THE NEW ITALIAN CAPACITY REMUNERATION MECHANISM. A DETERMINISTIC MODELING AND SIMULATION APPROACH

Michele Dalena, Corresponding author, REF-E Economics Engineering Energy Environment,
Via Gioberti 5 - 20133 Milan (Italy), Phone: +39 0243441034,
Fax: +39 0243441027, E-mail: michele.dalena@ref-e.com
Virginia Canazza, REF-E Economics Engineering Energy Environment
Giorgio Perico, REF-E Economics Engineering Energy Environment

Overview

Over the last few years, the high development of subsidized intermittent renewable generation associated with the lasting stagnation in electricity consumption has displaced many existing conventional power plants which were previously operating on the Italian wholesale electricity market. These power plants are consequently no longer able to cover their capital and fixed costs and started considering divestment or mothballing plans, which might result not only in short-term system flexibility issues, but also in long-term generation adequacy problems. In order to prevent these problems, the Italian energy regulator has thus decided to introduce a new market-based capacity remuneration mechanism in the form of a capacity market, which will replace the current regulated capacity payment for generation adequacy and will be based on a reliability options system.

Capacity remuneration mechanisms including capacity market have recently received renewed attention in the theoretical literature, but very few attempts have been made to model and simulate them from an empirical standpoint. Particularly, according to the best knowledge of the authors, the current empirical literature on wholesale electricity markets does not include any modelling and simulation attempt of the new Italian capacity market for generation adequacy. The aim of this paper is therefore to fill this gap by modelling and simulating the new Italian capacity market for generation adequacy in a predetermined market scenario for the capacity delivery years 2018-2020. As a matter of fact, the results of this simulation exercise and the related sensitivity analysis could prove of considerable importance not only for Italian wholesale electricity market players' which will have to calibrate their participation strategies in the energy and ancillary services markets and define their business plans, but also for the Italian energy regulator end even Italian and European policymakers as many of the parameters of the mechanism have yet to be established.

Methods

The functioning of the new Italian capacity market for generation adequacy has been modelled and simulated by explicitly building both the TSO's capacity demand curves and the market players' capacity supply curves, after fixing an expected market scenario in the capacity delivery years. In order to do this, REF-E's proprietary model ELFO++ has been used, which is a deterministic model whose output is the optimal dispatching (in terms of total system costs) of the hydro-thermal generation fleet on the Italian energy markets (both Day-Ahead and Intraday Market), given not only the expected electricity demand and the expected intermittent renewable generation with priority dispatch, but also transmission network constraints and market players' bidding strategies.

More specifically, the TSO's capacity demand curves are built in such a way that for each level of capacity the TSO minimizes Italian power system's overall costs, defined as the sum of both electricity production costs on energy markets and capacity remuneration costs on the capacity market. Electricity production costs on energy markets are then estimated through a series of simulations of the hydro-thermal generation fleet's optimal dispatching on these markets, starting from the current level of the hydro-thermal installed capacity and progressively reducing this capacity based on its economic merit order, that is from more expensive power plants to less expensive ones. Capacity remuneration costs on the capacity market instead depend on the yearly capacity premium awarded to the different levels of contracted capacity and are then expressed by a sheaf of straight lines whose slope is the awarded yearly capacity premium.

Market players' capacity supply curves are built based on their expected economic results in the capacity delivery years, assuming that a capacity market is introduced in the Italian wholesale electricity market design. In order to calculate market players' expected economic results, firstly an Elfo++ simulation is carried out of the hydro-thermal generation fleet's optimal dispatching on energy markets in the capacity delivery years, assuming that the introduction of the capacity market does not impact on energy markets' competition but only on energy and ancillary services prices due to reliability options' strike prices. Secondly, the resulting market players' expected margins over their variable costs on energy and ancillary services markets are taken into account to set their offers in the capacity market auctions. In this respect, two opposite approaches can be used to set market players' offers in the capacity market auctions, in order to illustrate the possible strategies which they might adopt depending on several factors (for instance technology mix, geographical mix, business chain diversification and size): the full coverage of fixed operative cost approach and the equal overall remuneration approach.

The equilibrium in the Italian capacity market for generation adequacy is therefore determined from the intersection between the TSO's capacity demand curve and market players' capacity supply curve.

Results

The capacity demand curve estimated for the Italian system is highly inelastic, mainly as a result of the very high value of the VOLL (Value of Lost Load), which is used to valorize the energy not injected into the grid to meet the load. Accordingly, for the TSO it would be almost always preferable to buy 1 MW of additional generation capacity to be able to cover the load, compared to bearing the VOLL for the production that would not be guaranteed. For this reason, the capacity demand curve is nearly vertical, considering a premium range between 0 and 100,000 €/MW/year, and it sets a level of "adequacy capacity" that is around two-thirds of the generation capacity that is expected to participate in the auctions. On the other hand, the capacity supply curve shows a very high degree of competition, with a first very large horizontal segment. In fact, a high share of generation capacity is expected to behave as "price-taker" in the capacity auctions. The "price-taking" capacity consists of not only the stochastic estimates of the demand-response and the interconnections' contribution to generation adequacy, that will be included in the capacity supply curve at zero price, but also of some coal power plants, CHPs and other thermal power plants which are able to cover their fixed operational costs on energy and ancillary services markets, due to their lower costs or other peculiarities (higher efficiency, flexibility characteristics, position on the transmission grid). After this first horizontal segment, the capacity supply curve assumes a stepwise shape, in which different levels of operational costs are identifiable for the different generation technologies.

The capacity demand curve crosses the capacity supply curve in the portion consisting in CCGT power plants, which will probably be the marginal technology in the capacity auctions. This means that not all the CCGT generation capacity is needed by the system for generation adequacy purposes. In fact, about half of that capacity could be rejected in the auctions, even if the newest and most efficient power plants are considered.

Regarding market player's bidding strategies, if the capacity premium they bid reflects exactly their fixed operational costs, the yearly equilibrium premium set in the capacity auctions is expected to stand around the avoidable operating costs of gas-fired power plants. But considering the high level of overcapacity existing in the Italian power system, a very high risk of discount of the bid yealy capacity premium can be observed. In fact, market players that expect to be rejected in the capacity auctions can make a more competitive bid, by reducing the bid yearly capacity premium up to a maximum level of discount that is just enough to cover the lost margins in the energy and ancillary services markets, due to reliability options' strike prices. In this case, the equilibrium premium may fall towards very low levels with the serious risk to be useless to cover power plants' fixed operational costs.

Conclusion

The simulation of the new Italian capacity market for generation adequacy shows a very high level of overcapacity in the Italian system, also in the mid-term. The mechanism is not needed to incentivize new investments in generation capacity, but to give a correct size to the generation fleet and help market players covering their fixed operational costs that are not obtainable on energy and ancillary services markets.

Moreover, the current design of the capacity market presents two main risks, one for market players who will participate in the auctions and one for the system itself. First, the premium to be paid to contracted capacity can be very volatile, due to the high level of competition in the auctions, and can fall down to very low levels. In this case, the new Italian capacity market for generation adequacy would not guarantee that market players' costs are totally covered. Secondly, if a "flexible segment" is not implemented in the new Italian capacity market for generation adequacy, the auctions could result in contracting only old and baseload generation capacity, while rejecting the most flexible one which can be useful for also flexibility purposes. In this case, system costs could increase instead of being reduced and for this it could be useful.

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