these meters has been gradually decreasing as rapid improvements have been made to address the issues that the conventional metered had. The consumers get a monthly feedback about their consumption with the usage of traditional meters which is inadequate as they are unaware of daily power consumption of the appliances in use [1]. Smart Meters have been updated and built to address the issues with conventional electricity meters. Energy warnings can be sent to consumers on hourly basis about their energy consumption and the main objective of reducing energy consumption could be achieved. This work deals with the real time data of hourly consumption values of small region of Mysore comprising of domestic, commercial, industrial, street light and water supply installations. Section II describes Advanced Metering Infrastructure; Section III highlights the consumers and their energy tariffs of CESCOM. Section IV highlights the real time smart meter data analytics of LT2,LT3 and LT5 installations. Section V Conclusion and future work.

II. ADVANCED METERING INFRASTRUCTURE

The term AMI (Advanced Metering Infrastructure) refers to the entire infrastructure, which includes everything from smart meters to two-way communication networks, control centre equipment, and all the applications that allow for the collection and transmission of energy consumption data in near real-time. AMI enables two-way connectivity with consumers and serves as the smart grid's backbone. The major building block of AMI is Smart Meter, Communication Network, Meter data acquisition and Management system [7]. Fig 1 illustrates the components that make up and AMI. Smart meters relay data to customers for better understanding of usage trends, as well as to energy suppliers for system tracking and customer billing. A smart meter is an electronic system that keeps track of data including electric energy usage, voltage levels, current, and power factor. Smart meter facilitate Demand side management with variety of load management features of the metering infrastructure. DSR can provide consumers with new options for managing their electricity use, such as the ability to schedule usage for specific times or to vary it on demand to save money.

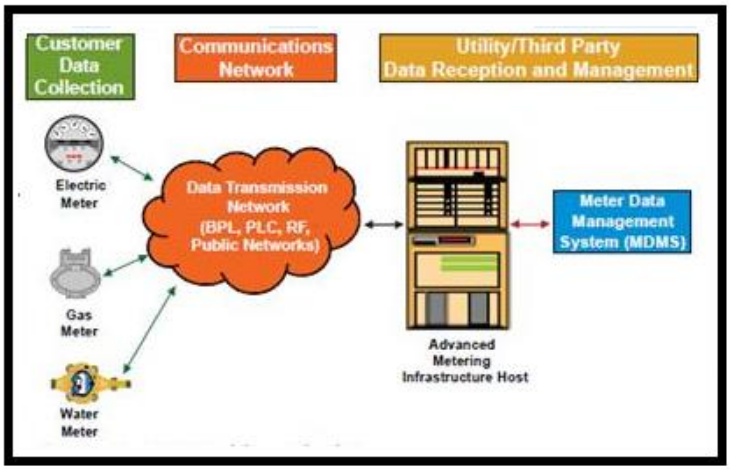


Fig.1 Building Blocks of AMI [7]

III. CLASSIFICATION OF CONSUMERS AND ENERGY TARIFFS OF CESCOM

CESCOM has been licensed to distribute electric power in eight Districts of Karnataka namely, Chamarajnagar, Hassan,

Kodagu, Mandya, Mysore. The total number of Consumers are categorized based on Domestic, industrial, commercial, Agriculture, Municipal Corporation Installations [8]

Tariff	LT1	LT2	LT3	LT4	LT5	LT6	LT7
Consumers	492955	1896933	246440	387268	41800	51551	45885
Percentage	15.57	59.93	7.79	12.24	1.32	1.63	1.45

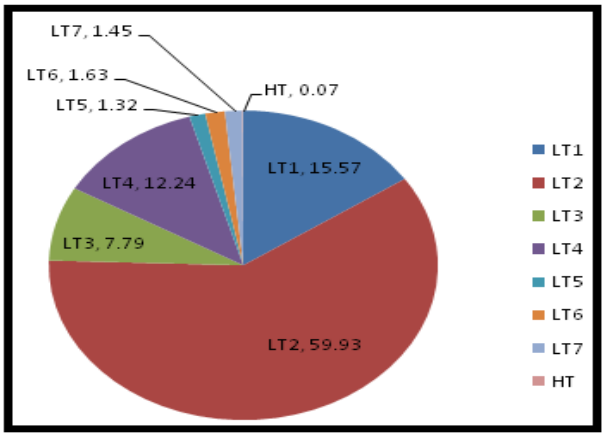


Fig.2 Percentage of Consumers under CESCOM

Table 1. Applicable Tariffs for various categories of Installations [2]

Category	Type of Consumers	Energy Charges	
LT1	Applicable to installations serviced under Bhagya Jyothi and Kutira Jyothi	NIL	Fully subsidized by the GOK
LT2	Consumption of Domestic Installations-Applicable to lighting/combined lighting, heating and motive Power installations of residential houses and also to consumers not meant for Commercial Purpose,	Based on units consumed varies from 3.85 ps to 7.55ps	
LT3	Commercial Installaltions-Applicable to Commercial Lighting, Heating and Motive Power installations of Clinics, Diagnostic Centres, X Ray units, Shops, Stores, Hotels/Restaurants/Boarding and Lodging Homes, Bars, Private guest Houses etc.	Based on units consumed varies from 8.25ps to 9.25ps	
LT4	Agricultural Pump Sets	Free	Fully subsidized by the GOK
LT5	Industrial Applications-Applicable to Heating & Motive power (including lighting) installations of industrial Units, Industrial Workshops, Poultry Farms, Sugarcane Crushers, Coffee Pulping, Cardamom drying, Mushroom raising installations, Flour, Huller & Rice Mills etc	Fixed charges per month based on hp Ranging from Rs 65/HP to Rs 150/HP	
LT6	Applicable to water supply and sewerage pumping installations and also applicable to water purifying plants maintained by Government and Urban Local Bodies/ Grama Panchayats for supplying pure drinking water to residential areas, Public Street lights/Park lights etc	Fixed charges per month. Rs.85/HP/month for water Rs.100/KW/month for lighting	
HT	Applicable to Bulk Power Supply at Voltages of 11KV (including 2.3/4.6 KV) and above at Standard High Voltage or Extra High Voltages when contract demand is 50KW	Billing based on contract demand	

Table 1 gives the category of consumers covered under each installation and their applicable tariffs .

IV. SMART METER DATA ANALYTICS-RESULTS AND DISCUSION

There are a variety of conventional methods for evaluating the meter and its data. Instead of opting for conventional meters, Smart electricity meters have a simpler way of measuring the meter data. The real time hourly power consumption data of various categories of Installations for the month of February and March for a small region of Mysore District was obtained in the form of excel sheets. Time, energy consumption are tabulated sector wise for specific days of the months to analyze the consumer behavior of LT2 installations. The data is arranged for all sectors and graphs drawn for energy consumption.

LT2 Installations- covers depicts the consumption of domestic installations-Applicable to lighting/combined lighting, heating and motive Power installations of residential houses and also to consumers not meant for Commercial Purpose.

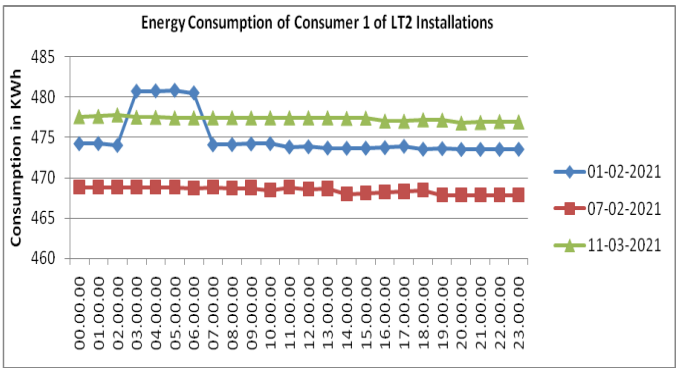


Fig.3 Energy Consumption pattern of consumer1 of LT2 Installations for a Weekday , Sunday and Holiday

Fig.3 indicates the energy consumption pattern of Consumer 1 of LT2 installations on 1st February 2021 which is a Weekday, 7th February 2021 which is a Sunday and 11th March which is a public holiday. It can be observed that the energy consumed on a Sunday and Public holiday is almost same throughout the day with slight variations where as on a Weekday a peak rise of energy in the early morning hours is observed. Also there is increased power consumption on a public holiday.

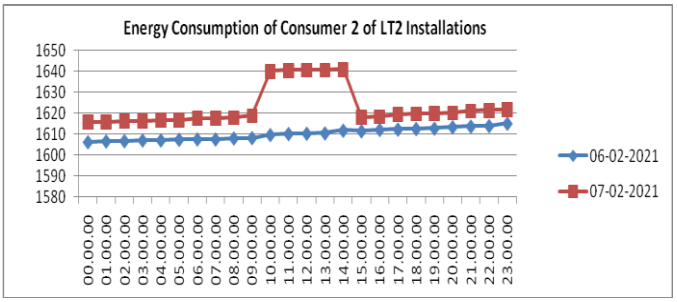


Fig.4 Energy Consumption pattern of consumer 2 of LT2 Installations for a Weekday and Sunday

Fig.4 indicates the energy consumption pattern of Consumer 2 of LT2 installations on 6th February 2021 which is a Weekday, 7th February 2021 which is a Sunday. It can be observed that the energy consumed on a Sunday has a peak rise of energy from 9.00 am to 3.00pm observed and a substantial increase in energy consumed when compared to normal weekday.

From the above results, it can be inferred that the electric consumption varies not only from consumer to consumer but also day wise. A small data set from the smart meter is used to make the inference; at a large scale such analytics can help the utilities study the behavior of each consumer and predict the overall demand per day as well as the overall demand. The utilities can in turn plan to either buy or sell electricity based on the Demand. From the consumer point of view if there consumption patterns are known to them at regular intervals, they can reschedule or curtail the loads so as to minimize their electricity bill. The cost is calculated based on the energy consumed and price/unit consumed. With the help of smart meters that consumers can get their daily consumption as well as the cost they pay for the energy consumed.

LT 3 Installations- covers the power consumption of commercial installations- Applicable to Commercial Lighting, Heating and Motive Power installations of Clinics, Diagnostic Centres, X Ray units, Shops, Stores, Hotels/Restaurants/Boarding and Lodging Homes, Bars, Private guest Houses etc.

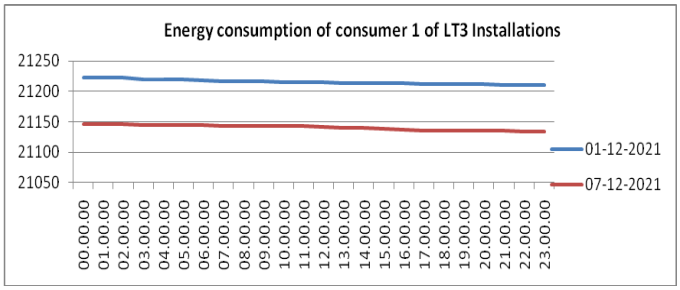
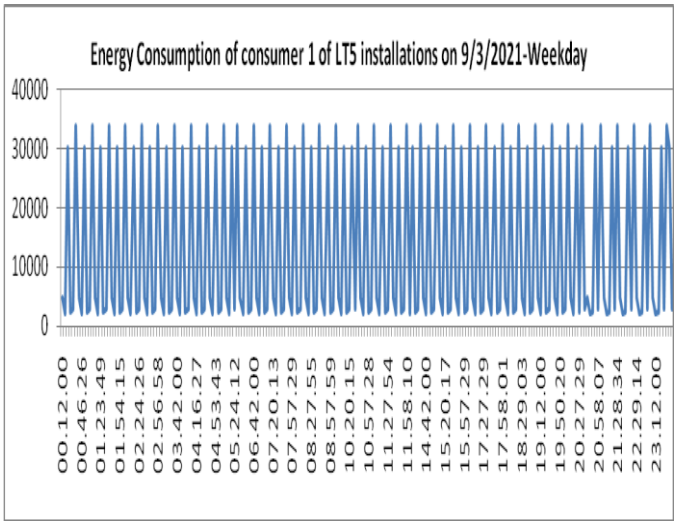


Fig.5 Energy Consumption pattern of consumer1 of LT3 Installations for a Weekday and Sunday

Fig.5 indicates power consumption pattern of Consumer 1 f LT3 installations and the inference is that there is no significant change in the energy consumption throughout the day with a slight dip from morning to evening. The amount of consumption is more on a weekday than Sunday as most of the commercial units may not operate on a Sunday.

LT 5 Installations- covers the power consumption of industrial applications- Applicable to Heating & Motive power (including lighting) installations of industrial Units, Industrial Workshops, Poultry Farms, Sugarcane Crushers, Coffee Pulping, Cardamom drying, Mushroom raising installations, Flour, Huller & Rice Mills etc. Fig.5 indicates power consumption pattern of Consumer 1 f LT5 installations. A lot of fluctuations in the consumption of energy throughout the day is observed in short duration of time.



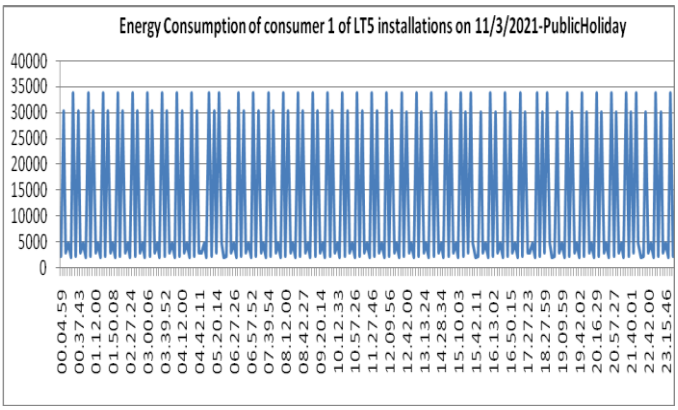


Fig .6 Energy Consumption pattern of consumer1 of LT5 Installations for a Weekday and Public Holiday

From the above consumption pattern, one can analyze the stability of the power system and adopt necessary measures for improving the stability of power.

The average power consumed by consumer 1 on 9/3/2021 =**12859.7382** KWH

The average power consumed by consumer 1 on 11/3/2021= **12580.25** KWH

V. CONCLUSION AND FUTURE WORK

In this paper we analyzed and interpreted the different sets of consumption data of various categories of consumers like domestic, commercial and Industrial installations. Their subjected patterns could be altered by adopting demand side management techniques so as to encourage users to shift their loads and optimize the cost. Based on the literature review conducted as part of the study, we can infer that Smart Meters can be used to reliably calculate electricity usage. In the case of analysis, various data computations such as correlation, autocorrelation, standard deviation, and daily price averages can be performed on the data set.

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