NEW DEMAND RESPONSE BUSINESS MODELS – OPPORTUNITIES AND RISKS

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ABSTRACT

The improved opportunities to utilize flexibility of demand side provides business opportunities for both the traditional players in the power system and also for technology providers and ICT companies. This paper reviews potential business models provided by demand response as well as the risks related to them.

INTRODUCTION

Demand response (DR) is often discussed as a necessity in the power systems hosting increasing amounts of intermittent renewable power generation. Also in systems with more stable or controllable power generation, DR can enable the efficient use of the generation and network infrastructure by helping to avoid demand peaks. From electricity end-users' viewpoint, DR may enable savings in energy costs if they modify their loads based on time variable tariffs, incentive payments, or availability of their own generation. Although DR holds various benefits to several stakeholders and the society, it can be considered an underutilized resource in the power system.

New business models utilizing DR are being developed all over the world as DR provides business opportunities not only for traditional energy sector players (retailers, distribution system operators) but also for companies from other sectors (e.g. technology providers, ICT service providers).

This paper reviews barriers to DR utilization and proposes solutions to the barriers. Furthermore, it presents and analyses new business models for both the traditional energy sector players and for newcomers. Finally, the paper discusses risks related to the new models from different stakeholders' viewpoint.

DR BARRIERS AND SOLUTIONS

DR programs can be classified as price-based or incentive based. In price-based or implicit programs, the incentives to modify electricity consumption are implemented through dynamic tariffs. In incentive-based or explicit programs, the DR resources are traded e.g. in ancillary service or markets and participating end-users receive direct payments to change their consumption upon request [1]. This paper considers barriers for both types of DR and solutions for these barriers.

Barriers

Previous research has recognized several types of barriers for DR utilization. For example, Eid et al. [2] reviewed barriers for DR development in in Europe. According to [2], the main issues that need to be addressed are the initial technology investments, coordination problems, and incumbent issues [2]. In addition to the installation costs of DR enabling technologies such a smart meters and in-home displays, [2] raises the question about who should be responsible for initiating the installation and how the costs are divided as DR can benefit several stakeholders as well as the society through environmental benefits. The coordination problems refer to different or conflicting needs of stakeholders in the power system [2.]. For example, analysis of Belonogova et al. [3] showed that controlling loads based on spot prices may cause local peaks in distribution networks. In a survey for Finnish distribution system operators (DSOs) and retailers by Honkapuro et al. [4], 45% of the DSO respondents and 59% of the retailer respondents said that there is a conflict of interest. More specifically, retailers highlighted the risk of increasing imbalance costs, if someone else controls their customers' loads. This relates also to the incumbent issues described in [2] as according to the article, hampering aggregators from offering flexibility services would make the transition toward a renewable based power system more challenging but on the other hand, without compensation arrangements retailers will be penalized for imbalances caused by the aggregators.

The respondents of the previously mentioned retailer and DSO survey by Honkapuro et al. [4] emphasized especially the lack of standards in data system interfaces (main point raised by DSOs) and lack of economic benefits (main point raised by retailers) as the most important DR barriers. In addition, retailers questioned also the motivation among customers and highlighted the lack of controllable loads.

In addition to technical and economic issues, the regulatory framework and market rules may act as barriers to DR use. From network operators' perspective, the economic regulation in many countries favours investments in network investments over buying services (see e.g. Vallés et al. [5]). This problem was noticed also in the recent report by the Smart Grid Working Group appointed by the Ministry of Economic Affairs and Employment of Finland [6]. Furthermore, in some cases, the regulation concerning the structure of network tariffs may prevent DSOs from incentivising DR via time variable or dynamic tariffs [7]. In countries with regulated retail tariffs, this problem applies naturally also to retailers. Furthermore, in some countries, the market places for DR may be very limited. In addition to market access and eligibility of DR resources, also the minimum bid size and

whether aggregation is allowed may act as barriers. The Smart Energy Demand Coalition [1] analysed the regulatory framework for explicit DR in 18 European countries. This report showed that the playing field for DR varies largely also within Europe. For example in Portugal, interruptible contracts were the only program open for DR and participation was limited to large industrial consumers as aggregation was not allowed. Furthermore, although in some US markets DR is mainly (over 80% of demand-side volumes) provided through independent aggregators, their role remains unclear in most EU Member States [1].

Solutions

Annala et al. [8] analysed expert suggestions for promoting DR utilization and classified them to six categories relating to:

- Market access
- Business models and services
- End-user incentives or obligations
- Information and examples
- Attitudes
- Technical issues.

The suggestions classified under market access related, for example, to lowering the minimum bid size and allowing aggregators in reserve markets. The expert views on new business models and services focused especially on selling electricity as a service and providing easy total service packages for end-users, and developing new types of business models and services to utilize DR and solar PV.
Some experts suggested tough measures such as mandatory DR participation for households with electric heating or banning fixed electricity prices whereas others focused more on incentives (e.g. implemented via the electricity tax). The experts also thought that end-users should be provided with more information about when DR is needed and encouragement to use new technologies. The suggestions classified as technical issues focused strongly on automation and control of end-users' response. Topics included, for example, standardized interfaces for appliances and taking DR utilization account already when buildings are being constructed.
The 'Clean Energy for all Europeans' package of legislative proposals published in November 2016 may mitigate some of the identified barriers for DR. For example, Article 13 of the proposed Electricity Directive [9] clarifies the role of aggregators by stating "Member States shall ensure that, where a final customer wishes to conclude a contract with an aggregator, such engagement shall not require the consent of the final customer's supplier." Furthermore, Article 17 of the same directive addresses the access of DR and aggregators in ancillary service markets: "Member States shall ensure that transmission system operators and distribution system operators when procuring ancillary services, treat demand response providers, including independent aggregators, in a non-discriminatory manner, on the basis of their technical capabilities." Furthermore, the same article states "Member States may exceptionally allow compensation payments between aggregators and balance responsible parties. Such compensation payments must be limited to situations where one market participant induces imbalances to another market participant resulting in a financial cost." Furthermore, Article 32 of the proposal addresses DSOs' incentives to utilize DR stating: "regulatory frameworks shall enable distribution system operators to procure services from resources such as distributed generation, demand response or storage and consider energy efficiency measures, which may supplant the need to upgrade or replace electricity capacity and which support the efficient and secure operation of the distribution system."

BUSINESS MODEL TYPES

This section discusses the business models of newcomers in the energy sector and of traditional powers system stakeholders. A summary of the business models is provided in Table 1 in the Appendix.

New models enabled by DR

A review and analysis by Burger and Luke [10] identified three business model archetypes for DR and energy management systems (EMS): 1) market-based capacity and reserve DR, 2) utility-based capacity and reserve DR, and 3) EMS providers. According to Burger and Luke, the businesses in the first cluster provide customers with EMS to control their energy consumption and potential generation. Furthermore, the DR businesses facilitate customer participation in DR market places through the EMS. Alternatively, the response of large customer loads may also be manual. According to [10], the profit for businesses in this cluster typically comes from taking a portion of the revenues from the sales of capacity and reserve services (brokerage fees) – and/or from subscription fees for the use of the energy management tools.
In the second cluster in [10] businesses sell DR products such as firm capacity, operating reserves and mitigation of network constraints directly to regulated utilities (i.e. distribution or transmission networks or vertically integrated utilities). The participants benefit from getting a share of the revenues earned by the DR aggregator whereas the revenue for the aggregator comes through subscription fees from the utility or through brokerage fees.
The final cluster identified in [10], EMS providers, focuses mainly on the optimization of local energy usage in response to energy prices and local needs. These companies target especially the commercial, industrial, institutional and municipal customers and earn their revenues from shared saving arrangements, subscription fees (software), and asset sales (monitoring and control equipment) [10].
It should be noted that EMSs are marketed also to small end users such as households. However, the marketing focus may then be different. Instead of DR, the focus may be more in energy efficiency or living control (e.g.

adjusting temperature separately for different rooms of home).

New models of traditional stakeholders

Whereas [10] focuses on DR business models of new players in the energy sector, flexibility provides new business opportunities also for the more traditional stakeholders such as retailers and DSOs and promotes changes in their business models.

Frei et al. [11] studied how the 25 biggest electric utilities worldwide adapted their business portfolios during 2003–2015. The three main developments noticed by Frei et al. were 1) de-carbonization, 2) decentralization and servitization, and 3) system integration and balancing. The main focus of the reviewed utilities was on de-carbonization and their activities related to both renewable power generation and energy efficiency increased during the examined period. The activities in the other two categories increased also and in 2015, 72 % of the reviewed utilities pursued activities in energy management and monitoring (discussed under decentralization and servitization). However, only about 40 % had activities related to DR.

As smart meter penetration is increasing, retailers are able to expand their tariff selection from the traditional flat tariffs or simple time of use tariffs to more dynamic options. For example, according to a report by ACER and CEER [12] electricity consumers in eight EU Members States could choose real-time or hourly pricing in 2017. Time of use pricing was available in 13 Member States and Critical Peak Pricing in one.

Retailers may also have better abilities to provide end-users with the total service packages proposed by the experts in [8] than companies not active in energy market (e.g. technology providers, ICT companies) or DSOs whose activities are more strictly regulated. In addition to the implicit programs, retailers may agree with their clients that their flexible resources can be utilized to provide services for TSOs or DSOs. For example in Finland, some retailers are active in the ancillary services markets, either utilizing the flexibility of their retail electricity clients or acting as 3rd party aggregators. Energy company Helen Ltd offers for households with a specific energy management system an hourly spot price based tariff without a premium added to the hourly spot price (whereas customers without the management system are charged an additional 0.24 c/kWh) [13-14]. In return, Helen may utilize these loads in the ancillary service markets. In addition, Helen offers a flexibility contract for large business clients even if they would not be their retail customers (thus acting similarly to third party aggregators) [15]. Examples of contracted businesses include Versowood saw in Riihimäki [16] and Yandex data center in Mäntsälä [17] utilized in the frequency containment reserve markets.

In addition to novel pricing option and new markets, DR capability provides retailers with opportunities for portfolio optimization [18]. Compared to traditional models in which the retailer forecasts its clients' consumption and acquires electricity based on these forecasts this model would provide the retailer with an opportunity to reduce its purchasing costs by taking into account the flexibility of its customers in the bids it makes in the wholesale market. Furthermore, the retailer could use the flexibility to reduce imbalance in its portfolio, if it fails to buy enough electricity for certain hour (or if the consumption forecast changes after market closure).

If the regulatory framework allows it, DSOs may design their network tariffs so that they incentivise flexibility. In some cases the change in DSO tariffs may be driven by regulation. In Australia, reforms introduced in 2017 required DSOs to implement tariffs reflecting the efficient costs of service which led most networks to adopt a form of demand tariff [19]. Demand or power based tariffs (discussed also for example in [20]) can also be a tool for DSOs to prevent (or at least penalize) new peaks caused by control actions by other stakeholders. In some cases, DSOs may be able to send control signals to their customers via smart meters.

DISCUSSION AND CONCLUSIONS

This paper has reviewed DR business model opportunities for traditional power system stakeholders and newcomers in the sector. The new business models address some of identified challenges for DR utilization as, for example, aggregation enables the participation of small loads in ancillary service provision and on the other hand the new tariff options offered by both retailers and DSOs provide end-users with DR incentives. However, new business models also raise questions summarized in Table 2 in the Appendix.

One issue is the impact on balance responsible parties if third party aggregators (or DSOs) control loads. However, potential arrangements regarding balance settlement, and compensation and remuneration mechanisms will be require careful consideration. On one hand, retailers should not be penalized for imbalances caused by others. On the other hand, too complicated and costly mechanisms will destroy the benefits for end-user.

Such problem does not occur, if retailer is the one controlling the loads and selling the flexibility of their own customers. Among others because of this, retailers are perhaps best equipped (no problems with balance responsibility/balance settlement, opportunity to combine energy supply and flexibility benefits to one contract + in many countries also distribution costs charged by retailer) to wrap total service packages for end-users (an issue which has been proposed as a solution to better DR utilization). However, from the viewpoint of an end-user wishing to switch supplier, such development could complicate things. Firstly, the increasing amount of variables to consider makes comparison of contracts more difficult. More importantly, when a specific control system has been installed, there is no guarantee that other retailers (or DR program managers, aggregators) are able utilize the same system.

From DSOs' viewpoint, the main risk related to controls is the potential of new local peaks caused by control actions. Furthermore, to enable flexibility use by DSOs, the regulatory frameworks must be updated to incentivize DR use when it is more efficient solution than network investment.
Finally, without coordination mechanisms all models contain a risk of locking resources for one use only even if they would not be needed frequently.

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APPENDIX

Table 1. Main types of DR utilizing business models

	Revenue streams	**Addressed markets**	**End-user incentives**	**Technical solutions**
3rd party aggregation and energy management	Fees for selling flexibility services (may be divided between aggregator and the DR resource) Subscription fees for technological solutions and/or asset sales	Typically ancillary service and reserve markets Potentially retailers and DSOs	Shared revenues	Energy management systems For large end-users manual response possible (notification of DR need)
Retailer utilizing flexibility of its customers	Savings in electricity procurement costs Fees for selling flexibility services	Retail market (new pricing structures and service packages for customers) Ancillary service and reserve markets Potentially DSOs	Flexible tariffs, tariff discounts, payments for activated flexibility based on separate contracts Simple service packages	Energy management systems
DSO utilizing flexibility	Savings in operation and investment costs	Customers connected to own network	Flexible tariffs, tariff discounts, payments for activated flexibility based on separate contracts	Utilization of smart meters' control capabilities Bought energy management services

Table 2. Risks for stakeholders in different business model types

	End-user	**DSO**	**Retailer**	**All**
3rd party aggregation and energy management	Imbalance compensation/reimbursement mechanisms may cut benefits Lock in to one aggregator (if investments in specific technologies)	New peaks due to controls	Imbalance caused by control	Risk of locking resources for one use only even if they would not be needed Conflicting control needs
Retailer utilizing flexibility of its customers	Lock in to one retailer (difficulty of supplier switching, investments in specific technologies)		Costs of control systems, how long will customers stay in the program	
DSO utilizing flexibility	Imbalance compensation/reimbursement mechanisms may cut benefits	Economic regulation of network industries may not incentivize	Imbalance caused by control	