The voluntary price for the small consumer: Real-time pricing in Spain

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A B S T R A C T

In 2013, a period of reform was initiated of the regulatory framework of the Spanish electricity sector. A year later, the methodology for the calculation of the Voluntary Price for the Small Consumer (VPSC) was approved: a real-time price tariff for small domestic consumers. Under this price-setting system, VPSC consumers are billed according to their hourly consumption and hourly prices along the day. Directive 27/2014/EU, on energy saving, was also transposed to Spanish regulation in 2014.

The impact on the Spanish electricity market and domestic VPSC consumers of these two recent energy policy modifications are analyzed in this work. A qualitative model, based on the flexibility of the merit-order curves, is first introduced to formulate a number of hypotheses. A set of scenarios are then examined to quantify the main effects on the market and on domestic consumers.

The results show that domestic energy-saving, and, to a lesser extent, load-shifting scenarios, can diminish the mean hourly price and the cost of the annual traded energy in the market. Nevertheless, these reductions are mainly granted to large qualified consumers, since domestic consumers mostly benefit from the reduction of their energy demand rather than from a reduction of the price.

1. Introduction

The regulatory framework of the Spanish electricity sector initiated a period of reform in 2013, and was mainly focused on the economic stability of the system, which began with the enactment of Royal Decree-Law 9/2013 of 12 July, which adopted measures to guarantee the financial stability of the electricity system (JE, 2013).

Noted for its impact on the majority of domestic and small electricity consumers, the Royal Decree 216/2014, of 28 March, was approved during 2014. This Royal Decree sets out the methodology for the calculation of the Voluntary Price for the Small Consumer (VPSC, or PVPC according to the initials in Spanish) (MIET, 2014). This VPSC tariff is applied to the electricity bill of low voltage consumers:

- who have a smart meter, capable of hourly metering;
- who are successfully integrated into the information and telecommunication (IT) systems of the reference trading company (suppliers allowed to offer VPSC tariff);
- whose contracted capacity does not exceed 10 kW.

Accordingly, the new price is to be calculated hourly by adding the regulated grid access tariff (which is a regulated trading cost), and the cost of energy as well as the appropriate levies and taxes. The energy cost is obtained from the actual hourly energy price in the production market.

Most real-time pricing schemes transmit the information corresponding to the hourly price of the energy through the smart meter, via a standalone in-home display. In the case of Spain, no physical feedback device is required since the price information is served via the internet. In accordance with the provisions of Royal Decree 216/2014, the transmission agent and operator (TSO) of the Spanish electricity system, Red Electrica de España (REE), at 20:15 each day, publishes the electricity pricing schedule that will be applied in each of the 24 h of the day ahead. Hourly prices (in the billing, the component of cost of the energy consumed) are displayed according to three types of tariffs, Fig. 1 (REE online a; REE online b; CNMC online):

- General (2.0 A)
- Night-time or hourly discrimination tariff (2.0 DHA)
- Super-off-peak tariff for electric vehicles (2.0 DHS)

Now, VPSC consumers can reduce their bills, provided that they move their electricity consumption (totally or partially) to the time slots in which electricity is cheaper, thereby avoiding the most expensive hours of electricity of the day.

According to the Report on the First Milestone of Implementation...
of the Meter Replacement Plan (CNMC, 2015), at the end of 2014, 11.91 million smart meters (43% of the fleet) were installed, of which only 10.19 million (36% of the fleet) were successfully integrated into the IT systems of the trading companies (suppliers). By 2018, 100% of residential consumers in Spain (28.02 million) are expected to have a smart meter installed. Until the completion of the Meter Replacement Plan, for those customers who still do not have a smart meter installed, the hourly price tariff is applied by means of a consumption profile that REE regularly updates, according to the patterns of behavior of consumers. Consumption profiles are also published weekly through the corporate website of REE (REE, online b) (Fig. 1).

In 2014, two regulations were also approved that transposed Directive 27/2014/EU on energy saving to the Spanish legislation. The Royal Decree-Law 8/2014, of 4 July, on the approval of measures for growth, competitiveness and energy-saving (JE, 2014a), transposed some principles set out in the aforementioned directive that were subsequently developed by Law 18/2014, of 15 October, which approved measures for growth, competitiveness and energy-saving (JE, 2014b).

1.1. Demand response policy and research activities

The growing social concern towards the environment and global warming led, in 1997, to the adoption of the UN Kyoto Protocol on climate change, which has been periodically re-issued until the recent Paris Agreement of 2015. The European Commission considers that: “Energy efficiency is one of the central objectives for 2020 as well as a key factor in achieving our long-term energy and climate goals” (EC, 2010). According to the International Energy Agency (IEA, 2014), energy efficiency is widely recognised as the most cost-effective and readily available means to address numerous energy-related issues, and to increase competitiveness and promote consumer welfare.

The VPSC tariff belongs to dynamic or real-time pricing which is a common instrument in the implementation of demand response (DR) strategies. The USA Department of Energy (DOE) defines DR as: “Changes in electric usage … to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized” (USA-DOE, 2006).

The Energy Efficiency Directive considers that demand response significantly increases the opportunities for consumers to take action on consumption and billing information, and provides a mechanism to reduce or shift consumption, which results in energy savings and a better use of networks and the generation of assets (EC, 2012).

Demand response programs based on real-time pricing are simple, efficient and sustainable, since they rely on the supply and demand rule of competitive markets: they are freely adopted by consumers and they do not include any compulsory temporary restriction of consumption or the payment of any premium. However, the success of real-time price-based demand response programs depends greatly on the receptiveness and disposition of customers. The balance between expected bill-saving and discomfort in changing consumption patterns plays an essential role in engaging customers in demand response.

Darby, in 2006, compiled and analyzed the results of various real-time direct feedback studies, mostly from USA, Canada and Europe, and reported an average saving in energy consumption ranging from 5% to 15% (Darby, 2006). Since this early study, many other authors have surveyed the impact of dynamic price tariffs on residential customers (Faruqui et al., 2007, 2010a, 2010b, 2013; Alvarez Bel et al., 2009; Faruqui and Sergici, 2010; Alcázar-Ortega et al., 2011; Alparslan Zehir and Bagriyani, 2012; Vine et al., 2013; He et al., 2014; Mehta et al., 2014; Bergaentzlé et al., 2014; Wang et al., 2015; Gils, 2016) with a wide range of results. Zimmermann (2009) analyzed the electricity consumption of 400 Swedish dwellings and reported that the share of flexible domestic load (i.e. time-shiftable) scarcely represents 10% of total consumption of electrical energy.

Real-time tariffs for domestic customers also produce effects both in the wholesale market and the power system, since load reduction may change the marginal generator. These changes in the marginal unit affect both the cost of energy and the volume of greenhouse gas emissions. Although the early literature was mainly focused on savings in electricity demand and costs, more recently it has incorporated the interest in the environmental effects (CO2 emissions) of DR (Gyamfi and Krumdieck, 2011; Nilsson et al., 2014). Stoll, Brandt and Nordström (2014) addressed the possible negative environmental effect of load-shifting by correlating the hourly price of electricity and the hourly CO2 emissions for three electricity markets. Nilsson, Stoll and Brandt (2015) reported the results of a pilot study that assessed the impact of real-time price visualization on residential electricity consumption in Sweden. Due to the characteristics of the Swedish electricity market, with a negative relation between spot price and CO2 intensity, the load shifted to a split effect; electricity costs modestly decreased while CO2 emissions increased.

1.2. Objectives

The purpose of this work is to envisage the potential impact of the following two recent energy-policy modifications on the Spanish wholesale electricity market and on domestic VPSC and assimilated consumers: the implementation of the VPSC real-time pricing scenario as a tool of demand response; and the transposition of Directive 27/2014/EU on energy saving, as a driver, for example, to prevent the waste of energy and to improve the efficiency of home appliances (for domestic consumers). In order to reach this goal, first a qualitative model, based on the slopes of the merit-order generation and demand curves, is used to formulate number of hypotheses. A simplified method, intended to replicate the behavior of the Spanish daily market without having to reproduce the complex matching process of the market, is then introduced. Finally an appropriate set of DR scenarios have been generated from the historical information retrieved from the Market Operator (MO) covering the one-year period from April 1, 2014 until March 31, 2015, in order to quantify the main effects on the wholesale market and on the VPSC consumers. Consequently, this work shows the results of a reanalysis of historical market data, properly modified to represent credible demand scenarios derived from the recent regulatory changes.

After the introduction, the content of the paper is as follows. First the Spanish/Iberian electricity market is briefly surveyed and a qualitative market model is introduced to lay out some basic hypotheses. The fundamentals of the proposed methodology for replicating the clearing of the wholesale market are then established. After that, the hourly merit-order generation and demand curves covering the one-year period from April 1, 2014 until March 31, 2015, retrieved from the archive of the Iberian Market Operator, are used as source data for the creation of realistic DR scenarios for VPSC costumers: energy saving and load-shifting. The main potential effects of DR on the
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