A Review on Energy Monitoring and Management for Domestic Consumption

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ABSTRACT

Due to global warming campaigns to reduce general electricity usage need has risen to analyse power consumption in different sectors which includes industries and domestic consumers. But due to the technology improvements energy consumption from miscellaneous loads have significantly increased residential energy use. This Paper represents literature survey on different energy management systems approaches, methods and tools which have been implemented and suggested in literature. By deploying energy management architectures and also a smart meter electricity usage can be minimized and hence cost can be reduced. Mainly the methods to estimate and reduce plug-load energy use i.e. household energy consumption by appliances in buildings are reviewed here.

Keywords: Energy management, smart mete, plug-load, domestic consumer

I. INTRODUCTION

Objective: All over the word several studies have been made in recent years in miscellaneous and electric load consumption to optimize the electricity usage. In India consumers are divided into three categories as big industries, medium & small industries and offices & domestic consumers. About 22% of energy is used in domestic consumptions, in India. In next decade primary energy demand and growth of electricity consumption is expected to grow by 2.3 times. This is due to the substantial growth in the building, transportation and industrial sector. Miscellaneous uses includes televisions, personal computers, kitchen appliances, laundry machines, and many other devices, have quickly penetrated into households and now account for almost half of delivered residential electricity consumption. Part of this proliferation of devices and equipment can be attributed to increased service demand for entertainment, computing, and convenience appliances. The main objective of this study is to determine energy saving potentials in the residential sectors. The sub objectives are listed below.

a.To bridge current gap between building performance and modelling data
b. To provide quantitative information
c. To estimate plug-load densities
d. To identify growth rate in energy consumption & to identify saving potentials
e. To recommend future actions to target and harvesting saving potentials.
1.2 System Design**:** To implement such systems a Smart Meter, Gateway unit and a interfacing platform for example android platform is needed.

Smart Meter: Smart Meters are electronic measurement devices used by utilities to communicate information for billing customers and operating their electric systems. It is required which can analyse multiple appliances in a household getting readings such as voltage, current, active power, apparent power, reactive power, power factor and frequency.. For over the years electronic meters, have been used effectively by utilities in delivesring accurate billing data for at least a portion of their customer base. With the help of a wired / wireless connection, the device can connect to a central gateway and the gathered information can be uploaded and processed by the gateway management system. The data can then be displayed on the platform's graphical android-based user interface. The platform allows users to access the data from any android enabled device. To reduce cost the system requires energy metering nodes that can communicate with the gateway wirelessly or in wired way in such a way that only one Wi-Fi access point is needed for a household containing many monitored appliances.

Gateway Unit: The gateway is responsible for collecting data and then sending it to the android application interface. It also has a console access that can show all the relevant information along with a small interface. The requests information from the energy node via wired communication. The energy node then sends the information back to the gateway. The gateway then forwards this information on to the android application interface. This process happens in regular intervals which can be set in the menu interface. Because the gateway and the energy nodes are separate a single system can comprise of many energy nodes. The advantage of this is that the cost to monitor another additional appliance is low because only the energy node needs to be purchased.

Android application interface: An android application is designed which is responsible for reading the gateway for each energy node connected and is also responsible for setting various gateway configurations and parameters like various thresholds, etc.

II. REVIEW AND DISCUSSIONS

S. Lanzisera [1].This study was designed to look at the methodology for collecting accurate energy information on annual energy use, usage patterns, and energy savings opportunities of representative plug-loads in a typical office building. A good set of tools, a taxonomy (a standard way to categorize devices), an inventory data collection systems &data analysis tools are described. The wireless power meters used here are a research platform called Acme ("AC meter") developed by the University of California, Berkeley and refined for use in this study. The final version used in this study consumed 0.4 W per meter, had a significantly smaller form factor, and was capable of handling 15 A currents for extended periods of time. Data collection, storing of data and analysis of data has carried out using open-source tools like Python and MySQL. The 455 wireless power meters in an office building with power data collected at 10-s intervals for 6e16 months. For a period of 2 months, by performing a device inventory for half of the floor area and metering 10%e20% from the key device categories representative data for test building representative generated.

R. S. Srinivasan [2]. This paper discus benchmarking plug-load densities. To build energy standards and rating systems it is necessary to implement plug-load density benchmarks to reward design team in their efforts so that plug load energy usage gets reduced. For benchmarking plug load densities may be calculated using equipment nominal power data and diversity factors. During typical operation equipment nominal power and name plate rating considerably differs. Nominal Power may be calculated through monitoring average power drawn to nameplate rating is the load factor [9]. However not all equipment's peak at the same time to the buildings peak load. Using case study buildings, this paper establishes benchmark plug-load densities for K-12 schools under two new categories– classrooms with computers and classrooms without computers. Eighteen K-12 schools including 9 elementary, 2 middle, and 7high schools are assessed for actual plug-load densities. For the same case study buildings, four existing approaches – NREL, COMNET, ASHRAE 90.1-1989, and Title-24 are evaluated for plug-load densities. Results show under- and over-estimation of plug-load densities over actual densities. The development of benchmark forK-12 schools will pave way for instituting targets for trimming down plug-load densities in new and retrofit building projects.

ASHRAE 90.1-1989 Standard [8]. This is a standard for energy efficient design of buildings except low-rise residential buildings. This standard discusses acceptable receptacle power densities for several building types. These values are referenced in ASHRAE 90.1-2007 User Manual; table G-B and the LEEDTM Reference Guide for Green Building Design and Construction [6]. The building types discussed include assembly, health/institutional, hotel/motel, light manufacturing, office, parking garage, restaurant, retail, school, and warehouse. Health/institutional and restaurant/ warehouse building types represent the highest (10.76 W/m2) and lowest (1.08 W/m2) recommended plug-load densities respectively

California Energy Commission (CAC) Report on office plug-load field monitoring [10]. This report discusses recommendations for near and long-term strategies to reduce plug-load energy consumption based on data collection and analysis of California's office plug-loads. This report lists average power data for office equipment, however, does not include diversity factor [11].

National Renewable Energy Laboratory's (NREL) technical report on methodology for modeling building energy performance across the commercial sector [12]. In this report, nominal peak power data is estimated based on a count of computers and other equipment in the space. This, then, is used to calculate plug-load densities (P)

$$P=(Csd\ PDsd + PDmisc)\times d$$

Csd is scale coefficient to scale power density from PDsd, PDsd is power densities of surveyed equipment listed in table C-24 "mean nominal peak power levels of surveyed devices, PDmisc is the power density of devices that are independent of the devices included in table C-25 of the report, and d is a scheduling diversity factor included in table C-25 of the report.

C. Beckel W. [5]. This paper focuses on these latter hybrid approaches and evaluate the performance of an existing state-of-the-art load disaggregation algorithm that relies on the use of ON/OFF events
along with smart meter data paper investigate the use of ON/OFF events, which signal when appliances have been turned on or off, to improve the accuracy of a state-of-the art disaggregation algorithm that uses such events along with

smart meter data to estimate the consumption of single appliances Results, obtained by applying the algorithm to a publicly available dataset, show that the accuracy of the algorithm quickly deteriorates
as the number of available ON/OFF events decreases. We thus suggest possible countermeasures to cope with this limitation and to provide accurate electricity consumption breakdowns in private households.

III. OTHER APPROCHES

To predict the electricity demand and consumption of energy by appliances their prices variety of methods have been suggested and used. Few of them are listed below.

a. Heuristic Search Approaches
b. Linear Programming Approaches
c. Mixed Integer Nonlinear Approaches
d. Neural Network Approach
e. Game Theory (GT) Approaches
f. Goal-Oriented requirement language
g. Multi-criteria Mining Algorithm
h. Location aware resource optimization
Etc

CONCLUSION

This paper has reviewed different approaches to reduce electricity consumption in miscellaneous loads. The deployment of Energy Management Systems (EMS) for the domestic consumer is main focus of this study. To improve EMS performance an improved communication network has suggested that involves twisted pair power lines, radio signals or fibre optic in a bus based network or an internet protocol as a standard. Such systems have numerous objectives like electricity bill minimization, user comfort level maximization, utility peak load reduction and CO2 reduction. This field found to be an interesting area of research for further study.

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