To:	NEPOOL Markets Committee
From:	Parviz Alivand, Manager and Principal Economist, Market Development Yujie Hu, Supervisor, Market Development
Date:	March 4, 2026
Subject:	Dynamic Operating Reserves for a Changing System: Update

In the 2026 Annual Work Plan, the ISO indicated that in Q1 it would review with stakeholders its continuing assessment of flexible response capabilities to address operational uncertainties with an increasingly weather-dependent resource mix.[1] This memorandum provides an update on these efforts.

In brief, the ISO is presently assessing market and operational enhancements to provide dynamically-determined quantities of operating reserves in the real-time markets. Our present focus is to develop dynamic operating reserve demand curves (ORDCs) that will improve the existing real-time markets, and that extend the familiar co-optimized real-time market design to handle an increasingly dynamic system. These enhancements are a promising, implementable step to address greater uncertainties cost-effectively and more reliably during the operating day.

In addition, the ISO continues to evaluate the potential development of a longer-response reserve product (e.g., 60- or 90-minute reserves). Further work would then be required, in a later phase, to extend the ORDCs and a longer-response reserve product from the real-time into the day-ahead markets.

Discussed below are the ISO's current thinking and directions, work to date, and next steps.

Context: Dynamic System Challenges

In March 2025, the Markets Committee reviewed an ISO memorandum discussing dynamic system challenges during the operating day.[2] In simple terms, increasingly weather-dependent net load and the continued development of weather-sensitive supply resources are adding new sources of

[1] ISO New England *2026 Annual Work Plan* (October 10, 2025), slide 9. *Available at* https://www.iso-ne.com/static-assets/documents/100028/2026_awp_final_10_10_2025.pdf.

[2] ISO New England memorandum, *Flexible Response Services for a Dynamic System* (March 5, 2025). *Available at* https://www.iso-ne.com/static-assets/documents/100021/a05_mc_2025_03-11-12_flexible_response_assessment_memo.pdf.

operational uncertainty. Given New England's continued development of renewable-energy resources (including significant behind-the-meter PV-solar generation), the ISO continues to believe it would benefit the region to proactively develop market and operational enhancements that can reliably accommodate these increasing operational uncertainties. Ideally, these enhancements should have a flexible design that can readily adjust to changes in (the frequency and magnitude of) operational uncertainties as the system continues to evolve.[3]

Since that time, the ISO has focused on developing formulations and models and analyzing data to achieve these objectives consistent with the directions outlined in the March 2025 memorandum. Specifically, one stream of work is developing methods to calculate real-time operating reserve demand curves for dynamically-determined incremental quantities of existing real-time reserve products (10- and 30-minute reserves), in amounts that vary during the operating day.[4]

A second, closely-related stream of work is developing dynamic, real-time probabilistic forecasting methods for the system's energy ramping needs, to ensure the system is reliably prepared to balance greater unanticipated fluctuations in net load and weather-sensitive supply during the operating day. Such probabilistic forecasts are an essential input to calculating dynamically-determined ORDCs, as they help quantify the system's potential ramping needs during periods when larger unanticipated net load or supply fluctuations are more likely to occur.

Dynamically updating the probabilistic forecasts of system ramping needs, and correspondingly updating the demand for real-time reserves, helps offer a cost-effective means to handle greater operational uncertainties in real time. For example, the quantity of incremental reserves procured will tend to be lower during hours when either (a) real-time reserves have a high cost, since operating reserve demand curves will tend to procure fewer reserves when their price is high; or (b) operating conditions imply large unanticipated fluctuations in net load or supply are lower-likelihood events (such as at night, when PV solar output is – predictably – zero).

A third stream of work is performing initial studies and evaluations of the potential benefits of a longer-duration reserve product. This work is dependent on the outcomes of the prior two workstreams, both because of technical interdependencies and because the benefits of a longer-duration reserve product may depend on the dynamic ORDCs' effectiveness.

Each of these inter-related assessment areas is addressed next in greater detail.

Dynamic Operating Reserve Demand Curves

Unanticipated real-time fluctuations in energy supply or demand requires, among other things, sufficient ramping capability to maintain the system's energy balance. While there are different ways

[3] As noted in the March 2025 memorandum, no standard or best practice has emerged among ISOs/RTOs for procuring, pricing, and maintaining sufficient flexibility (*viz.,* real-time ramping capability) to address operational uncertainties with increasingly weather-sensitive net load and supply. The ISO actively engages with other ISOs/RTOs to understand their market design efforts on these issues, as operational uncertainties are an emerging concern in many regions. *Id.,* p. 1-2.

[4] In this context, "incremental quantities" of 10- and 30-minute reserves means incremental to the minimum reserve requirements necessary to satisfy existing NERC and NPCC major source-loss reliability standards.

to do so at a technical level, a promising and practical way to achieve this, as such fluctuations become more prevalent, is with dynamic ORDCs for incremental 10- and 30-min reserves. The goals in doing so are to ensure that ramping capabilities to address these uncertainties are procured cost-effectively, priced transparently, and that the system maintains energy ramping capability in amounts commensurate with (dynamically-varying) system risk.

Concepts. ORDCs are technically involved in the details, but the concept is simple. The demand curve specifies an 'up to' price that may be paid for each incremental MW of real-time reserve. That price is based on their marginal reliability impact (MRI) – that is, the likelihood that each incremental MW may be needed to help preserve the system's energy balance in response to an unanticipated fluctuation in energy supply or demand. The existing real-time co-optimized energy/reserve market would then procure reserves at the level where the system's cost to procure incremental reserve matches the price specified by the MRI-based ORDC. The logic of the resulting real-time reserve prices remains the same as today: reserve clearing prices would continue to reflect the opportunity cost of energy.

Viewed from a practical perspective, this design enhancement serves to continuously "position" the system's dispatchable resources during the operating day with sufficient unloaded ramping capability (including offline response capability) to balance unanticipated changes in supply and demand, with high probability. The co-optimized dispatch would do more positioning for unanticipated fluctuations when that potential is greater in real-time, and less when that potential is smaller, commensurate with probabilistic forecasts of potential net load and supply fluctuations. The co-optimized dispatch would also do less when the system's cost of reserves is greater, and more when the cost of reserves is less, in order to align reserves' cost with their risk-reduction benefits.

Underway. In the details, there is considerable technical work underlying the engineering-economic formulations and data-driven analyses for ORDCs. Therein lies much of the ISO's work to date, and the planned work ahead during 2026. Much of it concerns details of timing and demand curve formulations, so as to guide precisely how the demand for reserves should vary, quantitatively, with real-time measures of operational uncertainties (e.g., the likelihood that net load may fluctuate by more than X MW over the next 15-minutes, by Y MW over the next 30-minutes, and so on). Such particulars enable an ORDC's precise specification to achieve (that is, to be derived from) the principle of balancing the expected benefits of incremental operating reserve against its cost.

To date, the ISO has developed initial mathematical formulations for ORDCs for 10- and 30-minute reserves consistent with that principle, examined their properties in small-scale test cases and simulations, and refined the formulations in light of the results. Considerable work also examines methods to simplify, while preserving accuracy, the relevant calculations to achieve the computational performance necessary for implementation in real-time markets. As this continues in 2026, the ISO plans to undertake larger-scale simulations for realistic operating days. This will help to evaluate the properties and benefits of implementing ORDCs before undertaking (time-consuming) simulations over longer periods to inform their potential impact on overall market costs and revenues.

While there is considerable technical work ahead, the ISO is increasingly optimistic that this is a viable, sound, and practical approach to cost-effectively maintain sufficient flexibility to handle a variety of increasing operational uncertainties through the real-time markets. Moreover, because it leverages the existing real-time co-optimization framework, it achieves these goals without necessitating the time-consuming development of entirely new products, new offers, or new settlement systems.

Probabilistic Forecasting of System Ramp Needs

As noted above, net load fluctuations and other operational uncertainties can vary materially in different system conditions. These dynamics make the system's potential energy ramping needs different from hour to hour, and from day to day. Probabilistic forecasts quantify, in a way that can be incorporated into markets and operations, the likelihood (*i.e.*, percentiles) of these potential changes.

Concepts. Frequently updated probabilistic forecasts are what makes an ORDC truly "dynamic": They provide the necessary information, given current system conditions in real-time, to quantify the likelihood that the system's energy ramping needs may exceed *X* MW over the next 15-minutes, and *Y* MW over the next 30-minutes, and so on. That information is what enables an ORDC to vary during the operating day in ways that procure more when the range of potential ramping needs is greater, and to procure less when it is smaller.

Underway. Probabilistic forecasting is a rapidly progressing discipline, and the ISO is examining and testing various statistical methods for modeling the system's real-time energy ramp needs as they vary across operating conditions and time. During the past year, the ISO has worked to identify, build, and refine probabilistic forecasting models of various distinct sources of operational uncertainty (*e.g.*, load net of behind-the-meter generation; front-of-the-meter PV solar fluctuations; wind energy resources' variation, and so on) and to model how these uncertainties interact to drive system ramping needs in real time. These uncertainties tend to be correlated in important ways, making the requisite data analyses and modeling work a significant undertaking.[5]

As this work continues in 2026, the ISO plans to refine the initial models into tractable, computable, and readily-retrained probabilistic forecasting tools that integrate and work smoothly with the dynamic ORDC design. This is a precursor to performing the larger-scale simulations for longer time periods, as noted in the previous section.

As noted in the March 2025 memorandum, the ISO is cognizant not to let perfect become the enemy of good. Probabilistic forecasts and ORDCs that address the most prominent sources of operational uncertainties today are the priority; other sources of operational uncertainties can be addressed as

[5] The application of probabilistic forecasting methods to support dynamic real-time ORDCs is part of a broader ISO focus area on probabilistic forecasting technologies to help assure a reliably system with increasing operational and planning-horizon uncertainties. *See* ISO New England's Multi-Year Roadmap (November 5, 2025), slides 39-42. *Available at* https://www.iso-ne.com/static-assets/documents/100029/rsp25-public-meeting-iso-bod-open-meeting-nov-5-2025-slides.pdf.

subsequent enhancements, and as the continuing evolution of the grid reveals other uncertainties that may effectively be addressed with this suite of market and operational enhancements.

Other Considerations: Longer-Response Reserves

In the March 2025 memorandum, the ISO indicated there may be benefit from developing a longer-response reserve product (such as 60- or 90-minute reserves). Work to date on this has examined specific operational situations, without definitive results. In some cases, additional longer-response reserves can help reduce 10- or 30-minute reserve shortfalls post-contingency, but the ISO anticipates that this result may be sensitive to (among other things) potentially better system positioning enabled by dynamic ORDCs for incremental 10- and 30-minute reserves.

Consequently, in 2026 the ISO plans to place a higher priority on the prior workstreams on dynamic ORDCs and their pre-requisite probabilistic forecasting tools. This reflects three considerations. One is that, as noted, the benefits of a longer response product may be lessened with dynamic ORDCs for incremental 10- and 30-minute reserves. Second, any future longer-reserve product would likely benefit from leveraging a similar demand curve design to determine the quantities to be procured, so finalizing the demand curve design first seems prudent. And third, developing a new longer-response reserve product is a considerably more involved (that is, longer time-to-implementation) effort: It requires more changes to the real-time co-optimized dispatch engine, developing new auditing systems (for offline 60- or 90-minute response capability), expanding the market settlement systems to handle a new product, and so on. These considerations lead to a greater focus on the dynamic ORDCs' development.

Day-Ahead and Real-Time Implementations

The ISO is presently focused on developing the dynamic ORDCs for the real-time markets. Current thinking is not to introduce ORDCs for incremental reserves into the day-ahead and real-time markets concurrently. This is a pragmatic approach at three levels.

One is that ORDCs depend on probabilistic forecasts of real-time ramp needs. These forecasts, and the tools needed to produce them, are different for real-time use (*i.e.*, looking forward in time only 15 to 90 minutes) than the tools needed for day-ahead use (*i.e.*, looking forward in time to next day operating hours 14 to 38 hours after the day-ahead market). That is, ORDCs for the day-ahead market are not simply a "copy and paste" of the real-time demand curve design and probabilistic forecast calculations. Rather, developing ORDCs to address operational uncertainties faced at the time of the day-ahead market would require additional development, modeling, and subsequent implementation.

Second, it seems improvident to delay the implementation of real-time operational and market improvements that prove promising in order to concurrently implement day-ahead versions. That is, current thinking is that it would be sensible to implement the real-time market enhancements first, and the day-ahead enhancements at a later date, as that work is completed.

Third, there is potential benefit to learning how the real-time energy and ancillary service market design enhancements perform in practice, and making any necessary adjustments based on that experience, before expanding them to the day-ahead market. The dollar value of participants' transactions in the day-ahead market is far greater (in the aggregate) than the comparatively far lower volume of transactions in real-time, and the ISO remains cognizant of the heightened concern over the costs of the reserves presently procured in the day-ahead market.

Next Steps

Two observations guide the ISO's current perspective on the timing of these market and operational enhancements. The first is the scope of the data analyses, modeling, and simulation study work ahead, as noted previously. If that proceeds smoothly and initial larger-scale testing is successful, the ISO may be in a position to support detailed discussion of a proposal in Q4 2026. However, this depends on a number of factors, including progress and testing of the two primary workstreams above.

Second, an important limitation on the ISO's resources lies in implementation. The ISO and its software vendors have a substantial queue of time-sensitive work ahead that will heavily load the ISO's implementation resources through 2026 and 2027.[6] Accordingly, anticipated implementation of any specific ORDC proposal would be no earlier than the second half of 2027.

The ISO will endeavor to keep stakeholders apprised as work continues in this important area, as market-based methods to address operational uncertainties remain important with the region's increasingly weather-sensitive power system. The ISO welcomes stakeholder feedback on this memorandum and looks forward to discussing these issues at the March NEPOOL Markets Committee meeting.

---

[6] These include implementing the Capacity Auction Reforms after a FERC 2027 order (on seasonal changes and capacity accreditation); FERC Order 881 (ambient transmission line ratings); Order 2222 (distributed energy resource integration); the MW-dependent Fuel Price Adjustments; and several major IT infrastructure enhancements (on the latter, *see* 2026 Annual Work Plan, *op cit.,* slide 22).