Joan Batalla and Elisa Trujillo-Baute

OPERATIONAL COSTS OF THE SPANISH ELECTRICITY SYSTEM: A DEMAND OR SUPPLY EFFECT?

Joan Batalla, Phd Student, URV University
Tinent Coronel Valenzuela, 1-11. 08034 Barcelona
Phone: + 34 630 964 507; e-mail: jbatallab@gmail.com
Elisa Trujillo-Baute, Phd Student, University of Barcelona &
Chair of Energy Sustainability – IEB (UB) - FUNSEAM
Tinent Coronel Valenzuela, 1-11. 08034 Barcelona
Phone: + 34 934 035 409; e-mail: elisatrujillo@ub.edu

Overview

Global demand for renewable energy continued to rise, despite the international economic crisis, electricity demand reduction, policy uncertainty and declining support in some key European markets (REN21, 2013). With the implementation of the Renewable Energy Directive (Directive 2009/28/EC) and national policies set out in National Renewable Energy Action Plans, most Member States experienced a significant growth in renewable generation capacity. In 2012, renewable electricity production represented a 23.5% of the electricity generation and a 14.1% of the final energy consumption in the European Union. Among the European Union, Spain has become one of the most important countries in terms of installed renewable power generation. By the end of 2013, Spanish overall installed solar capacity reached 6,981 MW and wind capacity reached 22,900 MW.

The abundant literature on renewable electricity generation has mostly been focused on the analysis and comparison – mainly in terms of cost-effectiveness and dynamic efficiency – of the different support schemes (Ragwitz, et al., 2007; Finon and Menanteau, 2008). Most recently, the academic interest moved towards the question of the merit order effect (Gelabert et al., 2008; Nicholson et al., 2010; Ray et al., 2010; among others), considering the dampening effect that renewable generation has on the electricity market price. But few papers have explicitly modelled the impact of renewable electricity on the operational costs of the electricity system.

Electricity generated from renewable energy sources must be integrated into the market, but its inherently different characteristics compared with conventional sources - mainly intermittent generation – implies that System Operators (SO) and market designs have to face increasing challenges as more renewable capacity is added. The analysis of the evolution of the operational costs in the Spanish electricity system and its explanatory variables constitute the main aim of this paper.

Method

This paper tries to explain the evolution, in terms of economic cost, of the adjustment services. In Spain, these services, the purpose of which is to facilitate the adjustment of the generation schedules resulting from the day-ahead and intra-day electricity markets to the quality, reliability and security requirements of the electricity system, have been increasing over the last years. Given that the adjustment services are integrated by several markets as the resolution of technical restrictions of the system, the allocation of ancillary services and the management of deviations, an in-depth knowledge of the rules explaining the functioning of these services is required in order to explain its evolution over the time.

Although several factors could be behind the increasing importance of the energy negotiated in the adjustment markets, the relationship between renewable electricity participation – *generation mix structure* - in the day-ahead and intra-day electricity markets and the errors in the demand forecast receive a special attention. Considering the simultaneous nature of electricity generation and demand, hence, any unexpected change in the forecasted electricity demand or supply has its immediate effects on the operational costs of the system.

Using hourly market data, a time series regression model controlling for seasonality is constructed. The econometric estimation uses as dependent variable the differences (€/MWh) between the final electricity price and the price after intra-day markets - operational costs -. Hourly adjustments in wind and solar electricity generation (supply side) together with real electricity demand are used as the main explanatory variables. In order to properly identify the effects coming from the demand and supply

adjustments, additional operational costs drivers need to be included into the analysis. More precisely, we included the total electricity load (demand profile control), the structure of the supply by generation technologies, the ratio between renewable generation and load or the residual load, the need for upwards reserve power.

Hourly data from the exploitation of the Spanish Power System for the different markets (daily and intra-day markets, technical constraints daily market, imbalances markets and other ancillary services) is used. The analysis covers the period from January 2010 to January 2014.

Results

In a European context where renewable capacities will soon become predominant in the generation mix, to minimise the volume of electricity imbalances within Europe and reduce the associated costs to end consumers becomes crucial. There are several reasons behind these imbalances between generation and consumption, but after the evaluation of the evolution of the operational costs in the Spanish electricity system, both deviations in the supply and in the forecasted demand, seem to be relevant.

The evaluation of the dynamic effects of these explanatory variables deserves further study. Nevertheless, our preliminary results indicate that the provision of strong incentives to invest in technologies (e.g. better forecasting tools) to minimise imbalance risk is required.

Conclusions

Renewable power is quickly becoming a significant source of energy in Spain with positive consequences in terms of security of supply and environmental protection and climate-change mitigation. By the end of the period analysed, the installed renewable capacity reached 40,170 MW that satisfied the 42.4% of the total electricity demand. However, renewable energy is a variable source of power and increases the operational costs of electricity systems because system operation is required to guarantee additional operational flexibility to balance fluctuations and uncertainties in renewable energies output.

The aim of this paper is beyond the analysis of the impact of renewable generation intermittency on the evolution of total economic costs associated with the operation of the electricity. We also aim to evaluate the sensitivity of these costs to other reasons such as the adjustments on real time of the electricity demand due to wrong estimations.

From a policy and regulatory perspective, the relevant question is how to improve the functioning of the adjustment services, integrated by several markets, as the resolution of technical restrictions of the system, the allocation of ancillary services and the management of deviations, without increasing its relative costs. The adjustment services in place in the majority of the electricity markets have been set up in a context without this huge penetration of renewable energies and need to be improved. An in-depth knowledge of its functioning and the role played by the different explanatory variables, with a special consideration for the demand and supply aspects, is crucial for a successful reform process.

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