The underlying factors in the uptake of electricity demand response: The case of Poland

Katarzyna Ewa Rollert*

Institute for Innovation Management, Leuphana University Lüneburg, Germany

ABSTRACT

Demand response (DR) is considered crucial for a more reliable, sustainable, and efficient electricity system. Nevertheless, DR's potential still remains largely untapped in Europe. This study sheds light on the roots of this problem in the context of Poland. It suggests that unfavorable regulation is symptomatic of the real, underlying barriers. In Poland, these barriers are coal dependence and political influence on energy enterprises. As main drivers, supply security concerns, EU regulatory pressure, and a positive cost-benefit profile of DR in comparison to alternatives, are revealed. A conceptual model of DR uptake in electricity systems is proposed.

1. Introduction

There is a growing consensus that encouraging consumers to adjust their electricity demand in response to constraints of the electricity network, demand response (DR),[1] is crucial for a more reliable, sustainable and efficient electricity system. Shifting consumption to periods when electricity is relatively inexpensive or available in abundance allows for a more effective use of generation, transmission and distribution infrastructure, thus preventing blackouts, reducing operational costs and deferring investments. Greater flexibility of the demand side, which helps to decrease the use of peaking power plants and to integrate variable (intermittent) renewable energy sources (RES), might also, depending on the generation mix (Holland and Mansur, 2008), contribute to reducing CO2 emissions. Consumers are expected to benefit from participation in DR programs not only through enhanced reliability of the supply, but also through an increased awareness concerning electricity consumption and lower electricity costs (Capgemini, 2008; EC, 2013; Eid et al., 2016). Due to these potentials, the European Union (EU) considers DR important for attaining the 20-20-20 goals and requires Member States (MS) to enable a level playing field for it (Directive, 2012/27/EU). However, although DR programs have begun to emerge across Europe in recent years, the flexibility of the demand side still remains largely untapped in most of the MS (EC, 2013; SEDC, 2015). Current real-life DR programs usually target energy-intensive industries and generally neglect the potential of smaller

commercial or industrial consumers and households (IEA, 2011; SEDC, 2015; Torriti et al., 2010).

Barriers to DR that are usually addressed in the literature can be clustered into three categories: consumer, producer, and structural barriers (Kim and Shcherbakova, 2011; Costello, 2004). Among them, insufficient consumer awareness, the risk of process disruption in industrial enterprises (Olsthoorn et al., 2015) and DR cost (investment) recovery (Eid et al., 2016) play a significant role.
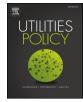
Nevertheless, one of the core and the most frequently discussed barrier to DR is unfavorable regulation (Benquey and Cesson, 2015; Chamoy, 2015; Greening, 2010; Grünewald and Torriti, 2013; IEA, 2011; SEDC, 2015). All other obstacles to DR cannot be effectively tackled without reforms at a regulatory level. Taking into account that the concept of DR is not new (Shen et al., 2014; Warren, 2014), it does offer numerous benefits and has been proven technologically feasible, it is not clear why there is only moderate progress in removing the regulatory barriers in Europe. The reasons for this situation have yet to be understood.

In particular, little is known about the mechanisms, defined in this context as "a process in a concrete system such that it is capable of bringing about or preventing some change" (Bunge, 1997), of uptake of DR in electricity systems. Despite the fact that this concept has been applied in e.g. the US (Eid et al., 2016) and the UK (Warren, 2014) on a significant scale for several years, major factors that impact DR uptake have not been sufficiently investigated. The DR-related behavior of key

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[1] In this paper, DR is understood as "changes in electric usage by end use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized" (U.S. Department of Energy, 2006; Bertoldi et al., 2016).

actors of the electricity system, including Transmission System Operators (TSOs), energy utilities and policymakers, also requires further research.

This study reveals the real factors in the uptake of DR, both drivers and barriers, in the context of the Polish electricity system. It suggests that the unfavorable regulation, which may appear as the main barrier to widespread DR adoption, is symptomatic of underlying systemic barriers. Further, this study investigates the DR-related behavior of key actors in the Polish electricity system. Based on the empirical results, a conceptual model of DR uptake in electricity systems is proposed and policy implications for Poland are provided.

Poland offers an interesting case study for the following reasons:

1) Poland urgently needs a short-term solution to cope with the threat of deficits in electricity supply (Maćkowiak-Pandera et al., 2015). Due to its relatively lower capital intensity compared to investments in electricity generation infrastructure (Green Alliance, 2012), DR seems to be particularly suitable to prevent peak load shortages. Other challenges of the Polish system such as the need to reduce CO_2 emissions could also drive DR adoption.
2) Numerous initiatives have been already undertaken in the context of DR; nevertheless, DR is still not on an equal footing with the supply side and only a small part of DR potential has been tapped (Bayer and Rączka, 2017; Pawłowicz, 2015; SIA Partners, 2015).

2. Methodology and data

As my goal was to investigate the factors which impact the uptake of DR and DR-related behavior of key actors involved in this process, I chose an explorative case study approach. The database consists of.

1) Semi-structured qualitative interviews with 15 experts representing key actors of the Polish electricity system (as listed below) as well as DR aggregators,[2] media, both mass media and media with a focus on the energy sector;
2) Secondary data, mainly media reports, publicly available policy documents and scientific papers.

The key actors of the Polish electricity system are:

- Polskie Sieci Elektroenergetyczne (PSE), the Transmission System Operator (TSO) that is responsible for the operation of the transmission network and the supply security across the country;
- The Distribution System Operators (DSOs) including approximately 169 companies, but only five of them (PGE, Tauron, Enea, Energa and RWE) are in charge of the grids that are directly connected to the transmission grid and are legally obliged to unbundle. PGE, Tauron, Enea, Energa are state-co-owned and belong to vertically integrated energy groups holding generation and distribution assets (below, they are referred to as energy utilities). They dominate the market and are so-called "default suppliers" for households that did not switch to a new supplier. In 2014, PGE, Tauron, and Enea accounted for more than 50% of the installed generation capacities;
- Urząd Regulacji Energetyki (URE), the Regulatory Authority that is responsible for the regulation of the Polish electricity system and, in particular, for setting electricity tariffs for households and small enterprises that did not switch suppliers;

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[2] A "DR aggregator is a service provider who operates – directly or indirectly – a set of demand facilities in order to sell pools of electric loads as single units in electricity markets. The service is provided separately from any supply contract. The aggregator (a service provider who may or may not also be a retailer of electricity) represents a new role within European electricity markets, but is well established in the USA, Australia, South Korea and Japan" (Bertoldi et al., 2016).

- Political decision-makers, in particular the Ministry of Energy that sets the strategic direction of the Polish energy policy; the state is the sole owner of the TSO ((PSE, 2016 (A), RAP, 2014) and the co-owner of the four largest energy utilities (URE, 2015).

For this study, the interviewed experts described their perceptions of the drivers of and barriers to DR in Poland, outlined and assessed activities undertaken to implement DR and provided policy recommendations. The interviews were carried out in the period April to September 2015. An interview lasted on average 0.5–1.5 h. The majority were carried out by phone. The interview language was Polish; for the purposes of this study, all interviews were transcribed and translated into English.

Many of the interviewed experts work for state-controlled enterprises in senior positions and, for this reason, underlie a certain amount of political censorship. As the experts shared to some extent sensitive information and their private opinions, the collected primary data has to remain confidential. Table 1 provides an overview of the interviews in an anonymised form:

Table 1
Overview of the expert interviews.

No.	Interviewed experts/system actors	Interview date	Duration in minutes
1	DR aggregator	24.04.2015	60
2	DR aggregator	28.05.2015	86
3	DR aggregator	29.05.2015	79
4	Energy utility (three employees within one interview)	21.05.2015	56
5	Energy utility (three employees within one interview)	21.05.2015	56
6	Energy utility (three employees within one interview)	21.05.2015	56
7	Energy utility	20.07.2015	60
8	Energy utility	12.08.2015	40
9	Energy utility	24.08.2015	52
10	TSO	10.04.2015	90
11	Mass-media	04.04.2015	56
12	Media – focus on energy	15.07.2015	40
13	Media – focus on energy	22.07.2015	34
14	Regulator	26.08.2015	92
15	Policymaker	28.05.2015	66

The analysis of the interviews followed the methodology proposed by Philipp Mayring (2015). A combined deductive-inductive coding procedure facilitated by the software MaxQda was implemented.

It involved a step-by-step thematic reading and re-reading of the interview transcripts to reduce the data volume and to identify core aspects relevant to the description of DR in the Polish context. Deductive codes were based on the categories addressed in the semi-structured questionnaire and they reflect researcher's assumptions on the topic in question. As deductive codes the following categories were used: definition of DR, status quo and activities of key actors in the context of DR uptake, barriers to and drivers of DR, recommended system amendments to accelerate DR uptake. Inductive codes rely on inductive reasoning in which key issues emerge from interview transcripts. The following inductive codes were derived (most importantly): coal mining, lobbying, politics, supply security, cross-border links, extension of generation capacity, nuclear power plant, cost-benefit profile of different technologies, renewables, EU, pilot projects, Polish mentality and history, DR in other countries, regulatory barriers, tariffs, tenders for negawatts, awareness, large enterprises, households, and environmental attitudes.

3. Results

The main aspects discussed in the expert interviews are used to