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Capacity Markets: Prices vs. Quantities

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Energy Regulation Insights

From the Editor

Economists know full well the advantages of competitive, efficient markets. They also know that relying on them may be unsustainable. Politicians and regulators seem to dislike electricity markets that encourage investment by giving generators high prices and high profits at precisely those times when they are providing too little capacity. The prospect of regulators intervening in electricity markets at such times does not encourage an efficient outcome. Capacity markets may be not perfect, but they only have to be better than the alternative.

In this Energy Regulation Insight, Jonanthan Falk, one of NERA's longest standing experts in electricity markets, discusses two different designs for a capacity market. In doing so, he observes that there is no obvious preference for setting prices or setting quantities. Only detailed understanding of economic risks and incentives explain the choices that designers make.

Graham Shuttleworth, Editor

Background

Economists are more liable to trust markets, and theorems about markets, than are politicians and regulators. Despite theorems that demonstrate that an energy-only market is perfectly capable of providing reliable electric service, few electric markets—outside of Europe[1]—depend on high energy prices alone to serve as the only spur to the increase in supply.[2] Even granting the theorems, many argue that payments to provide electric capacity are needed to smooth the volatility of energy markets.

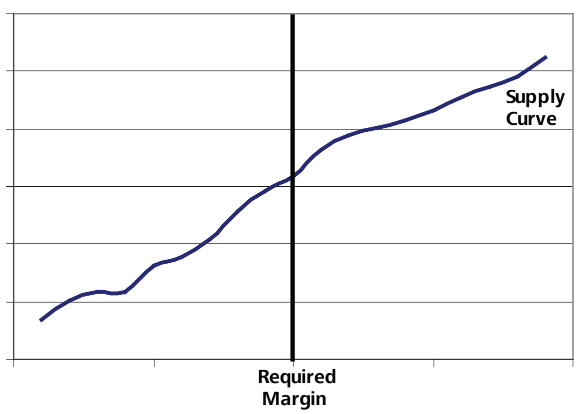
But this doesn't mean that capacity expansion can't itself be embedded in a separate market. In the eastern US, ISO-NE (covering the New England states) and the NYISO (covering New York) have each set up markets to make payments to generators who commit to supply reliability. This paper contrasts the two methods the markets employ. The two methods highlight a distinction first explored in a classic economics article[3] by Professor Martin Weitzman of MIT from 1976; the distinction between setting prices (letting quantities vary) and setting quantities (letting prices vary). The differences between these two approaches will be instructive for decision-makers around the world who are wondering how to create reliable incentives for new investment and to promote security of supply, while adhering to market principles. Rethinking investment incentives is an urgent task in many jurisdictions owing to the need to replace old thermal plants with new ones that are both cleaner and more flexible (to complement a surge in intermittent renewable supplies). However, the economists' basic theorems, by themselves, give very little direct guidance on market design and the archetypal capacity markets embody considerations which the simple theoretical expositions inevitably miss. Only a detailed understanding of the economic risks and incentives within a regulatory and institutional context can explain the designs that were actually chosen.[4]

Efficient market design depends on detailed understanding of economic risks and incentives, not just on theorems

The ISO-NE Market: Regulate Quantity[5]

The ISO-NE capacity market starts with an administrative determination of the capacity required to give an adequate level of reliability. At that point, an auctioneer runs a descending-clock auction in which the price to be paid for each unit of capacity falls until the supply offered by existing and new units equals the required capacity.[6] In essence, the auctioneer has a vertical demand curve like the one in Figure 1. The auction process then finds the lowest bid that just exactly garners the amount of capacity needed from new and existing units and the system operator pays all generators selected that market-clearing price.

Figure 1 Auction Mechanism with a Fixed Quantity as the Demand



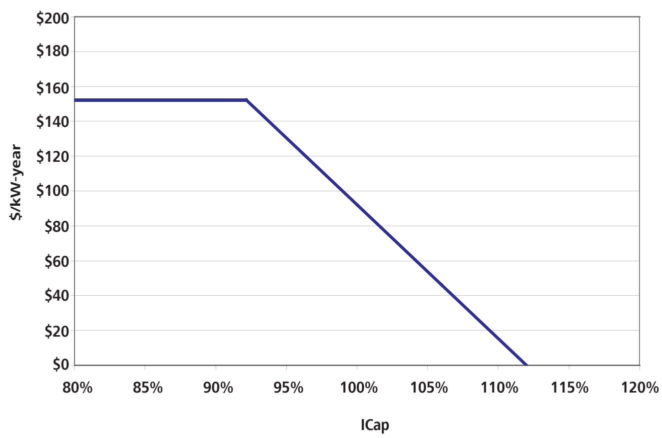
The implementation of this simple idea is somewhat more complex. Neither existing units nor new units have the freedom to bid whatever they want, for reasons related to the potential exercise of market power by buyers and sellers. Existing units, unless they wish to retire, have constraints on how high a price they can demand to withdraw from the capacity market. New units (which include any upgrades of existing units) have their bids screened by the market monitor to ensure that they are not, in effect, proxy bids placed by buyers to reduce the market price. In addition, there are caps and floors to avoid rapid price changes.

In essence, though, the ISO-NE capacity market works on the principle of defining a pure quantity: the market will purchase a given amount of reliability, and the price will be whatever is required to clear the market.

The NYISO Market: Regulate Price[7]

The NYISO's capacity market operates on a different principle: it specifies a demand curve, i.e., a price that all suppliers will be paid based on an aggregate amount of capacity. This demand curve is created administratively. The 2010 demand curve for the upstate region of New York is depicted in Figure 2.

Figure 2 Auction Mechanism with a Demand that Depends on Price



The horizontal axis gives installed capacity (ICap) as a fraction of an administratively determined requirement, while the vertical axis gives a payment in US$/kW-year. This demand curve has three regions: (a) a horizontal section above 12 percent excess capacity with a payment of zero; (b) a horizontal section for all capacity shortages of 8 percent or more with a maximum price (in this case around US$153/kW-year); and (c) a linear descending section connecting the two horizontal sections.

This demand curve is meant to account for three stylized facts: (a) above some level, additional capacity has no reliability value; (b) when the system is short enough, energy prices should be sending such strong signals that additional payments are unnecessary to incentivize supply; and (c) in equilibrium, the return to someone adding capacity ought to be around the "Cost Of New Entry" (CONE), which is defined to be net of expected earnings from the energy market. The process which determines the specific parameters thus turns on an administrative determination of CONE, a slope, and a minimal level of excess for the linear portion of the curve.

As in the ISO-NE market, there are a number of details that complicate the actual operation of the market. But this structure is the basic idea: the ISO determines a price and suppliers choose how much supply to offer.

Prices vs Quantities

In a classic article, Martin Weitzman of MIT answered an important question: in a world of uncertainty under centralized procurement, is it better to pick the quantity you want - leaving maximal uncertainty about the price you will pay to get that quantity - or is it better to pick the price you are willing to pay and be uncertain whether you get more or less than you need? The quantity strategy corresponds to the ISO-NE method of specifying a capacity level, while the NYISO method is a modified version of a price strategy.

The Weitzman result turns out to depend on the relative slopes of the marginal cost and marginal benefit functions around the region where they cross as well as the level of uncertainty about them. Suppose the marginal cost curve is very flat – then setting price is a very bad idea, since at any given level of price one could easily get way too much or way too little response. If the marginal benefit curve is very flat, then setting a quantity is a bad idea, since one could often achieve the same benefits for much less cost by reducing the required quantity.

In electric reliability, we know the marginal benefit curve is very steep as we approach blackout conditions: the cost of producing the most expensive power is orders of magnitude lower than the costs imposed on consumers who shed load. However, at reasonable levels of surplus capacity, the marginal benefit curve flattens out very quickly and is almost flat for substantial levels of surplus. Extra generating equipment conveys almost no advantage at all.

The marginal cost of capacity is broadly equal for existing generators (since the marginal costs consist largely of fixed operating and maintenance costs net of expected energy revenues)[8] but curves up sharply as new units are needed. Since the number of new units needed is usually quite small (usually only one or two units per year) the generation sector is also operating very close to a sharp rise in the marginal cost of capacity. A further complication is the difficulty of observing or estimating marginal costs of capacity. NERA has been involved in a number of contentious cases around the world about the level of CONE. Estimating CONE requires the choice of a technology, a series of hypotheticals about the costs of constructing new capacity, the net energy revenues that each type of new capacity would earn, and the rates of return required to encourage investors to sink capital into long-lived assets.

Applying Weitzman's findings has proven to be very difficult, since both curves show extreme curvature right around the optimal point at which marginal benefit equals marginal cost. And, not surprisingly, this venerable economic criterion has not been employed in either market to help determine structure.

So What Determines Capacity Market Structure?

In New England, the ISO was operating under a set of principles which made it willing to act *as if* the marginal benefit curve was a vertical line at the administratively determined margin, even though they knew that benefits were almost as high for slightly less capacity or slightly more. The designers therefore adopted an administrative simplification, to fix the marginal benefit curve, which then made an auction the best way to choose what to pay capacity, in the spirit of Weitzman.

New York was more realistic as to the shape of the marginal benefit curve, but sufficiently uncertain about its exact shape, and sufficiently worried about variations in the cost of new entry to adopt a different design. Reluctant to make the marginal benefit curve much flatter than in reality, the designers in New York created a capacity mechanism much closer to a price-regulated system than to a quantity-regulated system.

The benefit of adopting one system or the other cannot be measured in the short run, however. The success of the New York system will be measured by whether or not capacity settles into an area reasonably close to the required margin: in its initial years, the resultant capacity – for reasons that are arguably not linked to the capacity market – has seen quite a bit more capacity than the administratively determined required margin.

By contrast, the problem in New England, thus far, has been prices far below anyone's notion of the cost of new entry, partly due to the surprising success of demand-side bidders in the market and partly due to the recession. The test for

New England will be whether prices can adjust fast enough (and stably enough) to induce construction when substantial amounts of new capacity are needed.

Conclusion

The creation of real markets in the real world is not a theoretical exercise, and there may be a wide set of market forms that fulfill the basic goal of providing enough capacity. That said, there are also numerous ways in which such markets can go wrong. Good market design depends on understanding the uncertainties and risks inherent in each mechanism and assessing how best to manage them – not in theory, but in a real, administered system. It is chiefly in this area that recognition of the fundamental underlying economic principles helps to create efficient capacity adequacy schemes, and efficient markets in general.

EndNotes

1 All but a few European markets are energy-only, the exceptions being Ireland, Spain, and Greece, although they may soon be joined by the UK.

2 Australia is one of the well-known exceptions.

3 "Prices vs. Quantities", *The Review of Economic Studies*, Vol. 41, No. 4, October 1974, pp. 477-491.

4 This paper discusses the purchase of capacity to fulfill reliability requirements. Transmission system constraints, especially across broad regions, mean that all capacity is not necessarily interchangeable for reliability purposes. Various accommodations are made for this phenomenon in US markets, which will not be discussed here. PJM, for examples, defines 23 separate Local Deliverability Areas (LDAs), which form additional constraints on the exact manner in which capacity counts toward reliability requirements. New York currently has three zones and is considering a fourth. New England currently has two. To simplify this presentation, we assume all capacity has been denominated in units which reflect the addition of capacity to reliability in the region in which it wishes to offer reliability services.

5 The Greek market uses a quantity-based approach.

6 The rules are actually considerably more complicated than this, with a series of rounds, each constrained by caps and floors on how much the price can move and varying constraints on when particular units are allowed to drop out of the bidding. These details (and the fact that there are simultaneous clearings of geographically dispersed markets) are ignored here for simplicity.

7 The Irish and Spanish markets use price-based approaches.

8 The marginal cost of capacity is broadly equal, unlike the marginal cost of generating energy, which mainly depends on fuel costs and is measured in US$/MWh.

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