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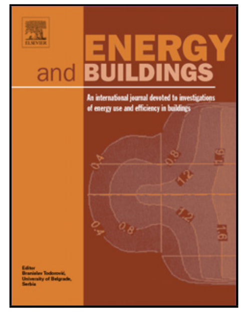

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Day-Ahead Predictions of Electricity Consumption in a Swedish Office Building from Weather, Occupancy, and Temporal data

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Abstract

An important aspect of Demand Response (DR) is to make accurate predictions for the consumption in the short term, in order to have a benchmark load profile which can be compared with the load profile influenced by DR signals. In this paper, a data analysis approach to predict electricity consumption on load level in office buildings on a day-ahead basis is presented. The methodology is: (i) exploratory data analysis, (ii) produce linear models between the predictors (weather and occupancies) and the outcomes (appliance, ventilation, and cooling loads) in a step wise function, and (iii) use the models from (ii) to predict the consumption levels with day-ahead prognosis data on the predictors. The data has been collected from a Swedish office building floor. The results from (ii) show that occupancy is correlated with appliance load, and outdoor temperature and a temporal variable defining work hours are connected with ventilation and cooling load. It is concluded from the results in (iii) that the error rate decreases if fewer predictors are included in the predictions. This is because of the inherent forecast errors in the day-ahead prognosis data. The achieved error rates are comparable with similar prediction studies in related work.

Keywords: Office Building Electricity Consumption, Load Level, Building Energy Management System, HVAC, Exploratory Data Analysis, Prediction, Regression, Demand Response.

1. Introduction

The demand for electricity consumption flexibility is likely to increase in the future power systems due to an expanding integration of intermittent energy resources, such as wind and solar power. Today, it is almost exclusively large producers that provide balancing power whenever there is an imbalance in the system, i.e. a mismatch between electricity supply and demand. However, if the imbalances increase, it might be necessary for the demand to follow the supply pattern as well, and not completely the other way around. Mismatch between supply and demand affects both transmission and distribution level of the power system. (1) Short-term energy mismatches cause the system frequency to deviate from its reference value within a larger synchronous power system area [1]. The Transmission System Operator (TSO) is responsible for the operation at the transmission system level [2]. (2) A share of the renewable energy production units is connected to the local power networks. A smaller share of production, in relation to the regional consumption, can improve the voltage quality and lead to reduced power flows in the network. However, if the integration is beyond the hosting capacity of the network, considerable imbalances can lead to unsustainable power flow levels. This may cause technical failure of individual power system components and power outages [3]. The Distribution System Operator (DSO) is responsible for assuring that his local power system can handle all variants of local supply/demand profiles [2].

Demand Response (DR) is a possible solution for the aforementioned problems. In essence, DR suggests that end-users (e.g., industries, households) adjust their electricity consumption based on price signals [4]. The signals are sent

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