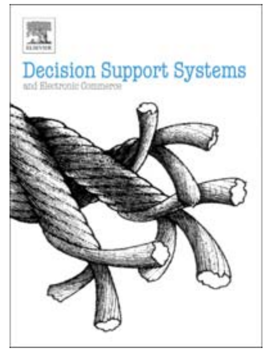
Accepted Manuscript



Effective Demand Response for Smart Grids: Evidence from a Real-world Pilot

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PII: S0167-9236(16)30136-1
DOI: doi: 10.1016/j.dss.2016.07.007
Reference: DECSUP 12752

To appear in: *Decision Support Systems*

Received date: 18 November 2015
Revised date: 28 July 2016
Accepted date: 29 July 2016

Effective Demand Response for Smart Grids: Evidence from a Real-world Pilot

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Abstract

We show how an electricity customer decision support system (DSS) can be used to design effective demand response programs. Designing an effective demand response (DR) program requires a deep understanding of energy consumer behavior and a precise estimation of the expected outcome. Excessive demand shifting or a high price responsiveness might create new peaks during low-demand periods. We combine insights from a real-world pilot with simulations and investigate how we can design effective DR schemes. We evaluate our pricing recommendations against existing economic approaches in the literature and show that targeted recommendations are more beneficial for customers and for the grid. Furthermore, we conduct robustness tests in which we apply our methods on two independent datasets and observe differences in peak demand and electricity cost reduction, dependent on individual characteristics. In addition, we examine the role of energy policy, as it varies across countries, and we find that the presence of competition in the electricity market creates lower prices and more cost savings for individuals. Finally, we measure the economic value of our DSS and show that our DSS can result in up to 38% savings on household electricity bills. Our results exhibit how the design of effective DR can be achieved and provide insights to energy policymakers with regard to understanding consumers' behavior and setting regulatory constraints.
Keywords: decision support, demand response, pilot, simulations, smart grid, smart homes

1. Introduction

Electricity markets are currently experiencing a fundamental change, transitioning from a traditional centralized structure to a decentralized formation, where renewable sources produce a significant share of electricity (Ketter et al., 2016b; Kirschen & Strbac, 2005). The restructured electricity grid, where all components are connected with an ICT infrastructure, is known as *smart grid* (Amin & Wollenberg, 2005; Blumsack & Fernandez, 2012). According to Gharavi & Ghafurian (2011) "the smart grid can be defined as an electric system that uses information, two-way, cyber-secure communication technologies, and computational intelligence in an integrated fashion". From a regulatory and policy-making point of view, grid reliability and quality have been identified as the main challenges in the smart grid (European Commission, 2003). One way to support the grid's reliability