CISTER
Research Center in
Real-Time & Embedded
Computing Systems

Technical Report

Smarter grid through collective intelligence: user awareness for enhanced performance

Michele Albano*

Marcel Macarulla

*CISTER Research Center

CISTER-TR-141007

2014/10/23

Smarter grid through collective intelligence: user awareness for enhanced performance

Michele Albano*, Marcel Macarulla

*CISTER Research Center

Polytechnic Institute of Porto (ISEP-IPP)

Rua Dr. António Bernardino de Almeida, 431

4200-072 Porto

Portugal

Tel.: +351.22.8340509, Fax: +351.22.8321159

E-mail: mialb@isep.ipp.pt

http://www.cister.isep.ipp.pt

Abstract

Smarter grid through collective intelligence: user awareness for enhanced performance

Michele Albano, CISTER/INESC-TEC, Polytechnic Institute of Porto, Portugal, mialb@isep.ipp.pt
Marcel Macarulla, GRIC, Department of Construction Engineering, Technical University of Catalonia, Spain, marcel.macarulla@upc.edu

Abstract

Purpose – In Europe nearly 40% of final energy consumption and 36% of the green house emissions are from buildings (EC, 2013), and is expected that this percentage is bound to increase (Gangolells et al, 2012). The introduction of Energy Management Systems (EMS) contributed to reduce buildings energy consumption with different degrees of success. However, the information tracked and stored by the EMS is rarely fully interpreted and used (Xiao and Fan 2014). The ENCOURAGE project (Albano et al, 2013) explores the possibility to use the information from EMS to enhance user awareness.

The increase of user awareness has been proved to have beneficial effects on energy usage (Coleman, et al, 2012), In the literature different strategies are described to increase user awareness, such as in Chen et al. (2014) where it is presented a visualization tool to determine user engagement with real-time and easily accessible information. Some authors such as Wang and Taylor (2014) study how to use online social networking platforms to promote energy savings. In the ENCOURAGE project the user awareness is enacted at two levels: directly informing energy managers using a visualization platform, and using social networks for recommending best practices for university campus users. For this purpose a set of Key Performance Indicators (KPIs) were developed and used in a manner depending on the type of user. In the energy manager's case, the KPIs are displayed assuming that the user has enough skills to understand the meaning of the KPIs. In the university campus user's case, messages concerning energy consumption are published automatically through the Twitter platform, to inform both the user and other campus inhabitants regarding the good or bad practices in the building energy usage, ending up creating peer pressure and beneficial competition between users in applying the good practices. The diffusion of energy saving practices using online social networking platforms could contribute to substantial reductions in energy consumption (Wang and Taylor, 2014), and the Twitter platform allows users to follow other users, have followers and write instant messages, to share experiences and discuss energy saving practices, thus orchestrating implicitly their behaviors and distilling their (limited) understanding of the KPIs into collective intelligence of the user group.

Design/methodology/approach – The KPIs are developed following 3 steps in a top-down manner: i) Define the main strategic objectives and scenario requirements, ii) identify the questions to answer, iii) Design KPIs that will answer the former questions.

With the aim to display the KPIs to the energy manager, different ways to visualization were studied and tested. An algorithm to publish pertinent messages in the Twitter platform was developed. An algorithm was developed to decide which messages have to be published in each moment, depending on the calculated KPIs and the rules that evaluate them. Two types of messages were defined: messages reporting historic events, and messages reporting real time events.

Findings – The first tests reveal that the enhanced awareness helped energy managers to identify strategies to reduce energy consumption by about 6%. Regarding the effect of the university users' awareness, the tests are still running and no results are available, but partial results hint that the expected energy savings will be at least 9%, proving that more energy can be saved by capillary actions targeting society at large, instead of supporting just energy managers' decisions.

The emerging collective intelligence of the final users ends up having a stronger effect on energy saving than the actions of more educated professionals.

Research limitations/implications – The paper presents initial results which are still not covering all possible scenarios. The paper contains some hypothesis on causality between user awareness and energy saving, which can be criticized.

Practical implications – The KPIs developed can be used to improve the energy user awareness in practical scenarios, and lead to (measurable) energy saving in building. On the long run, the developed KPIs can help identifying and prioritize which building areas are suitable to improve in terms of energy efficiency. The usage of edutainment to target the final users can enhance the effect of data by promoting general users' awareness on best practices and their effect on energy consumption. In addition the use of a social network platform allows the interaction between users, sharing experiences and increasing the collective intelligence in the energy efficiency field.

Originality/Value – This paper presents a novel approach to use data tracked by EMS, and proposes ways to take profit from this information. To the novelty of our approach concur how we use the computed KPIs, and how adapt delivery of KPIs data to their recipient, which both depend on the kind of user targeted by the information. We move the burden of evolving the energy saving strategies to new scenarios onto the collective intelligence of the users, by connecting the users – and their experiences in new scenarios – using a social network to provide guidelines to other users involved in the same decision processes. Bottom line, we use social technologies (Twitter, graphical interfaces) for a social goal (promote user awareness on energy usage) for the benefit of the society (energy saving).

Keywords (3-5): EMS, Key Performance Indicators, Energy efficiency

Research type (choose one): research paper

Bibliography:

EC, 2013. Financial support for energy efficiency in buildings, Report from the Commission to the European Parliament and the Council. [Accessed on 11 March 2014]. Available at: <http://ec.europa.eu/energy/efficiency/buildings/doc/report_financing_ee_buildings_com_2013_225_en.pdf>.

Gangolells, M., et al. 2012. Exploring the possibility of promoting energy conservation behaviors in public buildings within the ENCOURAGE project. ECCPM 2012. Reykjavik, Island, 25-27 July 2012, 723-729.

Xiao, F., and Fan, C. 2014. Data mining in building automation system for improving building operational performance. Energy and buildings, 75:109-118.

Albano, M., et al. "The ENCOURAGE ICT architecture for heterogeneous smart grids." EUROCON. 2013.

Coleman, M., et al. 2012. "Information, communication and entertainment appliance use—Insights from a UK household study." *Energy and Buildings* 54 (2012): 61-72.

Chena, V., Delmas, M., and Kaiser, W. 2014. Real-time, appliance-level electricity use feedback system: How to engage users? Energy and buildings, 70:455-462.

Wang, Q.; Taylor, J. E. 2014. "Energy saving practice diffusion in online networks." *Energy and Buildings* 76 (2014): 622-630.