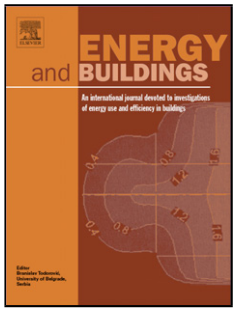
Accepted Manuscript



Title: Experimental Demonstration of Buildings Providing Frequency Regulation Services in the Swiss Market

Author: Tomasz T. Gorecki Luca Fabietti Faran A. Qureshi Colin N. Jones

PII: S0378-7788(16)31161-6
DOI: http://dx.doi.org/doi:10.1016/j.enbuild.2017.02.050
Reference: ENB 7411

To appear in: *ENB*

Received date: 13-10-2016
Revised date: 24-1-2017
Accepted date: 21-2-2017

Please cite this article as: Tomasz T. Gorecki, Luca Fabietti, Faran A. Qureshi, Colin N. Jones, Experimental Demonstration of Buildings Providing Frequency Regulation Services in the Swiss Market, *<![CDATA[Energy & Buildings]]>* (2017), http://dx.doi.org/10.1016/j.enbuild.2017.02.050

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

Experimental Demonstration of Buildings Providing Frequency Regulation Services in the Swiss Market[☆]

Tomasz T. Gorecki[a,*], Luca Fabietti[a], Faran A. Qureshi[a], Colin N. Jones[a]

[a] *Automatic Control Laboratory, École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland*

Abstract

This paper investigates the potential of commercial buildings to offer ancillary services to the grid. We consider a tracking procurement inspired by secondary frequency control, where the resource needs to commit to a nominal consumption profile ahead of time and then receives a power consumption deviation around this profile. We propose a model-based predictive scheme which formally assesses the amount of power flexibility that can be offered by the resource and of attaining the best trade-off between comfort and financial gain during real-time operation by adjusting the nominal power consumption with a delay, in accordance to the regulations of the Swiss energy market. Extensive simulation results highlight how the possibility to perform adjustments on the scheduled energy profile is of paramount importance for both maintaining comfortable operational conditions and offering larger tracking flexibility. Finally, the effectiveness and robustness of the proposed methodology are demonstrated by means of full-day experiments in an occupied office space.

Keywords: Ancillary services; Demand response; Building control, MPC; frequency control; Power flexibility

1. Introduction

Power grids are undergoing massive changes to reach ambitious targets in terms of reduced carbon dioxide emissions, higher energy efficiency, economic competitiveness and increased security of supply. The increasing share of intermittent renewable energy sources connected to the grid challenges the current power grid stabilization paradigms. The increasing need for reserve power, which is now mostly provided by hydro-units and fast-ramping generation resources, has brought attention to the provision of regulation services by demand-side resources [1]. The potential of demand side resources has recently been identified by authorities in the USA and Europe. For example, the Pennsylvania-Maryland interconnection (PJM), has incentivized the participation of loads in ancillary services by adapting their participation rules [2]. Regulation services to the grid require accurate and fast control, therefore, they usually take the form of direct control under the form of power production/consumption tracking [1], [3].

One challenge of demand side participation is that the loads have to maintain an appropriate quality of service while providing frequency regulation to the grid [1], which may be competing objectives. Nevertheless, numerous types of loads or pools of loads have been identified as suitable for providing regulation services, including thermally controllable loads [4], interruptible industrial and domestic loads [5], and plug-in hybrid electric vehicles [6]. [7] proposes a framework to study which resources are most suitable for each type of service. Building Heating, Ventilation and Air-Conditioning (HVAC) systems are more complex than most other systems considered since they are composed of numerous interacting subsystems and have many operational constraints. Numerous works have demonstrated the operational benefits of using predictive controllers for building systems [8], [9] for energy efficiency and cost savings. More recent work has concluded that savings might not always offset the cost of installation of the controllers [10]. Incorporating demand response strategies is however made possible by using such controllers and might further increase the savings [11].

The provision of regulation services follows the same logic and attracts a growing attention. Initial works have proposed methods to offer power consumption tracking using the HVAC system of a building [12], [13]. They assumed either a fixed regulation signal or estimated ithe capacity empirically. Several theoretical works have then proposed frameworks for computing the tracking capabil-

[☆] This work has received support from the Swiss National Science Foundation under the GEMS project (Green Energy Management of Structures, grant number 200021 137985), the NRP 70 Energy Turnaround Project (Integration of Intermittent Widespread Energy Sources in Distribution Networks: Storage and Demand Response, grant number 407040 15040/1), and from the European Research Council under the European Unions Seventh Framework Programme (FP/2007-2013), ERC Grant Agreement 307608.

[*] Corresponding author

Email addresses: tomasz.gorecki@epfl.ch (Tomasz T. Gorecki), luca.fabietti@epfl.ch (Luca Fabietti), faran.qureshi@epfl.ch (Faran A. Qureshi), colin.jones@epfl.ch (Colin N. Jones)

Download English Version:

https://daneshyari.com/en/article/4919189

Download Persian Version:

https://daneshyari.com/article/4919189

Daneshyari.com