Is green energy expensive? Empirical evidence from the Spanish electricity market

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(1) Overview

Renewable electricity deployment is nowadays one of the ongoing political priorities in Europe, because of its positive externalities, both environmental and socio-economic. However, there is a widespread debate concerning the economic implications of large scale renewable participation in the electricity market. On the one hand, electricity from Renewable Sources (RES-E) is supported in many forums because of the resulting reduction on the daily market price, due to the merit-order effect. On the other hand, one of the main criticisms of green generation is the excessive costs imposed on the public support scheme. In Spain, specifically, as a result of the incentive system of combined Feed-in Tariffs (FIT) and Feed-in Premiums (FIP) for the so called Special Regime (SR), which includes both renewable sources and cogeneration, the deficit of regulated activities rises every year.

In this paper we analyze the Spanish day-ahead market for the period 2008-2012 (last available data), with a twofold aim. First, we quantify the reduction of the system marginal price (SMP) of the spot market, driven by the merit-order effect of RES-E. Second, we compute the effect of the incentives on the deficit of regulated activities and, thus, on the consumer burden. We present both aggregated data for the SR as a whole and for each renewable technology separately. The methodology consists of a counterfactual approach without SR and a cost-benefit analysis. Time series of hourly prices have been simulated and the results show that the incentives received by SR generators during the analyzed period were too high compared to the reduction of the electricity price they entailed.

(2) Methods

Data. The market environment in Spain consists of a pool, as well as a floor for bilateral contracts and a forward market. Most transactions are carried out in the day-ahead market, which is the focus of our analysis. We exploit the information provided by the Spanish electricity market operator (OMIE), the regulator (CNE) and the system operator (REE). We use hourly bids of Spanish generation units for the period 2008-2012.

Model. We implement an algorithm to solve the day-ahead electricity market auction. The algorithm is able to find the amount of energy traded and the market price in equilibrium on an hourly basis:

$$\begin{cases} q(p_i) = min[q_{ask}(p_i), q_{bid}(p_i)] & [2.1] \\ q_{max}(p_m) = max[q(p_1), q(p_2), \ldots, q(p_i)] & [2.2] \end{cases}$$

where $q(p_i)$ represents the traded volume at price p_i, $q_{ask}(p_i)$ represents the aggregated volume of ask orders with prices lower or equal than p_i, $q_{bid}(p_i)$ represents the aggregated volume of bid orders with prices greater or equal than p_i, q_{max} represents the maximum tradable volume and p_m is the system marginal price (SMP). Volumes are expressed in MWh and prices in euro/MWh.

We run this algorithm twice: first for the market data and then for a counterfactual situation without SR sources. We remove SR generation in the supply curve, leaving the demand unchanged. The combination of real and simulated data allows us, first, to check that our algorithm works properly and, second, to quantify the effect of renewable sources in euro/MWh. We compute all the hourly prices for the period 2008-2012 and report annual weighted averages. We also divide the hours of the day into three different periods, according to the energy demand in each of them: low-demand, mid-demand, peak-demand, in order to see how results change with the demand.

Statistical testing. We run a test of unconditional means in order to check the significance of our results. The null hypothesis is that renewable generation is zero, so that actual market clearing prices (with and without SR generators, p^{SR}) are equal to the counterfactual prices (without SR electricity, $p^{No\ SR}$).

(3) Results

As preliminary results in Table 1 and Table 2 show, the fact that renewable energy units bid at the pool at zero prices has the effect of decreasing market prices (note that data in C are higher than in A). On the contrary, the incentives to the SR increase the cost substantially (data in B). Comparing the market savings of renewable with the costs of the incentives (A+B-C), we may conclude that after 2010 the SR was not able to pay for the premiums received, leading to an increasing deficit every year.

	2008	2009	2010	2011	2012
Market price reduction	36.35	44.67	40.42	24.87	35.91

Table 1: Market price reduction with green energy in Spain [€/MWh]. Period 2008-2012

	2008	2009	2010	2011	2012
Day-ahead market (A)	14,563	7,646	7,349	9,260	8,649
FIT/FIP system (B)	3,204	6,169	7,352	7,184	8,539
Day-ahead market without SR (C)	21,960	16,065	14,311	13,217	13,886
Deficit due to SR (A+B-C)	*-4,193*	*-2,260*	***390***	***3,227***	***3,302***

Table 2: Costs of the Special Regime in Spain [million €]. Period 2008-2012

(4) Conclusions

All in all, we conclude that the combination of feed-in tariffs and premiums has been an effective instrument in the promotion of the generation of renewable electricity in Spain. It has contributed to the take-off of green participation, leading to a significant reduction of the daily market price. However, the cost of RES-E has been extremely high to consumers and such a system may be hard to sustain in the long run. According to our preliminary results, since 2010 the price contraction due to SR has not been able to support the increase in the incentives and, as a result of this, the tariff deficit continues to rise year by year.

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