Energy Policy 85 (2015) 218–234

Contents lists available at ScienceDirect

Energy Policy

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

Evaluating the market splitting determinants: evidence from the Iberian spot electricity prices

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HIGHLIGHTS

- Assess determinants on market splitting behaviour of Iberian electricity markets.
- Logit and non-parametric models to express market splitting probability response.
- Explanatory variables: wind, hydro, thermal and nuclear power; ATC and demand.
- Results: increase of market splitting probability with higher availability of low marginal cost electricity.
- Coordination policies governing both interconnections and renewables deployment.

ARTICLE INFO

Article history:
Received 20 January 2015
Received in revised form
3 June 2015
Accepted 4 June 2015
Available online 17 June 2015

Keywords:
Market Splitting
Renewable Energy
Non-parametric models

ABSTRACT

This paper aims to assess the main determinants on the market splitting behaviour of the Iberian electricity spot markets. Iberia stands as an ideal case-study, where the high level deployment of wind power is observed, together with the implementation of the market splitting arrangement between the Portuguese and the Spanish spot electricity markets.

Logit and non-parametric models are used to express the probability response for market splitting of day-ahead spot electricity prices as a function of the explanatory variables representing the main technologies in the generation mix: wind, hydro, thermal and nuclear power, together with the available transfer capacity and electricity demand. Logit models give preliminary indications about market splitting behaviour, and then, notwithstanding the demanding computational challenge, a non-parametric model is applied in order to overcome the limitations of the former models.

Results show an increase of market splitting probability with higher wind power generation or, more generally, with higher availability of low marginal cost electricity such as nuclear power generation.

The European interconnection capacity target of 10% of the peak demand of the smallest interconnected market might be insufficient to maintain electricity market integration. Therefore, pro-active coordination policies, governing both interconnections and renewables deployment, should be further developed.

1. Introduction

The single market for electricity is a substantial part of the European internal energy market. After the required unbundling of the electricity sectors, wholesale electricity markets were implemented and then partially joined through regional electricity markets (ERGEG, 2006; Karova, 2011; Meeus and Belmans, 2008).

The interaction between electricity markets occurs through high voltage (HV) cross-border interconnections with limited capacity, offering numerous advantages under normal operating conditions; such as optimal power station daily production, increasing opportunities for operation with renewable energies, the promotion of competition and enhancement of supply security. Several authors have studied electricity market integration, addressing different geographic areas: De Vany and Walls (1999), Park et al. (2006) in the US regional markets; Worthington et al. (2005) and Higgs (2009) in Australia; Armstrong and Galli (2005), Zachmann (2008), Bosco et al. (2010), Bunn and Gianfreda (2010), Pellini

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http://dx.doi.org/10.1016/j.enpol.2015.06.013
0301-4215/

(2012a) and Figueiredo and Silva (2012 and 2013) in Europe. Regarding the South-west regional electricity market, composed of France, Portugal and Spain, all studies are unanimous in establishing that there is integration between both Iberian electricity markets (Mibel) in the period analysed in this study. France has not been found to be integrated with the Iberian markets, as analysed by these authors.

The electricity generation mix is changing in Europe with the increasing penetration of Renewable Energy Sources Electricity (RES-E). The impact of high penetration of RES-E has been discussed throughout a number of scientific papers and reports. In particular, some of the issues discussed related with the high level growth of wind power installed capacity reported are: the importance of adequate interconnections and transmission capacities to transport excess production, electrical system fault endurance, available and flexible standby generating capacity to accommodate load variability and effective control or curtailment of wind power production (Benatia et al., 2013; Franco and Salza, 2011; Söder et al., 2007). Also wind forecasting is fundamental to allow wind power load management and electrical system balancing (Milligan et al., 2009). Due to the almost inexistent marginal costs of RES-E generation, they are the first in the merit order of power plant dispatch. Therefore, by displacing higher marginal cost electricity generation, one could expect some level of decrease in the electricity spot market prices. This fact is reported by several authors (Amorim et al., 2010; Cruz et al., 2011; Cutler et al., 2011; Gelabert et al., 2011; Jónsson et al., 2010; Klessmann et al., 2008; Mauritzen, 2010; Moreno et al., 2012; Mulder and Scholtens, 2013; Sáenz de Miera et al., 2008; Sensfuß et al., 2008) and implies the hypotheses of increasing the cross-border transit of electricity, therefore market splitting.

The integration of the European electricity markets together with the fast expansion of renewable generation is thus creating one of the most demanding challenges to transmission grids and their operation (Henriot et al., 2013; Ragwitz et al., 2012). The large deployment of RES-E, with related increasing electricity flows at particular climate conditions can create congestions, leading to strengthening requirements of transmission grids throughout European Member states. Moreover, cross-border interconnections are increasingly essential for the targeted European electricity market integration, which, with the observed high availability of renewable generation, might not be sufficient for the required commercial electricity transits. Literature is scarce on the assessment of the impacts that high penetration of RES-E generation have on interconnected market behaviour and specifically on market coupling. The only study found addressing this issue was done for the Electricity Reliability Council of Texas (Woo et al., 2011), considering the influence of the existing high wind power penetration on the behaviour of the market coupling arrangement.

This study addresses the market splitting behaviour of the Iberian electricity spot market, through parametric and non-parametric probability response models, using data from the 1st July 2008 until the 31st December 2012. This approach brings a new perspective on the use of non-parametric models in the assessment of electricity markets. Therefore, the research questions are twofold: (a) does increasing renewable power generation increase market splitting probability of occurrence?; and (b) does empirical data confirm the available cross-border interconnection capacity influence on market splitting?

In this Section overviews of the EU legislative framework and the Iberian electricity markets are presented. Additionally, a summary of the renewables deployment and cross-border interconnections in Iberia is made. Data and model specification used in this study are presented in Section 2, followed by the obtained results in Section 3. In Section 4 the analysis and discussion of the results is provided. Section 5 concludes with some policy recommendations.

1.1. A brief overview of the EU legislative framework

The objectives set for the European energy policies were to: guarantee the supply of electricity, reduce costs, foster competition, ensure security of supply, and protect the environment. The European Directive 96/92/EC established for the first time common rules for the various electricity markets in Europe, based on the liberalisation of the sector without prejudice of the public service required and the access by the generators and consumers to the transmission and distribution grids (Jamasb and Pollitt, 2005).

These requirements are guaranteed by regulating authorities established in each country (Silva and Soares, 2008). The adequate integration of national electricity transmission grids and associated increase of electricity cross-border transfers aim to ensure the optimisation of the production infrastructure (Jacottet, 2012). However, different levels of market opening and diverse development stages of interconnectors between electricity transmission grids across European countries are observed. In consequence, Member-States took necessary measures to facilitate transit of electricity between transmission grids in accordance with the conditions laid down in the Directives.

In 2006 the European Regulators Group for Electricity and Gas (ERGEG - currently the Agency for the Cooperation of Energy Regulators – ACER) launched seven Electricity Regional Initiatives for the creation of seven regional electricity markets (Karova, 2011; Meeus and Belmans, 2008). The objective for the creation of these regional electricity markets was to provide an intermediate step for the consolidated European Electricity Market (ERGEG, 2006).

Almost simultaneously, the European Directive 2001/77/EC, called for the promotion of electricity generation by renewable energy sources (RES) in Europe. The aim was to reduce dependency on imported fossil fuels and to allow a reduction in Green House Gas (GHG) emissions. The large deployment of RES-E generation in Europe was achieved through a programme of strong financial support mechanisms (Amorim et al., 2013; Jager et al., 2011; Meyer, 2003), like feed-in tariffs, feed-in premia, fiscal incentives, tax exemptions and others. The RES electricity (RES-E) generation in Europe was 467,7 TWh in 2013 consisting of 42.4% hydroelectric, 27.4% wind, 10.4% solar, 9,9% biomass and 10% of other renewable technologies (Eurostat, 2015). The RES-E generation technologies are in different stages of development which explain the different shares of deployment achieved in each technology (Brown et al., 2011).

1.2. The Iberian electricity market

The agreement reached between the authorities and the electricity companies late in December 1996 (Ministerio de Industria y Energía - Spain, 1996), allowed for electricity sector reform in Spain. The law for the electricity sector was then issued in November 1997, establishing its regulation with the objectives to guarantee the supply, the quality of supply at the minimum possible cost and respect of the environment. Therefore, the existing public service was replaced by the guarantee of supply for all consumers; the electrical sector was privatised on the generation and commercialisation sides and regulated on the transmission and distribution sides (Boletín Oficial del Estado - Spain, 1997). The transmission system was assigned to Red Eléctrica de España (REE) as a regulated monopoly, and in January 1998 an electricity spot market was introduced in Spain (OMEL).

In Portugal, Decree-law 7/91 of the 8th January established the conversion of the existing public electricity company Electricidade de Portugal (EDP) into a private company, however still owned by the state. This allowed the unbundling of the Portuguese