WHY WILL CAPACITY MARKETS NEVER ACHIEVE EQUILIBRIUM LEVELS OF SUPPLY?

Victor Chung, London Economics International LLC, +1-617-933-7200, victor@londoneconomics.com
Julia Frayer, London Economics International LLC, +1-617-413-8628, julia@londoneconomics.com

Overview

The paper will examine why electricity markets with capacity mechanisms have not been able to achieve equilibrium levels of supply as theoretically intended by the design and use of resource adequacy targets. The focus of the paper is on retirements (or the lack of retirements) of existing power plants in electricity markets with capacity mechanisms. The paper will explore the idea and present evidence that the primary issue preventing capacity markets from reaching equilibrium levels is the embedded real options value for power plant owners, which capacity markets have not been designed to handle properly. Why do we care about this particular failure of capacity markets? Simply put, the energy transition is challenging the traditional sources of revenue (and stability thereof) for existing generators. As more intermittent resources are deployed, whose operations depend on weather conditions and not on price-based dispatch, the ability of existing resource adequacy constructs in energy markets to meet their objectives will be reduced. A reinvigorated interest in "capacity markets" has emerged and is likely to build. Therefore, it is important to understand the limitations of capacity market mechanisms. Regulators and market designers have long recognized that variable costs are best assigned to variable rates and fixed costs are best recovered through fixed or demand-based charges. As such, when market designers thought about the application of these same concepts to deregulated competitive market designs, energy markets were created to recoup variable costs while capacity mechanisms, like demand-based tariffs from the cost-of-service playbook, were put in place to remunerate for fixed costs. But in the real world, that distinction between variable and fixed costs is not so simple. Fixed costs may be viewed as variable when the timeframe being considered is long enough – this is the case for capacity mechanisms, where decisions are generally made on an annual basis but are made for multi-year forward outcomes. There are also considerations including competition between incumbents and new investors, and uncertainties in the market design and costs. These factors, among others, create conditions that are not aligned with economic theory. This paper will explore why economic theory will not play out as expected in a real-world setting in relation to capacity markets. Specifically, we will show that a smaller quantity of power plant retirements has occurred in various capacity markets around the world – less than the amount suggested by economic theory of the firm. This outcome has implications for the expected equilibrium in capacity mechanisms, and most importantly, has consequences for new investments.

Methods

The paper will begin by describing what a "capacity market" is. It is in fact not a true economic market, but a mechanism where certain competitive dynamics are simulated, usually without the benefit of a two-sided market. The historical legacy for capacity mechanisms is grounded in cost-of-service rate design and the concepts of variable and fixed costs. The capacity mechanism concept dates to the early days of wholesale electricity market experimentation to remunerate power plant owners for fixed costs (as it was assumed that a competitive energy market would not be able to fully fund the fixed costs for all units, based on the premise that perfect competition in the energy markets would only lead to short run marginal cost recovery for the marginal unit). A key feature of capacity mechanisms is that they would enforce a surplus amount of operable capacity in excess of the forecasted peak energy needs of the system, in order to prevent loss of load when some resources suffer outages (and there is insufficient supply) or when the realized peak demand exceeds the forecasted peak demand (and there is insufficient supply to meet the higher realized peak demand).

Over the years, capacity mechanisms have evolved – forward-looking elements have been added, and more complex auction principles have been employed (such as a multi-round, descending clock auction); demand curve features and resource qualification and performance requirements have also been incorporated. Many changes were introduced in order to improve the investment signal. But the rules have generally not advanced as it pertains to motivating the retirement of incumbents, with exceptions such as the Competitive Auctions with Sponsored Policy Resources (CASPR) mechanism introduced in the ISO New England market in the US (although this addition has

had very limited success to date). The paper will provide an overview of different types of capacity market mechanisms that exist across the world's deregulated electricity markets and how their retirement signals vary.

Next, the paper will examine the application of real options theory to electricity markets. First, we observe that electricity markets are inherently uncertain – in other words, suppliers are not sure about the future (value of information). We also observe from the historical capacity mechanism results in the US that generation retirements are sometimes delayed or deferred – despite low capacity clearing prices. We will conduct a profit analysis to show that capacity clearing prices are not remunerating power plant owners with a return on capital for existing resources, and in some cases are not covering estimated debt and taxes. Despite these financial outcomes, generation owners are not making the decision to retire their assets. In other words, the amount of power plant retirements in electricity markets with capacity mechanisms is lower than the theoretical expectation. This results in capacity clearing prices that are lower than the intended market equilibrium levels. This observation suggests that generation owners place an additional value to these power plants above their expected profits from energy markets and capacity mechanisms – a real options value. In the context of real options theory, a retirement decision would mean that the real option is no longer valuable. When the real option has a zero value, the expected future conditions are so overwhelmingly negative for the capacity resource (e.g., known capex needs far exceed any range of future revenues). Game theory also comes into play too: expected revenues for capacity resource owners are interdependent with the decision of other resource owners, and the lumpy nature of power plants results in price-making instead of price-taking market dynamics. In this way, we see a bit of brinkmanship – if I wait and delay my power plant's retirement, maybe my competitor will retire and increase my capacity mechanism revenues. Through analysis of actual capacity market outcomes and announced retirements, we will present data to support this theory.

Results

It is a well-known phenomenon that deregulated electricity markets with capacity mechanisms tend to be oversupplied, whereby the actual capacity available in the market is higher than the reserve requirement used by the market designer to setup the capacity mechanism – even as new resources commit (because of expected economic advantages and other drivers), existing resources exhibit a tendency to delay retirement. We observe that retirement decisions are typically made once some information uncertainty has been resolved (e.g., due to environmental rules, for which compliance is costly, or when life extension costs increase due to mechanical failures, or when going forward operating costs become prohibitively high). In other words, retirement decisions occur when the real options value dissipates. By cataloguing trends in power plant retirements in jurisdictions with capacity markets, we will present evidence of real options value. As part of the findings, we will then consider what the presence of real options value means for ISOs, system planners, and generation owners. For example, if current capacity market philosophies result in oversupply, then we are not achieving the equilibrium level of resource adequacy that the market is targeting. As a consequence of conventional capacity markets' inability to reach the equilibrium, is there a cost to society? Who does it effect?

Conclusions

Based on the track record from electricity markets around the world, capacity mechanisms tend to result in oversupplied conditions. One of the reasons for this is because the market design does not consider how resource owners price the real options value of their facilities. Capacity market design may need to evolve – either in terms of more sophisticated determination of resource adequacy and procurement targets, or in terms of remuneration – in order to reach equilibrium levels of supply. We will consider the pros and cons of lowering target reserve margins to reflect the predisposition of oversupply. We will also consider the efficacy of changing market rules around retirement decisions to reduce the lost opportunity for retiring assets and to speed up the process of convergence to the optimal level of resource adequacy. The benefits are not limited to existing asset owners. A faster convergence of the market to equilibrium may also reduce costs for new entrants, by diminishing the risk profile for new entry from suppressed capacity prices due to deferred retirements.

References

Cramton, Peter, and Steven Stoft. "A Capacity Market that Makes Sense." *The Electricity Journal* 18.7 (August-September 2005): 43-54.

Joskow, Paul L. "Capacity payments in imperfect electricity markets: Need and design." *Utilities Policy* 16.3 (September 2008): 159-170.

Kaszynski, Przemyslaw et al. Capacity Market and (the Lack of) New Investments: Evidence from Poland. Energies 14.23 (2021): 7843.