



Ancillary Services Market Enhancements White Paper

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Summary

This white paper describes the proposed ancillary services markets project,¹ including the details of its design and content, the rationale used to develop that design, and an overview of the implementation process. The term ancillary services markets project replaces the term “co-optimized reserves” because of changes to the reserves market design and to reflect the proposed improvements to the regulation market.

ISO-NE has been working on improving its ancillary service markets since the implementation of SMD on March 1, 2003. Two major enhancements were made in 2003. First a “shortage pricing” mechanism was introduced in July 2003. Second, a forward reserves market was introduced in November 2003.

Objectives

The Ancillary Services Markets Project will continue improving the wholesale electricity market through achieving the following objectives:

- Improving the dispatch software by jointly optimizing the use and assignment of capacity in the real time market to meet the energy and reserve requirements of the system. This joint optimization will improve pricing and dispatch during shortage conditions by enabling the dispatch software to price dispatch actions (including opportunity costs) needed to meet system reliability requirements.
- Improving pricing in reserve shortage conditions through implementation of Reserve Constraint Penalty Factors (RCPF) (similar to a demand curve for operating reserves). The RCVPF will put a value on the decrease in reliability created by a reserve shortage thereby improving the efficiency of the energy price signal.
- Create Ancillary Service and Energy Markets that:
 - Reflect the value of reserves by location in New England.
 - Reflect the unit commitment and out of merit dispatch costs incurred to provide reserves.
 - Provide price signals to encourage new investment in reserves.
 - Improve the regulation market by recognizing the amount of regulation provided by a unit as ordered by the FERC.
 - Enable demand to participate directly in the real time energy market and in the forward and real time reserve market.
 - Enable external transactions to set nodal prices
 - Enable generators to submit multiple response rates for their units.

¹ The project also includes some small improvements to the energy market.
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Background

In the development of SMD, it was recognized that SMD did not include any reserve markets. Since New England needs additional peaking resources and the implementation of co-optimized reserves markets would require at least two years, the ISO committed to implementing a “Quick Start” Auction as soon as possible after SMD. The ISO met this commitment with the implementation the Forward Reserve Market in the fall of 2003.

Prior to the implementation of the Forward Reserves Market, the ISO’s initial vision of long-term reserve markets was a co-optimized multi-settlement market structure with day ahead and real time markets for the three reserve products needed by the ISO 10 Minute Spinning Reserve (TMSR), 10 Minute Non-Spinning Reserve (TMNSR), and 30 Minute Operating Reserves (TMOR). The introduction of the forward reserve market and the need to integrate it with the day ahead and/or real time market resulted in the ISO revisiting the assumption of a co-optimized, multi-settlement reserve market design. During this time, initial planning had started on the co-optimized reserve project. This planning revealed certain vendor risks with AREVA/ESCA related to the day ahead reserve market design; larger than expected project costs, (once the implication of the project for hardware and other infrastructure were known) and an implementation date sometime in 2006. This combination of the need to integrate forward reserves with the new market structure, cost increases above original estimates, vendor risk and a long lead time resulted in a significant rethinking of the original design.

This rethinking has resulted in a better reserve market design that can be implemented more quickly and at a lower cost than the co-optimized reserve concept. The proposed design improves the current forward reserve design, establishes a real-time market for reserves and introduces a locational component to both the forward and real-time reserves market. This approach is described in more detail below.

Overview of Proposed Reserve Markets Design

The proposed reserve markets have two major elements; an improved forward reserve market and real time pricing for reserves provided by units that are not participating in the forward market. These elements and their interrelationship are described below.

Forward Reserve Market Enhancements

The existing forward reserve market will be improved by:

1. Adding locational reserve requirements in addition to system reserve requirements;
2. Changing the market to support portfolio offers, rather than solely physical offers and;

3. Enabling bilateral trading.

To make forward reserves locational, the ISO will identify reserve zones (zones for which system operations frequently require out-of-merit commitments to provide reserves) and the amount of reserves needed for the system, subject to constraints that assure that the minimum amount of reserves needed in each reserve zone is purchased.

Only physical resources can participate in the current forward reserves auction and resources that win in the auction must both bid into the day ahead market and be available in real time. The forward reserves auction will be improved to enable market participants to bid a portfolio of resources into the auction and trade obligations until the close of the day ahead market. Those who win the forward reserve auction or who contract to supply reserves bilaterally will then meet that obligation by providing reserves through offering a physical unit into the day ahead market and having it be available in real time.

The incentives structure in the current forward reserve market remain the same. There is a penalty for those that fail to bid in the day ahead market and a penalty if a unit fails to provide energy when called in the real time dispatch. The amount of the penalties will be reviewed in light of the proposed new design. As described below, those providing forward reserves will not receive the real time clearing price for reserves or the shortage adder to the energy price triggered by insufficient reserves.

Real Time Reserve Pricing

The project will create hourly prices in real time for reserves for each of the three reserve products needed by ISO-NE, TMSR, TMNSR, and TMOR for each reserve zone.²

There will be no real time offers for reserves. Real time reserves will show positive prices under two conditions:

1. Where a unit must be operated out-of-merit to provide reserves, creating an opportunity cost and;
2. When there are insufficient reserves to meet the reserve requirements causing a violation of a reserve constraint. This will result in a reserve constraint violation penalty factor setting a reserve price.³ If there is both an opportunity cost and a reserve constraint violation, the reserve price will be the reserve constraint violation price. The hourly reserve price will be paid to all units designated as providing reserves in real time that are not in the forward reserve market.

² There will not be a day ahead market for reserves.

³ This approach is quite similar to NY's Operating Reserve Demand Curve.

The dispatch software will price reserves and select which units and blocks of units to provide reserves and energy. This co-optimization of energy subject to reserves constraints in real time is a major improvement to the dispatch software and is the key element in Dr. Patton's recommendation to implement co-optimized reserves. The current software dispatches only to energy requirements. Today reserves constraints must be applied manually in the present SMD implementation.⁴

Relationship between Forward Reserve Market and Real Time Reserve Pricing

This design is not a multi-settlement design, but two separate, related markets.⁵ As noted earlier, payment for providing forward reserves will be based solely on the forward reserve auction price adjusted by penalties for failure to reserve (offering capacity into the day ahead market), and failure to provide (failure to provide energy when called upon). The real time price for reserves will be paid to all those providing reserves in real time that are not in the forward reserve market. The market intentionally does not allow those in the forward market to "buy out" of their position by purchasing reserves in real time.⁶ However, it does, as noted above, allow bilateral trading of forward reserve obligations before the close of the day ahead market.

Relationship between Reserve Markets and Capacity Markets

Assuming the FERC approves a demand curve for the capacity market, the relationship between the revenues from the reserves market and the capacity demand curve must be addressed. The implementation of reserve constraint violation penalty factors will increase the locational price for all energy; consequently the capacity demand curve should be adjusted downward by the estimated revenue from the reserve constraint violation penalty factors.

The demand curve under consideration by the FERC was not adjusted for forward reserves revenue. Nothing has changed to cause us to revisit that design choice.

Summary of Market Settlements

Forward Reserve Market performance will be evaluated hourly. Those resources that meet their obligations in a given hour will not incur any penalties while those that fail to perform will incur the appropriate penalties.

In the real time reserve market, resources will be paid the appropriate hourly locational clearing price for reserves. This will be charged to both real-time load and to the owners of the resources of the two largest contingencies, based on the increase in reserves caused by the size of the contingency.

Key Design Choices

The successful implementation of forward reserves, lead to a reconsideration of the co-optimized, multi-settlement reserve design. This reconsideration lead to a conclusion that having three reserve markets (a forward reserves market, a day ahead reserve market and a real

⁴ This has not been done often during actual operation.

⁵ The reason for this market design choice are described below.

⁶ The reasons for this design choice are detailed below.

time reserve market) was needlessly complex. It also concluded that co-optimized dispatch of reserves and energy with appropriate pricing was essential. This framework resulted from the following key design decisions.

1. A choice between the current forward reserve market and a day ahead market for reserves.
2. A choice between the multi-settlement design and two separate markets.
3. Use of reserve constraint penalty factor.
4. The design of the real time market for reserves.

The rationale for these design decisions is described below.

1. A Forward Reserve Market or a Day Ahead Market

The recommendation to retain the forward reserve market and not implement day ahead markets for reserves was done for the following reasons:

- A. A forward reserve market will yield prices that reflect certain costs of providing reserves that cannot be reflected in a day ahead market. Many of the costs of providing reserves are not avoidable in the day ahead time period but are avoidable in the forward reserves market time frame. Consequently, these costs would not be included in prices in the day ahead market but can be priced in the forward reserves market. Most importantly, the forward market prices the cost incurred by off-line units to provide reserves (start-up, no load and out-of-merit energy costs) while a day ahead market for reserves does not. This is an important design feature that drove other design choices.
- B. The forward reserve market is new. Replacing it with a day ahead market so soon after its implementation will increase uncertainty about the market and market design, reducing the likelihood that investments in new plants or improvements to existing plants will be made.
- C. Our vendor, AREVA, has not implemented a day ahead market for reserves and there was high risk that they could not do it in a timely, cost effective manner.

2. Choice between a Multi-Settlement Design or Two Separate Markets

This was the most difficult design decision. The conventional approach to reserve design would be to enable those in the forward market to “buy out” of their position by either bilaterally contracting to do so or to simply pay the real time price for reserves. This approach works well if there is confidence that the real time price for reserves is correct. In New England, much of the costs of providing reserves, particularly in Connecticut and Boston, are unit commitment and out-of-merit dispatch costs. It is not possible to include the costs of unit commitment (start-up and no-load), and the costs of out-of-merit dispatch in an hourly reserve price. Since it is not possible to include the costs of unit commitment and out-of-merit dispatch in hourly price for reserves, the price of hourly reserves may often be zero even when costs have been incurred to obtain those reserves.

However, the forward reserve market does enable participants to price commitment and out-of-merit costs in the forward reserve auction. The forward reserve market design requires on-line units that provide reserves to forego any operating reserve (uplift) payments. Presumably any such units that offer into the auction will reflect any foregone uplift in their offer.

Given that these costs cannot be included in the real time reserve price, if the design allowed those in the forward market to buy out in the real time market, the forward reserve market benefit of including unit commitment costs in reserves would be lost. This was the main reason that a design based on two separate markets (forward reserve market and an hourly market for those not in the forward market) was chosen rather than a multi-settlement or a more traditional forward market/spot market design.

3. The Design of the Real-Time Market

Given the design decisions described above: (maintaining and enhancing the forward market and not using a multi-settlement design), the next major design choice was the pricing of reserves in real time.

Two options were explored. The first was to simply pay opportunity cost only to those units that incurred an opportunity cost to provide reserves and not pay anything to units providing reserves but not incurring an opportunity cost. In this approach, units providing reserves would not be paid the RCPF. The alternative approach, which is recommended, is to calculate an hourly clearing price for each reserve product and pay that price to all units providing that product. The hourly reserve price will be set by either the opportunity cost of providing reserves or, in shortage conditions, the RCPF. This approach was selected because it sends price signals that reserves have value and encourages resources to provide reserves when capacity is tight. It should provide an incentive for those not in the forward reserves market to provide as much capacity as possible in those conditions. It also addresses concerns that have been expressed by market participants that all units providing reserve service should be paid when the price of that service is positive.

4. Pricing of Reserves in both normal operations and shortage conditions

As described above, in normal (non-shortage) operating conditions the real time price for reserves will be positive only when a unit has to be “backed down” to provide reserves, resulting in an opportunity cost. Otherwise, the price of reserves will be zero. In shortage conditions, when there are insufficient resources available to meet the reserve requirement for a given product, a constraint in the dispatch algorithm is violated. Each constraint in the dispatch algorithm has a penalty factor associated with it that reflects the cost or value of violating the constraint. Reserve prices in shortage conditions will be set by the penalty factor associated with each reserve constraint [the Reserve Constraint Penalty Factor (RCPF)]. The RCPF will be developed according to the following principles:

- A. They will be consistent with operations practice. That is, the constraints will bind when operators would be willing to take out-of-merit actions to supply reserves.

- B. They will reflect the costs the ISO would be willing to incur to procure reserves given a \$1,000 price cap. In other words, when the ISO is sufficiently short of reserve it would be willing to pay up to \$1,000 for energy to create additional reserves. This will be reflected in the RCPF.

The discussion below elaborates on the technical issues associated with the RCPF.

The objective function of the real time dispatch and pricing algorithm is cost minimization. This objective requires that all input control variables have a “cost” associated with the variables such that the algorithm can correctly determine the cost of meeting all the constraints and minimize that cost. In the case of the energy dispatch these costs are the offer data submitted by the Participants. In addition, there are penalty costs within the algorithm for violating the any unit characteristics in the offer data (i.e., resource ramp rates and operating limits), penalty costs for violating transmission operating parameters (i.e., line and/or interface limits), and penalty costs for violating the system power balance equations at a nodal level and for the Control Area. With the addition of the reserve constraints into the objective function, reserve constraint violation penalty costs must be developed and implemented.

When there are sufficient resources to meet all of the reserve requirements (either system or locational), the algorithm will minimize the cost of meeting energy and any transmission constraints based on their penalty variables and will satisfy the reserve requirements at a zero cost. When the set of resources to meet the energy, transmission and reserve requirements becomes limited, the algorithm must have the appropriate (and properly prioritized) set of penalty costs to meet the cost minimization objective with maximum reliability.

The Reserve Constraint Penalty Factors (RCPF) will be developed, along with other penalty factors, to meet the objective of minimizing the costs of all system constraints to the extent possible. A RCPF will be developed for each reserve requirement (system or Locational and TMSR, TMNSR, TMOR) that is modeled in the dispatch algorithm. Given a shortage of a particular reserve product, the relevant constraint will bind and the RCPF will set the reserve price. The RCPFs must recognize the priority of the resultant dispatch actions (i.e. system energy requirements are most important, transmission constraints must be satisfied in order to prevent equipment damage, and reserve constraints can be satisfied to the extent eligible resources are available) and should produce real time reserve prices that reflect the relative value of the remaining resource capacity when the reserve requirements cannot be met.

As noted earlier, the RCPF serves the same purpose as the Operating Reserve Demand Curve in the New York design. It serves as a means to reflect the risk to reliability of a shortage in reserves in the energy price. The RCPF quantifies the value of the reduction in reliability when there are fewer reserves than needed to meet the reliability requirement. The RCPF will replace the current “Scarcity Pricing Rule” and improve pricing in shortage conditions. The RCPF will give us more flexibility in pricing shortages of reserves than the current scarcity pricing rule. By reflecting the cost of a reserve shortage in the energy price, better price signals will be sent, and increase the incentives for units to be available and demand to respond in these conditions.

The RCPF will be developed by the ISO, likely with assistance from consultants and discussed with stakeholders.

Additional Elements in the Project

1. Regulation Market

The Ancillary Services Market Project proposes to replace the existing Regulation Market structure and Regulation Clearing Price methodology with a market structure that closely resembles the AGC market that existed under the Interim Market environment. As proposed, the Regulation market will include:

- A. The Regulation Clearing Price will be determined as a part of the real time dispatch and will be the highest offer price of the resources assigned to regulation service,
- B. The assignment of resources to regulation service will be based on a ‘Regulation Suggestor’ that executes prior to real time and attempts to determine the most economic set of resources to meet the energy, reserve and regulation requirements for the operating hour,
- C. Regulation Offer Data and operating parameters for Regulation Resources will remain the same as today,
- D. Hourly Regulation requirements will be determined and posted in the same manner as the requirements for the existing Regulation market,
- E. Resource compensation will consist of a) a reservation payment (time on Regulation within the hour), b) a service payment (amount of requested movement while on Regulation), and c) a unit specific opportunity payment if a resource is constrained out of economics to provide regulation service,
- F. Regulation self-supply will be accommodated by a resource requesting to self-schedule Regulation prior to the Regulation Suggestor execution.

2. Enabling Demand to Participant in the Real Time Energy and Reserves Markets.

The Ancillary Services Markets Project will include the infrastructure and software to allow price sensitive demand (dispatchable load) that has submitted energy bids into the Day-Ahead market to participate in the Real-Time energy market clearing. The A/S project will modify the software, Market Rule and NEPOOL Manuals such that Real-Time dispatch will properly recognize the demand bids and associated operating parameters of price sensitive demand when clearing the real-time energy and Ancillary Services markets. The project will identify and enumerate the operating requirements for participation in real-time market clearing, including the requirements for dispatch flexibility in response to nodal energy prices. In addition to demand clearing in the energy market, the A/S project will include the capability for eligible demand resources to participate in the reserve market clearing.

It is the intent that price sensitive demand will be able to participate in both the Day Ahead and Real-Time energy and ancillary services markets in the same manner as supply side resources. These resources will be allowed to submit operating parameters (minimum run/down times, effective dispatch ranges), self schedules and incremental energy and ancillary service bids in order to provide the same dispatch flexibility as supply resources.

In addition to price sensitive demand that is responsive to real-time dispatch instructions, it may be desirable to recognize other classes of system demand that are eligible to participate in the Real Time markets (energy and reserves) on an hourly basis. These resources (conceptually the Demand Response resources presently defined in the NEPOOL markets) may not be able to justify and/or meet the real time requirements for scheduling and dispatch, but can offer services to the market on an hourly basis.

3. Enabling External Transactions to Set Price

The Ancillary Services Market Project will be expanded to include the software to allow External Dispatchable Transactions to be evaluated in the ex-ante dispatch software, and if marginal (within some predefined bounds) to be eligible to set ex-ante dispatch rates.

The concept used to implement this in the dispatch and pricing software will be to allow External Transactions to have a flexibility range around the Transaction MW point and if the price within that range becomes marginal for a particular dispatch execution, then the Transaction will be allowed to set the nodal dispatch rate.

4. Multiple Response Rates

The Ancillary Services Market Project will enable generating resources to submit offer data that includes multiple response rates throughout the operating range of the resources rather than the single response rate in the current market. The offer data would include the capability for a pre-defined number of MW ranges and corresponding response rates to be used (both day-ahead and real-time clearing).