

This document is to provide a summary of supporting documentation for the short-term goals of Energy Price Formation Senior Task Force and a summary of all Operating Reserve Demand Curve materials that have been presented and shared during Task Force Meeting thus far.

Overview of PJM Proposal

[Drivers of PJM reserve Market Enhancements Proposal](#)

This paper is to provide an explanation of the changes that PJM has proposed to the Reserve Market design and Operating Reserve Demand Curve.

[Executive Summary of PJM Proposal](#)

Summary of the PJM proposal for Synchronized Reserve Market changes, Flexible Reserve Sub-Zone Modeling and Operating Reserve Demand Curve for Shortage Pricing.

Operating Demand Curve Supporting Material

5.4.2018 [Item 6 - EPFSTF Capacity Reserves vs Operational Reserves](#)

This presentation defines Capacity Reserves and Operational Reserves, establishes differences between the two types of reserves and comments on the interdependence between the markets in which each type of reserves is procured.

5.23.2018 [Item 3 - EPFSTF - Simplified Operating Reserve Demand Curve \(ORDC\)](#)

This presentation lists the issues/opportunities with the current ORDCs. It also establishes which of those issues/opportunities PJM is proposing to address with the short-term ORDC enhancements. This was the first presentation in which a very preliminary new ORDC was presented. Other topics discussed are:

- Key concepts for the new ORDCs (MRR, PBMRR).
- Uncertainties to be considered in the ORDC development: load forecast, wind forecast, solar forecast. During this presentation, PJM stated that thermal generation uncertainty was not going to be considered. This position changed in subsequent meetings.
- Length of look-ahead uncertainty interval to calculated uncertainties (30 minutes)
- Season and time-of-day block definition for ORDC development
- 30-min load, wind and solar forecast error values by season and time-of-day block

- Step-by-step example to calculate PBMRR using normality assumption. The normality assumption was abandoned by PJM in subsequent meetings.

A set of example graphs were also added to the presentation. The examples/graphs are aimed at: illustrating the objective function used in the co-optimization of energy and reserves (maximization of social welfare), how such objective function is represented graphically and how the market clearing prices can be visualized in such graphs. A two-generator stylized example is also added to illustrate the trade-off between energy and reserves that may result from the co-optimization of energy and reserves.

6.8.2018 [Item 3B - ORDC Supplemental Information](#)

This presentation supplements the ORDC presentation from 05/23/2018. Topics discussed include:

- Inclusion of forced outages uncertainty (thermal generation uncertainty) in ORDC development. At this meeting, PJM signaled the need to add this uncertainty in the ORDC development.
- Assessment of impact of the normality assumption on the ORDCs. At this meeting, PJM's position was to still use the normality assumption. The normality assumption was abandoned by PJM in subsequent meetings.

In addition, multiple two- and three-generator stylized examples were included to illustrate how the new downward-sloping ORDCs work and impact market clearing prices for energy and reserves. The stylized examples included scenarios that may occur in real-life markets such as: capacity-constrained system, reserve offers from generators, ramp -constrained system, and reserves surplus. The examples are meant to illustrate concepts, not to predict future real-life energy and reserve prices.

Finally, a set of preliminary ORDCs was added to the Appendix. These ORDCs included the forced outages uncertainty but were developed using the normality assumption. The normality assumption was abandoned by PJM in subsequent meetings.

7.17.2018 [Item 6A - ORDC Supplemental Information Part II](#)

This presentation supplements previous ORDC presentations by covering the two types of reserve requirements currently available at PJM: synchronized reserves (SR) and primary reserves (PR). The presentation also discusses the price cascading effect for resources satisfying the SR requirement.

In previous meeting, only SR ORDCs had been presented. At this meeting, PR ORDCs are presented for the first time including how they were developed.

In addition, multiple two- and three-generator stylized examples were included to illustrate how the new downward-sloping ORDCs for SR and PR work and impact market clearing prices for energy and reserves. The price cascading effect is also illustrated via the examples. The stylized examples included scenarios that may occur in real-life markets such as: capacity-constrained system, reserve offers from generators, ramp-constrained system, and reserves surplus. The examples are meant to illustrate concepts, not to predict future real-life energy and reserve prices. Example 5 is not correct; it was modified on the 08/06/2018 version of these slides.

Finally, a set of preliminary ORDCs for PR and SR was added to the Appendix. These ORDCs included the forced outages uncertainty but were developed using the normality assumption. The normality assumption was abandoned by PJM in subsequent meetings.

8.6.2018 [Operating Reserve Demand Curve Supplemental Information Part II - Updated](#)

This presentation is almost identical to the 07/17/2018 ORDC presentation. However there are two differences:

- Example 5 was updated
- The appendix includes the ORDCs for PR and SR now calculated using empirical distributions (the normality assumption was abandoned). **This is the most up-to-date version of the ORDCs.**

8.2.2018 [Item 3A - Adjustments to the Operating Reserve Demand Curve for Operator Actions](#)

This presentation provides the latest proposal for adjustments to the ORDC for operator actions to procure additional Synchronous Reserves for system reliability purposes.

8.22.2018 [Item 3B - Example - Procuring Reserves Above the MRR](#)

This presentation uses an example to illustrate the rationale for why it is valuable to procure reserves in excess of the MRR under certain circumstances.

9.26.2018 Additional links and data for 30 minute and 15 minute uncertainty for Synchronized Reserves and Primary Reserves :

- 30-min ORDC Curves Data
 - [30 Minute Uncertainty PJM ORDC Curves SR.xlsx](#)
 - [30 Minute Uncertainty PJM ORDC Curves PR.xlsx](#)
- 15-min ORDC Curves Data and Graphs
 - [15 Minute Uncertainty PJM ORDC Curves SR.xlsx](#)
 - [15 Minute Uncertainty PJM ORDC Curves PR.xlsx](#)
 - [15 Minute Uncertainty PJM ORDC Curve Graphs.pptx](#)
- 30-min Load/Wind/Solar Forecast Error Mean and StDev
 - [30-min Uncertainty Load Wind Solar Forecast Error for PJM ORDC](#)