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Building load management using cluster and statistical analyses

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ABSTRACT

Building energy management systems has become very significant to monitor and control loads, mainly due to the tariff and demand side management programs. This technology allows the performance of key energy management functions such as organizing energy use data, identifying energy consumption anomalies, managing energy costs, and automating demand response strategies. Load management techniques allow the energy manager to reshape the building load curve and reduce the peak demand. The synthesis of load shapes is one of the most critical steps in evaluating load management programs. The energy manager should be able to recognize the typical shape of the daily load curve in order to manage the energy use. This paper presents a methodology to perform the synthesis of load shapes. On that purpose, it is essential to identify typical daily load curves as well as the best way to find their representative model. By getting to know the typical load curves of a building, an energy manager may predict load and peak demands. Results have shown the efficiency of clustering technology in the analysis of time series data such as load curves. Using historical data, the total accumulated energy in the end of the day as well as the maximum peak demand of the day may be predicted.

1. Introduction

Load management programs have become increasingly valuable as a result of electricity deregulation and volatile energy prices. The capacity to manage loads, by load reduction or load shifting and minimal interference in the operations of a company may be quite valuable for the energy user [1,2]. The load modelling quality strongly influences the energy management [1–6].

In case the analysis and operation planning for energy and demand in a building is necessary, load modelling becomes very important, as long as it allows the energy manager to predict load shapes in different days. The quality of load modelling influences the system expansion plan and the energy management.

Typically, each building can present different daily load curves and their shapes strongly influence the energy cost. A manager mainly uses expertise and experience in order to better analyse the behavior of the load curve. A load curve is a time series representative of the Building Energy Usage (BEU). A building may or may not work in the same way within a week and the load curve will reflect such behavior. The energy manager should recognize, on historical basis, the load growth during the day and subsequently compare it with the load tendency to allow properly decision-taking actions.

The investigation of load curves is very useful to understand the behavior of BEU. Such analyses can be used to determine the application of special prices proposed by Energy Companies in order to try to have a global consumption that behaves as uniformly as possible.

As observed in literature, cluster techniques are applicable in a large set of curve analyses, so that experts assess a small number of classes instead of a whole set.

This paper presents a methodology that will permit the energy manager to obtain information from measured data and take more appropriate decisions. From such methodology, the energy manager will be able to predict energy and peak power demand besides taking decisions regarding energy management.

A case study has been used in order to show the methodology's capacity. The dataset considered herein comprise a set of several daily load curves corresponding to electric power consumption of a large Brazilian hospital. Hospitals are generally intensive users of energy, both electrical and thermal; furthermore the energy usage in such buildings is distinctive, when compared to other types of commercial buildings, since they comprise typical operating schedules for different functional facilities such as restaurants, laundry, and medical test central office in addition to the variability of occupancy levels throughout the year. These will lead to

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