Hardware vs. software: How to make the energy system smarter?

Very preliminary draft. Comments and critiques are welcome!

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ABSTRACT: The goal of this paper is to compare different solutions for implementing demand response programs in order to solve the peak load problem. There are two ways to organize these energy aggregators one is via a physical smart meter and the other is via a software platform linking connected objects and energy producers. Based on arguments from various literature, we argue that the business model of a software platform is more promising than the one of a hardware platform. In the latter, the physical asset investment is very costly and highly depreciable. It is also unclear who should bear its costs. These issues are not problematic in the case of a software platform. However, other issues arise like attracting a sufficient end-users' base and a tendency to lead to a natural monopoly. We claim that industrial and regulatory policies can circumvent these issues by encouraging the interoperability of technology standards used by connected objects.

KEYWORDS: smart grid, connected objects, two-sided markets, regulation
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1. Introduction

Imagine a residential user who wishes to use his washing machine or load his laptop/electric vehicle. As the wholesale price varies throughout the day following the movement of the supply and demand of electricity, the time of the day at which the usage of these devices takes place influences the cost of producing, and supplying, the energy. If consumption is displaced from a time period with a higher production cost to one with a lower production cost, the producer benefits from costs savings. To promote the displacement of consumption, energy producers are ready to compensate the final energy users. The aim of this paper is to study how we can organize this transaction between energy producers and end-users by an energy aggregator.

Currently, in most energy systems, such a transaction does not take place.[3] The main reason is that there is no two-way communication between the energy producer and consumer. Absent this communication, the possibility of making this transaction is very limited, despite being valued by the producer. Furthermore, a displacement of consumption is not valued by the consumer per se, as the pricing of energy is mainly flat.

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[3] Contracts where large industrial consumers offer flexibility to a TSO or an energy producer already exist for long. In this paper, we will focus on organizing the transaction between small-scale residential users and energy producers. For residential users, some form of coordination is necessary to displace enough load to create a valuable transaction.

In this paper, we shall argue that this transaction requires an intermediary platform between the producer and the consumer. We discuss two alternative technologies/business model for the platform: a meter- and an ICT-based intermediary platform. On the one hand, the meter-based approach requires the installation of a smart meter in the residential user's home. The meter measures real time consumption and it can be used for transmitting information to the consumer e.g. price signal. On the other hand, the ICT-based approach takes advantage of the emergence of connected objects. Objects are connected to the platform that can give instructions (load/unload) to the objects. They both allow a two-way communication between the producer to the user. Each of them can be used to tackle the peak load problem, and more broadly the problems created by the time-varying cost of producing electricity, by implementing direct and indirect demand response programs. One of the key argument of our work is that the meter-based approach allows to have some sort of control on the electricity flow while the ICT-based approach allows to influence the usage of electrical appliances. Supported by the conclusions of the policy and empirical literature on this topic as well as the insights brought by various economic models, and especially the one of multi-sided markets, we highlight the pro's and con's of each approach.

Our main conclusion is that an ICT-based approach seems to have the most promising business model. A software-based approach does not require the installment of a physical meter that can be both expensive and quickly outdated. It is also unclear who should make this investment as benefits are spread along the value chain, a current player in the energy system or a new independent one ? In addition, an ICT-based platform can function independently from the electricity infrastructure as it is not a network-based approach. It controls the usage of devices not the flow of electricity that feeds them. Thanks to this, the platform is able to by-pass complex regulatory barriers and can be more easily active under various jurisdictions. Despite these advantages, we argue that the emergence of such an ICT-based platform will face several challenges, especially the one of providing a service both valued by energy producers and users.

Section 2 discusses the peak load problem and the demand response programs that can be implemented in order to tackle it. Section 3 analyzes the need for a device allowing a two-way communication between producers and users in order to put these programs in place. Section 4 describes, discusses the pro's and con's and the potential business model of a smart-meter based intermediary platform. Section 5 does the same for an ICT-based intermediary platform. Finally, Section 6 concludes.