RELIABILITY OPTION CONTRACTS: THE EFFECT OF THE EXPLICIT PENALTY ON THE MERIT ORDER OF THE AUCTION

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Overview

Since the early times of power sector restructuring and liberalisation, the ability of electricity markets to provide enough generation to reliably meet demand has been called into question. Mistrust of whether the electricity market, left to its own devices, can efficiently provide sufficient generation when needed has gradually but inexorably led to the implementation of additional regulatory mechanisms and to the abandonment of the so-called energy-only market approach. This issue has increased in importance with the passing of time, and it is now present in the regulatory agendas of most power systems. In Europe, after several years of firm opposition to the implementation of capacity mechanisms, a general rethink is swiftly taking place, as testified for example by the consultation paper on generation adequacy and capacity mechanisms that the European Commission has launched in 2012 (EC, 2012). Due to the failure of the initial price-based capacity mechanisms (capacity payments), the trend is currently moving towards the introduction of quantity-based schemes, based on market-wide (bilateral) capacity markets or centralized long-term capacity auctions (Batlle & Rodilla, 2010).

One of these quantity-based capacity mechanisms is the reliability option contracts scheme (Vázquez et al., 2002). This scheme is based on a centralised procurement of option contracts, which limit the remuneration from the wholesale market of the generating units that sign them to a strike price. The strike price is set at a high enough level so as to define the scarcity conditions in the system. This mechanism is at the base of the Reliability Charge mechanism implemented in Colombia and the Forward Capacity Market implemented in New England. With the aim of discouraging bids not backed by reliable generation, the original proposal by Vázquez et al. added an explicit penalty to be paid by the generating units selling the options whenever they are not able to deliver under scarcity conditions. While the FCM includes a penalty of this sort, the Colombian system does not consider any explicit penalisation scheme.

In the current context in which this mechanism and similar desgins are about to be implemented in other power systems (e.g. the Italian one), the goal of this paper is to demonstrate that a properly designed penalisation scheme can properly alter the merit order of the reliability auction, causing the exit of non-firm energy blocks and the entrance of new and more reliable generation plants. This will be achieved through a simulation of the auction results based on a unit commitment problem, in which the unavailability of generating units is taken into account through a two-state Markov chain.

Methods

The bids that the agents present in the reliability auction are based on their expectation on the income from the short-term market to be returned because of signing the option contract, plus the expected penalty to be paid in case of under-delivery. In the case of new entrants, an additional term must be considered in the bid, which represents the difference between the expected short-term market remuneration and the minimum annual income required for the agents to be willing to invest, so as to allow for the recovery of their investment costs. In this study, the short-term market behaviour is modelled through a unit commitment (UC) problem and the auction is simulated assuming that the agents have perfect information on the future market results. The UC model takes into account the unavailability of generating units to properly include their contribution to the reliability of the system during scarcity conditions. The representation of unavailability is obtained through a Monte Carlo simulation based on a two-state Markov chain, which allows to take into account the expected duration of each unit outage. Through this process, an availability matrix is built, which defines for each plant and for each period (hours, in this case) whether the unit is available or not.

The consideration of unavailability in the model results in the thermal units to “fail” in the unit commitment for a certain number of hours, causing the start-up of more expensive plants and, in the cases in which the available generation is not sufficient to cover the demand, the occurrence of non-served energy, with the consequent reaching of the non-served energy price. The solution of the modified unit commitment problem provides with all the information required for the bid calculation. The scarcity conditions are identified according to the resulting spot price. Moreover, the performance of each generator during scaricity conditions is known. Finally, market results can be calculated for all the agents and this permits to define also the additional term in the bids from new entrants.

Results

The auction simulations are run for different sets of input parameters (capacities, EFOR rates, reserve margin, strike price, price cap, and explicit penalty). This allows to study the dependency of the merit order on the explicit penalty value and to analyse the impact that other factors can have on the auction results. The outcomes of the model can be presented both in tables of data or in charts showing the merit order of the auction. A sample of these charts is provided in Fig. 1, which shows the effect on the merit order of increasing the explicit penalty value (*pen*). For higher values of the penalty, new and more reliable plant (new CCGT) displaces non-firm (less reliable) fuel-oil unit (the unit in lighter blue is not selected in the auction).

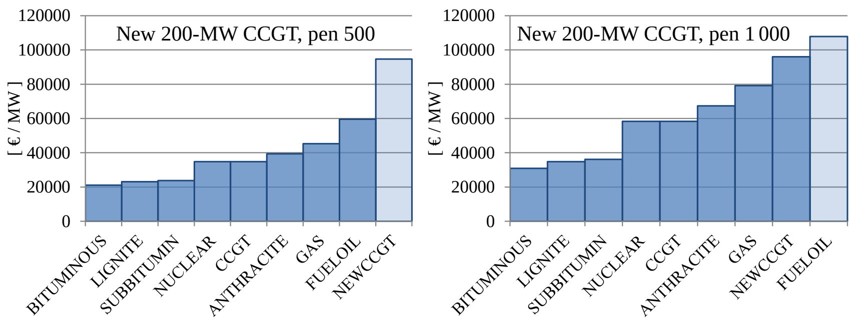

Fig. 1. Effect of the explicit penalty on the merit order in the case of new entrants

Conclusions

The results obtained from this model illustrate how the explicit penalty, can alter the merit order of the tender, causing the exit of non-firm energy blocks and the entrance of new and more reliable generation plants. The influence of the penalty can be illustrated as in Fig. 2.

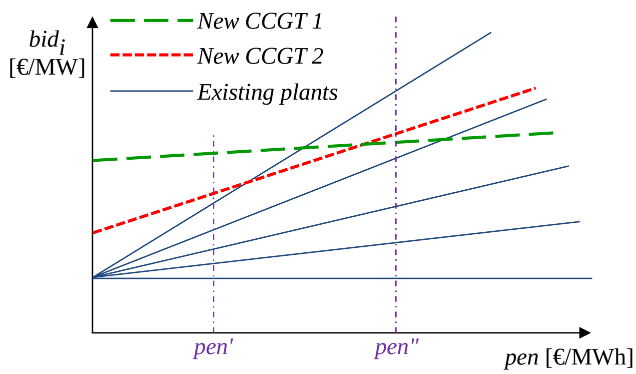

Fig. 2. Representation of bids from existing and new plants in a bid - pen chart

In this *bid-pen(alty)* chart, the bids from existing generators are represented by a family of straight lines, leaving from the same intercept (the option value) and having different slopes (determined by what we term as the under-delivery factor). The bids for two new entrants are represented by the dashed lines. An increase in the explicit penalty can widen or narrow the gap between the bids from existing plants, but it cannot affect the merit order among existing plants, as their capital costs are sunk. Nonetheless, the penalty value can alter the position in the merit order of new plants. When the value of the explicit penalty is *pen'*, the bids from new entrants are still too high to compete with those from existing generators. However, in the case of *pen"*, some existing plants are displaced.

The results from the model illustrate the key role that the explicit penalty can play in the overall impact of the capacity mechanism on the generation mix. Therefore, it is argued that the introduction of a penalisation scheme it is essential to drive the auction outcomes towards the original objectives of the mechanism, i.e. not only to increase the adequacy of the system but also the global firmness of the generation mix.

References

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