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Thank you for inviting me to participate in this technical conference on the design of capacity markets. My analysis of the issues surrounding capacity market design starts from a context of the importance of increasing the integration of wholesale and retail markets in electric power. The situation in which we find ourselves is the desire to achieve a robust, reliable network during and after the transition toward integrated, competitive wholesale and retail markets. In that transition, we face:

- Concerns about long-term reliability and the investment to provide reliability;
- A perceived need for a centralized resource adequacy planning process;
- Immature integrated physical and financial wholesale markets;
- Immature demand-side participation in both wholesale and retail parts of the value chain; and
- Reluctance to allow wholesale energy spot price fluctuations to signal investment opportunities to entrepreneurs.

Consider the question of reliability, which is an intertemporal supply/demand coordination problem. The basic question is how to facilitate optimal future consumption and resource allocation. In addressing this challenge, our toolkit essentially consists of four tools: more generation, more transmission, less demand, and technological change that could affect any or all of the other three tools. No one knows the optimal combination of those four tools, and that combination is likely to be very local depending on the existing resource portfolio, customer characteristics, and so on. A capacity market construct with locational product definition is frequently discussed as a way to use price signals to induce investment in generation. A capacity market is one way to deal with the regulatory distortion imposed by price caps, but in many ways it is inferior to integrated forward energy markets.

If you were to model this problem, you would weigh the costs and benefits of each resource over time against each other, then pick the net value-maximizing portfolio of resources. The information requirements to make that decision in a centralized manner are large, as the knowledge required to discover the optimal resource portfolio is diffuse, distributed among the market participants, customers, and entrepreneurs who are the agents in the electric power network. The best way to access, aggregate, and get action on that distributed knowledge is to use market processes to determine the resource portfolio. But there is a twist – the intertemporal nature of the problem, and the time that some resources take to build, mean that the market in question has to be a market with delivery commitment in the future. That means integrated spot and forward energy markets.

I see the target design as a market process in which generation, transmission, demand, and new technology can all participate in producing electric power (or its equivalent in demand reduction), in which a consummated forward transaction commits the agents in the transaction to meet the agreed obligation by the date specified in the contract. Note that this is a decentralized contractual approach to the resource adequacy question, not a centralized regulatory approach.

The crucial demand side agents are the ones who will value the future delivery of the capacity resources. This is where property rights definitions become important – which agents have the legal liability in the event of a reliability failure due to insufficient resources? Here the insights of the economist Ronald Coase become valuable; the market rules should minimize transaction costs and assign legal liability clearly to the least-cost avoiders of the harm. In this transaction, that agent is the load-serving entity (LSE). In a forward market for future capacity, whether a capacity market or an energy market, LSEs should be the demand side of the market, and the clarity of the property right definition would provide them with appropriate intertemporal incentives to procure forward commitments to meet their anticipated forward obligations. My reading of PJM’s proposal suggests that they perceive the importance of this point.

The important market design elements should be clear from this discussion:

- A double-sided market in which the transaction is the capacity to deliver an additional MW in X years

- LSEs on the demand side with clear property rights and legal definitions of obligations
- Generation, transmission, demand reduction, and new technology resources all free to participate on the supply side
- Transparent market rules governing the submission of bids and offers and determining the market clearing price

This transaction, like many other similar transactions in other infrastructure industries, can occur through existing financial markets, if property rights are well defined, transaction costs are low, and regulatory barriers to the equivalent participation of generation, transmission, demand reduction, and new technologies are low.

However, these three assumptions do not currently hold. So ISOs/RTOs use capacity markets instead of clarifying property rights definition, reducing transaction costs in existing financial markets, and reducing regulatory barriers to the equivalent participation of all resources in markets. Many of these decisions do not fall within the jurisdiction of ISOs/RTOs. So capacity markets have artificial demand curves and do not treat all four types of resources equivalently.

If this analysis is correct, then capacity markets may be a valuable short-run mechanism while demand-side participation develops, property rights clarify, and forward energy markets evolve that will take on their proper role of providing intertemporal resource allocation signals. If that is the case, however, the design of that capacity market is crucial. First, the capacity market design must treat generation, transmission, demand reduction and new technologies equivalently. For example, PJM's 4-year timeframe may not enable transmission resources to offer into the market. One alternative may be to allow sellers to submit two-dimensional offers ($,t). Second, the capacity market must be allowed to evolve, dare I say atrophy, as integrated spot and forward financial markets evolve. Enshrining a capacity market for all time does not contribute to a resilient, agile, flexible network or set of markets. Imagine if 1850s law had dictated the existence in perpetuity of a capacity market for the production of whale oil. We do a very bad job in this industry of letting dinosaurs go extinct, but the extinction of the capacity market construct as integrated financial markets evolve is one key to industry robustness and adaptability. One way to operationalize the reduction of the capacity market is to establish transparent rules for its decreased use as the volume of forward commitments in financial markets approaches the desired reserve margin.

If a capacity market is to serve as a constructive bridge to integrated competitive markets it must also be tested carefully. My natural inclination is to recommend experimental testing of market designs and changes to them. Experimental economics uses a laboratory environment and profit-motivated human participants who get to keep what they earn to test-bed market designs. Such testing complements system-level simulations that are common in the industry by generating knowledge about how real humans with profit incentives will behave in the proposed market environment. Experimental testing can catch design flaws and allow correction before the market is implemented.

At a meeting in April, 2005 at PJM, a group of economists discussed potential experiments to test-bed the PJM RPM capacity construct. Each experiment has one environment variable and one institution variable. Changing each of those two variables gives us four treatments per experiment, and we can quantify the magnitude of the effect of changes in both the environment variable and the institution variable. Each experiment we will have a 2x2 square set of environment-institution treatments.

Some experimental designs discussed include

- Institution: vertical demand curve vs. RPM demand curve; Environment: contingency (input constraint, load pocket, unanticipated outage) vs. no contingency
- Institution: RPM demand curve vs. LSE demand curve bidding into double-sided market; Environment: contingency (input constraint, load pocket, unanticipated outage) vs. no contingency
- Institution: vertical demand curve vs. RPM demand curve; Environment: unilateral market power in capacity market vs. no market power
- Institution: RPM demand curve vs. LSE demand curve bidding into double-sided market; Environment: unilateral market power in capacity market vs. no market power

Such experiments could enable the investigation of the effects of the institution and the environment in each case on such variables of interest as

- Investment in new capacity
- Retirement of less efficient capacity
- Long-term energy prices

Thus I conclude that the ISO/RTO capacity market policy should include

- Equivalent participation of generation, transmission, demand, and new technology resources in such a market
- Transparent rules for the capacity market's retirement when it is no longer needed
- Working diligently to decrease the transaction costs hampering the development of integrated spot and forward markets for electricity products. The challenge will be liquidity, particularly in the out years. Also, electricity is not perfectly intertemporally substitutable, so finding a benchmark financial market or transaction for the development of forward markets may prove difficult. But it has been done, in places like Australia.
- Clarifying property rights, particularly legal rights and obligations attending to capacity transactions
- Using a model of resiliency and agility for reliability, not a static concept of "iron in the ground" plus planning to a specific reserve margin
- Extensive testing, preferably using experimental economic methodology

Forward markets are the key to a resilient and agile industry and provide the clearest price signals to investors. Forward energy markets are superior to generator-specific capacity markets precisely because they provide the lowest-cost means of transmitting intertemporal opportunity cost information to parties with the widest variety of possible ways to respond. If a capacity market is necessary to get us there, it has to be thoughtfully designed, carefully tested, and allowed to retire.