

EVOLVE OR DIE: NEW BIDDING STRATEGIES FOR COMBINED CYCLE ELECTRICITY PLANTS AFTER THE INTRODUCTION OF RENEWABLE ENERGY

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Overview

In the last years huge interest has been given to the analysis of the effect of renewable energy sources (RES) on electricity markets. All the empirical studies conclude that there is a reduction of electricity prices, due to the merit-order effect ([2], [4], [5], [8], [9], among others). However, little research has yet been done focusing on the reaction of conventional producers to such a decrease in market prices. In this sense, the question we pose is: Did non-renewable generators in Spain change their bidding strategies as a result of the increasing renewable participation in the electricity market? Depending on the answer some findings of past merit-order effect analysis could be reevaluated. On the one hand, price reductions entailed by RES could have been underestimated in previous works, if traditional sources would bid now at lower prices in order to avoid being displaced from the market by renewable units. On the contrary, price reductions could have been overestimated, if conventional sources would be bidding currently at higher prices or imposing more complex conditions, in order not to be matched, so that they could participate in adjustment markets (technical restrictions) at higher prices (otherwise they could not afford their participation, because market prices are now below their production costs).

In this paper we analyze how combined cycle bidding strategies evolved after the entrance of renewable generators in the Spanish electricity market. We focused on combined cycle plants because with such an intermittent generation in our electricity markets, the role of combined cycles is crucial in order to ensure the security of supply. However, after the massive entrance of RES in the electricity market, they experienced the most drastic reduction in the number of operating hours of all generators. According to data provided by the Spanish system operator, the utilization ratio¹ of combined cycle plants has dropped from 50.9% in 2005 to 18.8% in 2012 [7]. Additionally, combined cycle plants have experienced a shift in the schedule of their operation hours, where from the 1300 production hours in December 2012 (a very low figure according to previous behavior, 5119 hours in 2005 [6]), less than 500 were matched at the pool and most of them corresponded to the resolution of technical restrictions [3].

Methods

Combining the methodology used in [1] and [2] we constructed a synthetic supply curve for combined cycle generators and we computed the electricity spot market outcomes under different scenarios, in order to see how combined cycle producers changed their bidding behavior after the massive entrance of renewable production in the Spanish spot market.

To construct the synthetic supply curve we selected one year before RES took part actively in the market (reference year, hereinafter), and we considered different situations for years with a high share of electricity from RES (analysis years, hereinafter). We chose 2005 as the reference year because it was a stable year in regulatory terms. Similarly, we started the analysis in 2008 because it was the first whole year after the New Renewable Energy Act (RD 661/2007) entered into force, which led to higher shares of RES in the Spanish spot market. The analysis years included the period 2008-2012.

We considered three different scenarios for every analysis year. All synthetic scenarios are counterfactual situations:

- (i) Actual Scenario (actual outcomes): We run our market clearing algorithm [2] for the actual bids and we get the actual equilibrium prices. This is the benchmark to the other scenarios. We compute it for the reference year and all the analysis years.
- (ii) Synthetic Scenario 1: We take actual bids of combined cycle generators of the reference year to replace the bids of the year of analysis and we run the market clearing algorithm. We do not change the demand

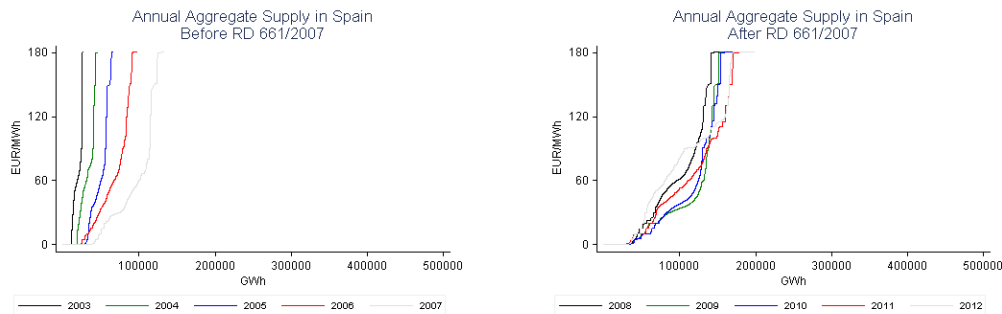
¹ The utilization ratio is the ratio between actual and maximum available production or production that the power plant could reach operating at nominal capacity during the hours in which the plant is available.

- and we take only the common generating units in both reference and analysis years. New synthetic bids add the change in gas prices from the reference to each of the analysis years.
- (iii) Synthetic Scenario 2: We take actual bids of combined cycle generators of the analysis years to replace the bids of the reference year and we run the market clearing algorithm. We do not change the demand and we take only the common generating units in both reference and analysis years. New synthetic bids add the change in gas prices from each of the analysis years to the reference year.

Results

From a qualitative standpoint, we observe a smoothening effect in the supply curves of combined cycle after the massive entrance of RES in the spot market (See Figure 1), which indicates that their bids are lower now.

Figure 1. Combined cycle annual aggregate bidding before (left) and after (right) the entrance of RES.



From a quantitative standpoint, we also conclude that combined cycle bids are now lower than before RES. We find a 6% increase in the market price including the bids of 2005 into 2012 and a 24% decrease in the market price with the bids of 2012 into 2005. The discrepancy in percentages is explained by the fact that the demand in 2005 and 2012 is different and also the elasticities. Thus, the same change in bids generates a different variation depending on the elasticity of demand.

Conclusions

The participation of RES in the Spanish electricity market not only led to a decrease in equilibrium prices, but also caused a change in combined cycle bidding strategy in the spot market. Such a decrease in prices forced combined cycle producers to change their bids, so that they could afford their production costs when they are matched in the pool. We observe that (i) combined cycle plants bid now at lower prices and that (ii) their participation in adjustment markets has increased. The question now is if the market price reductions entailed by RES are enough to pay for the increasing costs of the adjustment markets.

References

- [1] Ciarreta, A., Espinosa, M.P., 2010. Market power in the Spanish electricity auction. *Journal of Regulatory Economics* 37: 42-69.
- [2] Ciarreta, A., Espinosa, M.P. and Pizarro-Irizar, C., 2014. Is green energy expensive? Empirical evidence from the Spanish electricity market. *Energy Policy* 69: 205-215.
- [3] Comisión Nacional de Energía (CNE), 2013. Informe de supervisión del Mercado peninsular mayorista al contado de electricidad. Noviembre y Diciembre 2012 y avance Enero 2013.
- [4] Gelabert, L., Labandeira, X., Linares, P., 2011. An ex-post analysis on the effect of renewable and cogeneration on Spanish electricity prices. *Energy Econ.* 33, S59-S65.
- [5] Jónsson, T., Pinson, P., Madsen, H., 2010. On the market impact of wind energy forecasts. *Energy Econ.* 32, 313-320.
- [6] Navarro, C., 2011. Presente y futuro de las centrales de ciclo combinado. Document of the Fundación Ciudadanía y Valores.
- [7] Red Eléctrica de España (REE). Informe del sistema eléctrico español 2005-2012.
- [8] Sáenz de Miera, G., del Río González, P., Vizcaino, I., 2008. Analysing the impact of renewable electricity support schemes on power prices: the case of wind electricity in Spain. *Energy Policy* 36, 3345-3359.
- [9] Sensfuss, F., Ragwitz, M., Genoese, M., 2008. The merit order effect: a detailed analysis of the price effect of renewable electricity generation on spot market prices in Germany. *Energy Policy* 36, 3086-3094.