Energy Policy 86 (2015) 529–543

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Methodology for the identification, evaluation and prioritization of market handicaps which prevent the implementation of Demand Response: Application to European electricity markets

Manuel Alcázar-Ortega [a,*], Carmen Calpe [a], Thomas Theisen [a], José Francisco Carbonell-Carretero [b]

[a] RWE Deutschland AG, Department of New Technologies, Kruppstraße 5, 45128 Essen, Germany
[b] Universidad Politécnica de Valencia, Institute for Energy Engineering, Camino de Vera, s/n, edificio 8E, escalera F, 5ª planta, 46022 Valencia, Spain

HIGHLIGHTS

- Market handicaps prevent the application of Demand Response in electricity markets.
- A methodology to identify and organize such market handicaps has been developed.
- The evaluation and quantification of criticality and difficulty to overcome is done.
- A hierarchical list prioritizing handicaps to be addressed is obtained.
- Market handicaps of three European countries were evaluated through this methodology.

ARTICLE INFO

Article history:
Received 8 April 2015
Received in revised form
22 June 2015
Accepted 3 August 2015

Keywords:
Demand response
Market handicaps
Renewable integration
Industrial production
Energy regulation
Load management

ABSTRACT

This paper presents a methodology for the identification, analysis and comparative assessment of the handicaps which nowadays prevent the higher implementation of Demand Response (DR) in the electricity market. Its application provides a hierarchical organization of handicaps from the most critical to the less critical and then, from the easiest to the most difficult to overcome. This makes possible to determine which barriers would be a priority, which may indicate the direction of regulatory changes to properly address these handicaps and so, stimulating a higher participation of the demand side in electricity markets. After applying the methodology to three European countries, 34 handicaps have been identified, analyzing which of these handicaps affect such stakeholders as grid operators, retailers and customers and how these stakeholders are affected. For each handicap, the criticality and difficulty to overcome the different handicaps have been studied, based on detailed information coming from personal interviews to experts representing the different stakeholders in the electricity trading chain. Regulatory barriers have been identified as the most critical and difficult to overcome. Together with regulatory changes, the promotion of aggregators and the training of customers on DR applications are some of the most significant initiatives.

1. Introduction

The use of Demand Response (DR), understood as the ability of energy consumers to modify the power demand from their expected consumption (Alcázar-Ortega, 2011), may benefit many different market agents in the power system, who can use DR mechanisms for different reasons. Among others, Transmission or Distribution System Operators (TSO/DSOs) may use DR resources to increment capacity reserve in their operation area, or retailers could make use of it in order to balance their energy portfolio. DR can also help to integrate renewable energy resources (RES) in electricity systems, whose production depends on the availability of the primary energy resource and it is not usually correlated to

* Corresponding author. Present address: Universidad Politécnica de Valencia, Institute for Energy Engineering, Camino de Vera s/n, edificio 8E, escalera F, 5ª planta, 46020 Valencia, Spain.
E-mail addresses: manuel.alcazar-ortega@rwe.com, malcazar@iie.upv.es (M. Alcázar-Ortega), carmen.calpe@rwe.com (C. Calpe), Thomas.Theisen@rwe.com (T. Theisen), jcarbonell@iie.upv.es (J.F. Carbonell-Carretero).

http://dx.doi.org/10.1016/j.enpol.2015.08.006
0301-4215/

the local demand where such generators are placed (Montuori et al., 2014). Most of RES, like wind power generation, depend on variable and unpredictable external conditions and their supply is not directly controllable (Klobasa, 2009). Therefore, the expansion of renewable energy sources requires new means of load management and greater quantities of various ancillary services (Cappers et al., 2013). In this context, DR aims at adjusting the electricity demand to the grid requirements at a given point of time, meaning an adequate option for reserve capacity.

Several examples worldwide show the interest in increasing the share of RES in the national electricity mixes. Thus, state governments and federal initiatives such as the production tax credit and others have promoted the growth of renewables in the United States (Cardell and Anderson, 2015). In Australia, some research has demonstrated that wind power producers can employ DR to maximize its profit (Mahmoudi et al., 2015). At the other side of the World, in Europe, the promotion of electricity from renewables is a key European Union priority for several reasons, including the security and diversification of energy supply, environmental protection and social and economic cohesion. It makes DR an important pillar for achieving the EU's 20/20/20 goals, which pursue by 2020 not only to raise the share of energy consumption produced from RES to 20% (European Commission, 2008), but also:

- Reducing the greenhouse gas emissions in 20% from 1990 levels, which can be achieved if demand packages are shifted to periods during which less contaminant technologies are producing power (Alcázar-Ortega et al., 2012).
- Increasing a 20% the energy efficiency in the Union. As discussed in Strbac (2008), DR can contribute to increase the efficiency of the power system due to the relatively low utilization of generation and networks.

Different provisions dealing with demand side participation have been included in various EU policy documents, specifically the Electricity Directive (2009/72/EC) and the Energy Efficiency Directive (2012/27/EU). On the other hand, a large potential of DR resources have been identified in Europe (Gils, 2014). However, as stated by Torriti et al. (2010), the market designs and policies in place in most of the European countries do not promote today the participation of demand in electricity markets. On the contrary, DR and related activities such as aggregation remain illegal in many of them and in the majority of system services and wholesale markets (SEDC, 2013).

As it was mentioned above, DR has proven to be a useful mechanism that produces significant benefits for both the customer and the power system (Alcázar-Ortega, 2011; Shariatzadeh et al., 2015). Customers can obtain significant benefits from DR with the proper price framework (Dupont et al., 2014; Ghazvini et al., 2015) and DR may bring new business model opportunities for the different stakeholders involved in the trading of this kind of resources (Behrangrand, 2015). However, in spite of the benefits that DR may bring to the society (Alcázar-Ortega, 2011; US Department of Energy, 2006), allowing a more efficient use of system assets and resources (O'Connell et al., 2014), a number of market handicaps keeps preventing nowadays the massive implementation of DR resources in electricity markets.

The evaluation of market handicaps is not an easy task due to the many different factors to be accounted. Different research examples about market barriers which prevent nowadays the further implementation of DR in the market can be found in the scientific literature. Thus, market barriers for DR implementation in the United States for the provision of ancillary services are studied by Cappers et al. (2013) and Greening (2010). Similarly, other structural and regulatory barriers for the North-American power system are considered in Kim and Shcherbakova (2011). In Europe, barriers for the participation of aggregators in the German balancing market are considered in (Koliou et al., 2014). Moreover, similar examples applied to other electricity markets like Denmark (Katz, 2014), China (Zhang et al., 2015) and (Wang et al., 2010), or Austria (Prüggler, 2013) can be found. However, even if there are some examples of quantitative analysis for energy efficiency purposes (Trianni et al., 2013; Luthra et al., 2015), no previous research is found regarding market handicaps applied to DR which clearly prioritize which should be the first barriers to be addressed, or how critical may be for the electricity market to do it according to one direction or another. Therefore, a methodology for the identification, evaluation and prioritization of market handicaps which prevent the implementation of Demand Response has been developed and it is here presented. Indeed, the added value of this methodology resides on the systematic evaluation of these barriers, obtaining a hierarchical organization of handicaps according to their criticality and difficulty to solve them. In addition, the responsible to solve each handicap is identified and some recommendations to overcome the different barriers are also given.

This methodology has been designed and applied in the framework of the European LIFE+ Project "Demand Response in Industrial Production" DRIP (Demand Response in Industrial Production "DRIP", 2015). The DRIP consortium was composed of partners from Germany, Spain and the Netherlands, including end-users, distribution system operators (DSOs) and retailers in a way that the whole energy chain was represented. Due to this fact, first-hand information has been used to apply the aforementioned methodology, producing a realistic picture about the market barriers which can be currently found in different places of Europe, including regions from the south-west to the north-east of the continent.

The paper is organized as follows: Section 2 describes the methodology developed for the evaluation of market handicaps on DR. The results of the application to the above mentioned European markets for consumers, system operators and retailers are detailed in Section 3. After that, the results of this research are discussed in Section 4 and finally, the most significant conclusions are summarized in Section 5.

2. Methodology for the evaluation of market handicaps for DR implementation

The methodology here presented is schematically shown in Fig. 1. This methodology is based on a sequence of steps, as it is detailed in the following paragraphs, which include the gathering of information, the organization of this information in a matrix (MHM), the quantification of the different concepts which define each handicap (such as the category, criticality or difficulty to overcome) and the final aggregation and sorting, resulting in a hierarchy of actions to prioritize the solutions of the identified barriers.

2.1. Definition of the list of handicaps and organization in the market handicaps matrix

The first step of the developed methodology is the identification of the list of handicaps which may affect the different stakeholders. This identification should be done by means of market analysis and direct contact with different stakeholders in the area where the methodology would be applied. In the case of the DRIP project, the handicaps list was defined based on specific interviews to 57 stakeholders representing the different market roles under study (industrial and commercial customers, DSOs, power