



Reserve Market Price Formation Enhancements

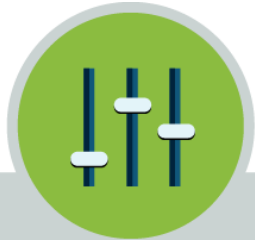
Synchronous Reserve Deployment
Task Force
April 30, 2021

- Reserve market price formation changes discussed in the Energy Price Formation Senior Task Force (EPFSTF).
 - Stakeholder meetings January 2018 through March 2019
- PJM Reserve Filing (206) submitted to FERC on March 29, 2019.
- FERC ruled and largely adopted PJMs proposals (May 21, 2020).
- Compliance Filing submitted to FERC on July 06, 2020.
- In Docket Nos. EL19-58-000 and ER19-1486-000, the Commission accepted proposed revisions to the PJM Tariff and Operating Agreement to effectuate enhanced reserve price formation in PJM markets.

The PJM Board has determined that a comprehensive package inclusive of the components outlined below, is needed to meaningfully address the reserve procurement and pricing issues.

1. Consolidation of Tier 1 and Tier 2 Synchronized Reserve products
2. Improved utilization of existing capability for locational reserve needs
3. Alignment of market-based reserve products in Day-ahead and Real-time Energy Markets
4. Operating Reserve Demand Curves (ORDC) for all reserve products
5. Increased penalty factors to ORDCs to ensure utilization of all supply prior to a reserve shortage

Consolidation of Tier 1 and Tier 2 Synchronized Reserve Products



Tier 1 Market Product

Remaining ramping capability on flexible dispatchable generation resources after economic dispatch



10-minute response time



Obligation to respond



Non-compliance penalty



Paid for response to an event

Vs.



Tier 2 Market Product

- Generation resources reduced from their economic set point
- Synchronous condensing resources and DR



10-minute response time



Obligation to respond



Non-compliance penalty



Paid market clearing price regardless of deployment

- Tier 1 and Tier 2 reserve products will be consolidated into one, uniform, Synchronized Reserve product that is similar to Tier 2 today
- This unified product will:
 - Be obligated to respond based on the assigned quantity
 - Be compensated at the applicable clearing price for the assigned MW amount
 - Face the existing penalty if the resource does not respond during an event
- This proposed change is motivated by the need to enhance the accuracy of PJM's reserve measurements and the reliability of response in addition to creating comparable compensation for comparable service

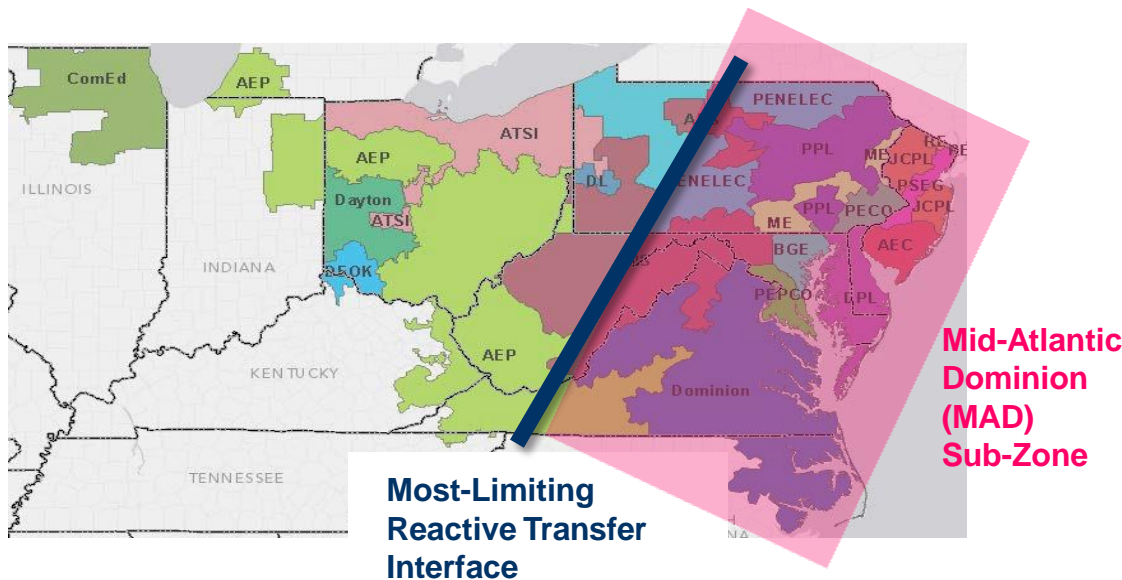
- PJM will strengthen the synchronized reserve must offer requirement
- PJM will calculate a resource's availability and reserve offer MW using the availability and unit parameters offered in for energy, with some exceptions
 - Participants will be provided additional flexibility to update energy ramp rates intra-day and to update the Synch Reserve Maximum MW intra-hour to enable more accurate representation of their reserve capability
- The proposal reduces the maximum level of synchronized reserve offers.
 - The Variable Operations & Maintenance component will be removed from SR offers (it is already included in energy offers)
 - The \$7.50/MWh offer margin will be reduced to the expected value of the penalty (\$0.02 for 2018).
 - The expected value takes into account the actual penalty, as well as the probabilities that a resource will underperform and that a synchronized reserve event will occur.
 - PJM is investigating the use of multiple year averages and/or quartile distributions to make allowances for differences between historical and future expected values (*update from 11/28 meeting*)

- By applying these standards across all Synchronized Reserve resources, PJM expects the following benefits:
 - More accurate reserve calculations that require less operator intervention
 - More reliable reserve assignments that will improve Synchronized Reserve performance
 - Consistent compensation and penalties for all resources providing the same service
 - More accurate energy and reserve pricing due to improved Synchronized Reserve measurement

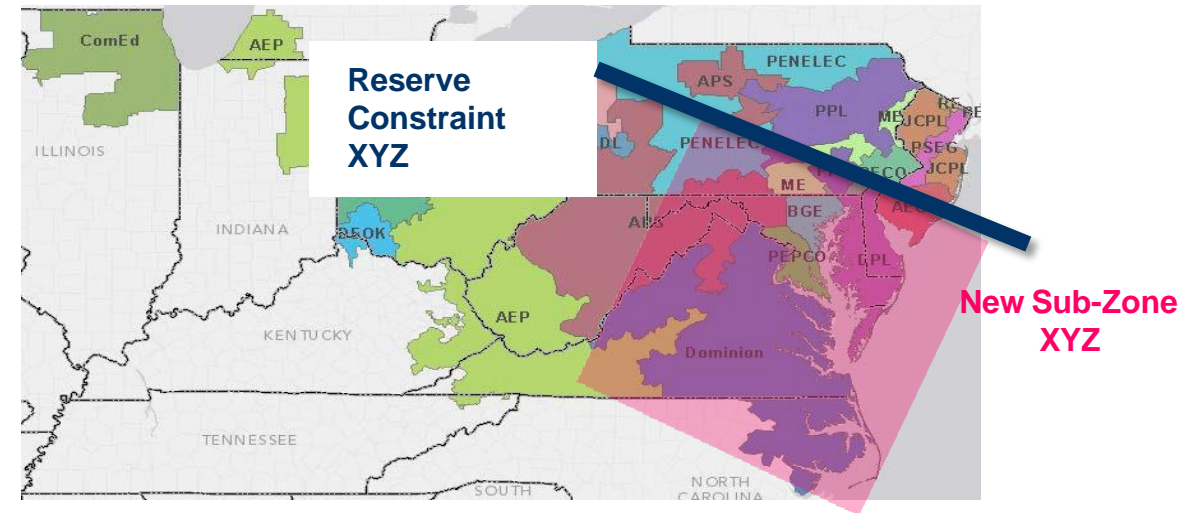
Improved Utilization of Existing Capability for Locational Reserve Needs

- The current, static reserve zone modeling approach (RTO reserve zone with MAD sub-zone) does not always accurately reflect the constraints dispatch is most concerned with overloading
 - Can lead to procurement of reserves that could overload these constraints when deployed
 - Can lead to reserve prices that may be misaligned with the reliability value of those locational reserves

- **More Flexible Reserve Sub-Zone Modeling**
 - Keep existing RTO reserve zone with closed loop sub-zone structure, but allow flexibility to change the location of the sub-zone on a day-ahead basis, as needed
 - Allow changes intraday on an exception basis
 - Define several reserve sub-zones, of which only one will be used at a time

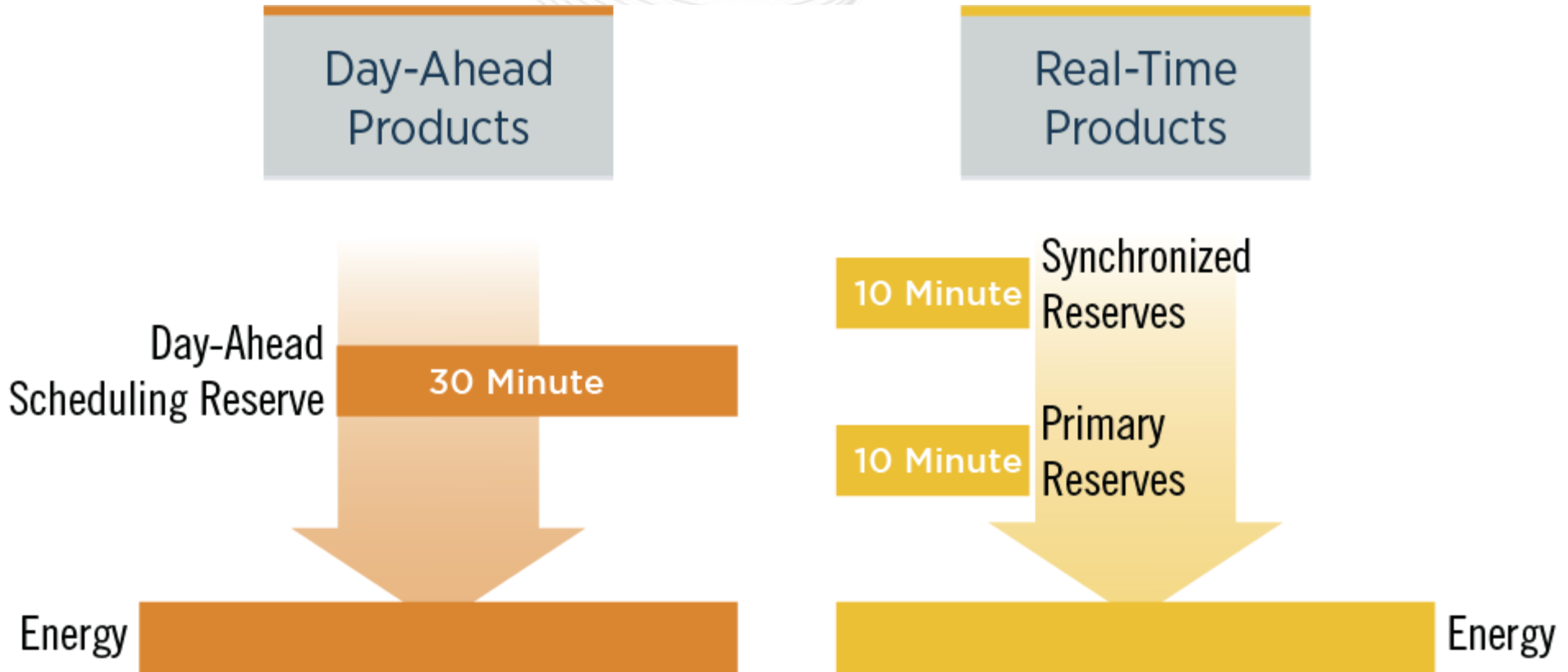


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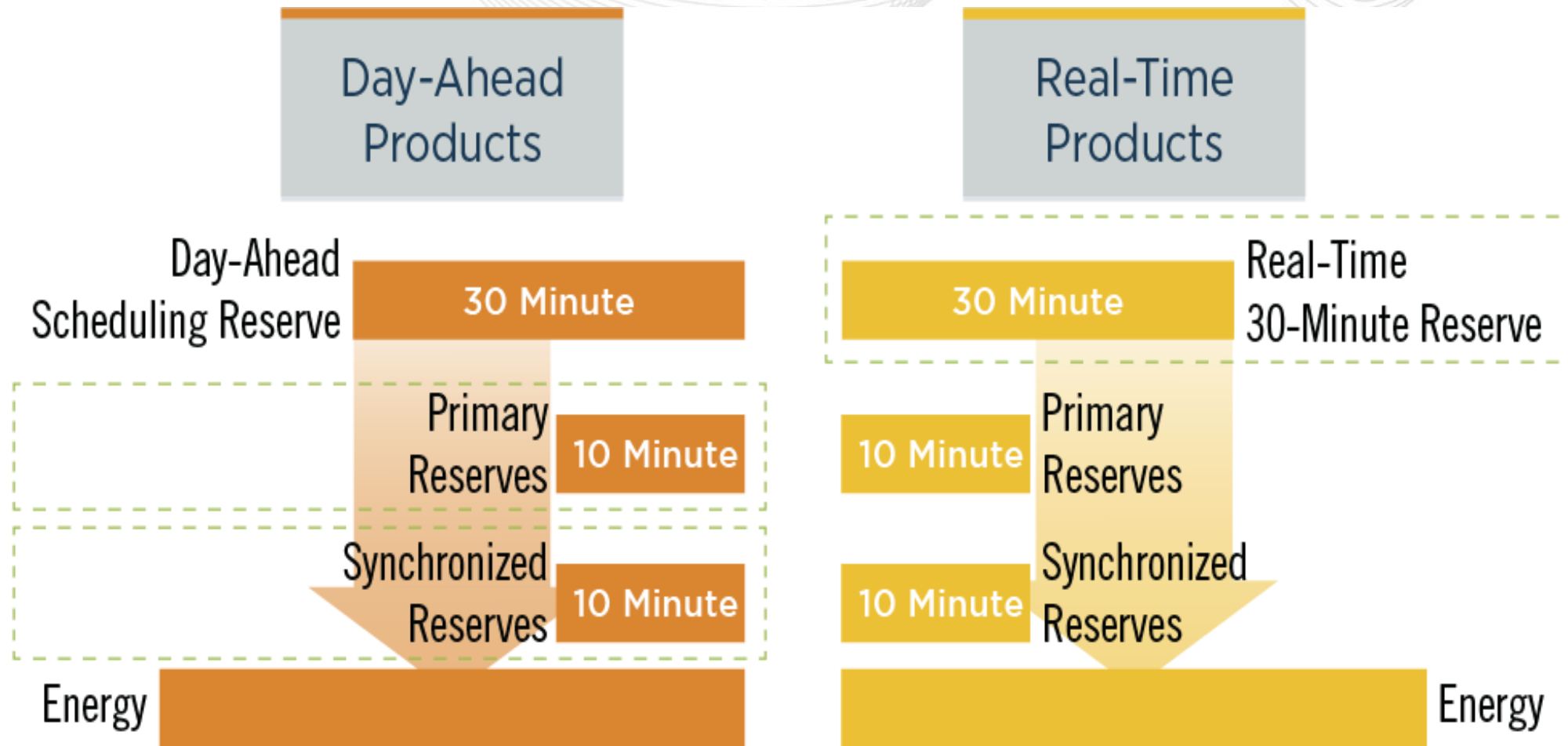


Alignment of Market-Based Reserve Products in Day-Ahead and Real-Time Energy Markets

Current Reserve Market Architecture



Proposed Reserve Market Architecture



ORDCs and Offer Price Caps will be consistent between DA & RT for each product

- Quantity deviations from day-ahead are settled in real-time
- We do this today for energy and will apply the same concept for all reserves

- Awards for Synchronized and Non-Synchronized Reserve cannot occur simultaneously
- Secondary Reserves reflect the portion of 30-minute reserves that occurs between 10 and 30 minutes

- While ORDCs will be identical, it does not mean cleared quantities will be the same.
- Economics in the DA and RT markets will ultimately determine the level of cleared reserves.
- PJM does not plan to change the modeled reserve zone between DA and RT unless there is an operational emergency requiring it.
 - For example, the limiting facility trips.

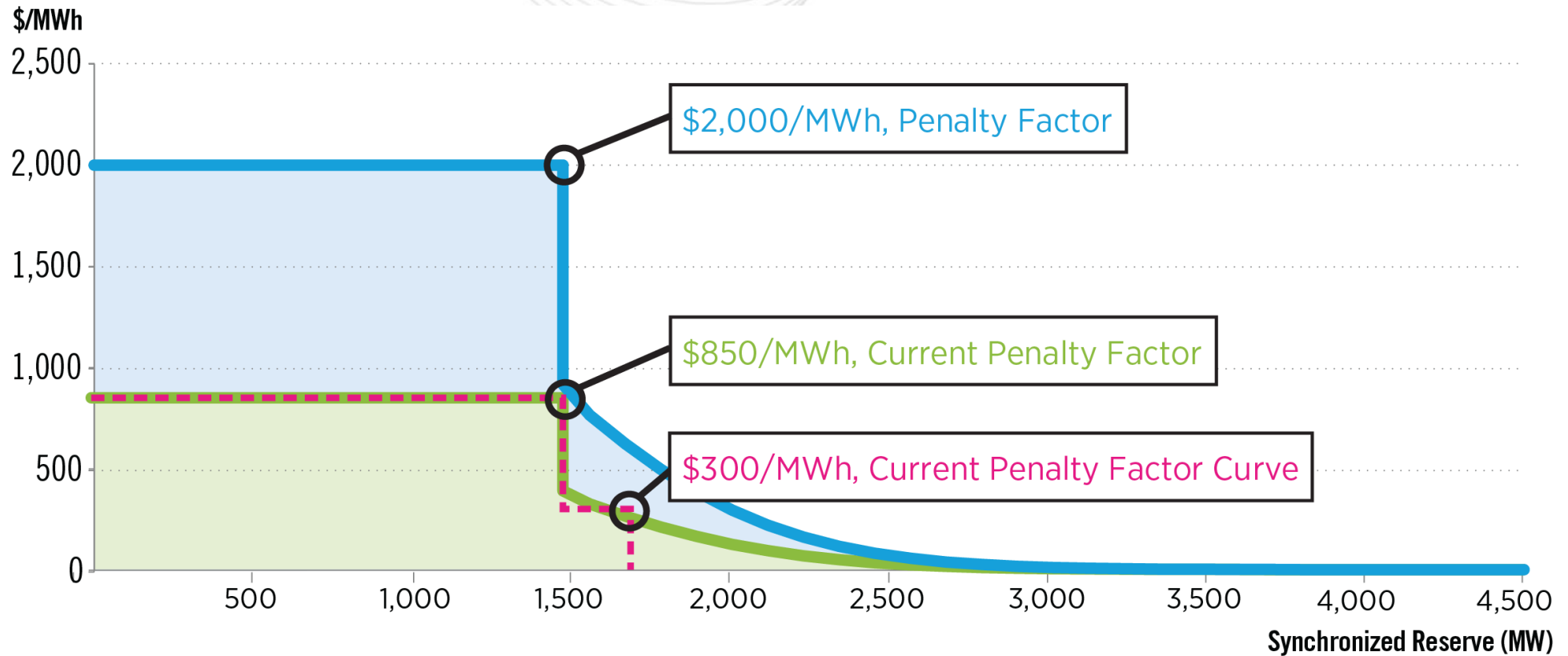
Operating Reserve Demand Curves (ORDC) for all Reserve Products

The ORDC:

Sets the reserve requirement for market clearing purposes

Puts a defined limit on the cost to be incurred when procuring reserves

Synch Reserve ORDC Penalty Factor Comparison



For illustrative purposes only.

	10-Min (SR)	10-Min (PR)	30-Min
MRR	Output of largest online unit (~1,450 MW)	150% of output of largest online unit (~2,175 MW)	Max of 3,000 MW or largest gas contingency (approximately 200% of largest unit)
Uncertainties	Load, Wind, Solar, Thermal Forced Outages	Load, Wind, Solar, Thermal Forced Outages	Load, Wind, Solar, Thermal Forced Outages, Net Interchange
Adjusted by Regulation?	Yes	Yes	Yes
Look-Ahead Uncertainty Interval	30 minutes	30 minutes	60 minutes
Penalty Factor	\$2,000/MWh	\$2,000/MWh	\$2,000/MWh

Twenty-four different ORDCs will be modeled per reserve zone, one for each season and time-of-day blocks.

Using historical uncertainty data from most recent three full calendar years

Season	Time-of-Day Block (in Hour Beginning)
Summer (June – August)	1 (2300 – 0200)
Fall (September – November)	2 (0300 – 0600)
Winter (December – February)	3 (0700 – 1000)
Spring (March – May)	4 (1100 – 1400)
	5 (1500 – 1800)
	6 (1900 – 2200)

- The zonal ORDCs for each of the three products will be developed in a similar manner to the RTO ORDCs.
- The data used to calculate the zonal ORDC will be zonal data.
- The penalty factors will be identical to the RTO penalty factors.

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