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Internet of Things and Data Analytics for Energy Management in the Retail Sector

Background

The Danish retail sector is a major consumer of electricity and is, therefore, a principal actor to consider in the green transition of the Danish energy system. In 2013, the Danish retail sector used 9.344.270 GJ [1], which is approx. 8% of the total consumption of the industry sector. Electricity consumption and other energy costs are important for the retail sector, as they are the second largest operating cost after labour cost. Breakdowns of the electricity consumption in the retail sector have shown that more than 50% of the consumption can be attributed to lighting, ICT, and other plug-loads [2]. To better utilize the rising fluctuating electricity generation in Denmark requires means to promote and provide flexible consumption.

In the retail sector, projects have so far considered flexible consumption in connection with refrigeration. However, the remaining loads totalling up to more than 85% percent have not been considered. A report requested by energinet.dk [2] made a rough prediction that 10% of the lighting and plug-loads in the retail sector could be made flexible. However, there is a clear lack of work that considers how the retail stores actually in practice can provide flexible consumption and what barriers retail stakeholders have towards providing flexible consumption.

The concept of software-defined buildings [3] aims to improve the operation of buildings by providing an information platform for the creation of efficient and human-centered building systems. A core challenge within this vision is the creation of portable software applications to scale deployments to large parts of the building stock. Portability following the ISO 9126-1 software quality model refers to how well software can adapt to changes in its environment or requirements. Particular relevant in a building setting is the environment (i.e. building instrumentation). To enable portable software applications for buildings the community has proposed several types of Building Operating Systems (BOS) sandboxing applications from the particular instrumentation of a building. These software platforms include research driven efforts (e.g., sMAP [4], BOSS [3] and BuildingDepot [5]), open source community projects (e.g. OpenHAB [6]) and industry-driven efforts (e.g., HomeOS [7]). The BOS platforms improve portability of applications at the level of the building instrumentation.

Problem Statement

The overall domain problem of this project is to assess what is the potential for demand response (DR) in the retail sector. To utilize such a potential requires means to operate retail stores in a software defined buildings manner. Therefore, the technical problem of the project is how does a software infrastructure for software defined buildings look like in the retail sector. What loads of a store can through Internet of Things concepts and technology be enabled to operate in a software-defined building setting to provide flexible energy consumption.

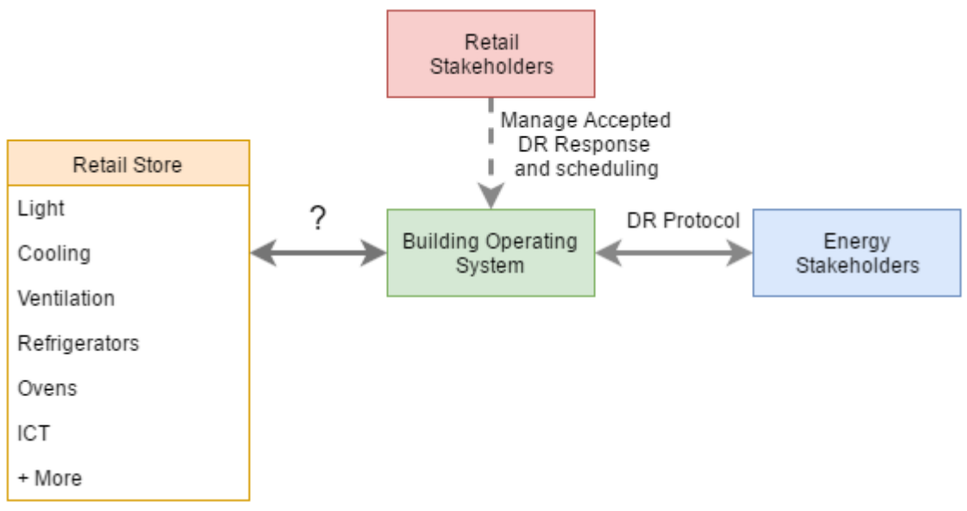

Figure 1 – Domain Overview

Figure 1 shows the current lack of knowledge of what loads can be interfaced to the building operating system (BOS). At the top, the Retail Stakeholders needs a useful method to operate the store in a cost effective manner. To the right, the Energy stakeholders can negotiate DR requests with the retail stores BOS. These DR requests initiate events to take place within limits of successful store operation. Acceptable parameters of store operation are defined by the Retail Stakeholders.

Overall Project

This Ph.D. project is part of the FlexReStore project to explore the possible potential for demand response implementation in the retail sector and develop potential IoT solutions to support the future implementation. The project interacts with other partners in the industry, like Insero, the GreenTech Center and AURA to complete the objectives set in the FlexReStore project.

Project Outcomes

The outcome of the project will include implementing an IoT tool to support the operation of flexible consumption in stores. The solution will also include means to communicate to retail customers that by providing flexibility the stores are helping the green transition. The goal is to produce a prototype of an IoT tool that will make it easier for store chains to roll out flexible consumption. The project will map how demand response services can be implemented and provided by retail store loads. The scheduling strategies will among others include how to trigger lighting (or other loads), to be in a low power mode, how to change the service level of ICT equipment and screens to decrease consumption and how to run store consumption on a local battery. The project will include an evaluation of the solution.

Project Period

1 September 2016 - 31 August 2019

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