Proposed Changes to Primary and Synchronized Reserves

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Removal of the Primary Reserve Product

Proposed update to PJM’s sub-zone market design for Synchronized Reserves

Additional Synchronized Reserve Reforms

Removal of the Primary Reserves Product

Removal of the Primary Reserve Product from the PJM Energy and Ancillary Service Markets

- Today, PJM procures 1.5 times its largest contingency in Primary Reserves, where Primary Reserves can be provided by online or offline resources that can respond within 10 minutes.
- PJM has proposed a new reserve market design that would better capture the 10-minute flexibility needed beyond what’s procured to address the largest contingency by procuring reserves to address forecasted net-load ramp and net-load forecast uncertainty in the 10 minutes beyond the target time.
- PJM has also proposed market reforms to reflects its need to provision 30-Minute Reserves to backfill and replace 10-Minute Contingency Reserves in the event of a unit loss.
- PJM believes these reforms quantify and express the reserves needed to meet PJM’s reliability obligations based on resource capabilities, system operational conditions, and PJM’s evolving flexibility needs. **PJM is therefore proposing to no longer additionally clear Primary Reserves in its markets.**

Rationale for Eliminating the Primary Reserve Product

- Today, unlike Synchronized Reserves and Offline Secondary Reserves, 10-minute Non-Synchronized Reserves (NSR) do not have clear performance obligations that align with how they are used operationally.
- Currently, Primary Reserves are cleared to provide backfill contingency reserves and additional 10-minute flexibility to manage other reserve needs.
- Moving forward, these reliability services will be provided by other reserve products that have been explicitly defined to meet these needs, along with clear performance obligations, performance incentives and consequences for non-performance.

Considerations for Shortage Pricing

- If Primary Reserves are removed from PJM's Energy and Ancillary Service Markets and Synchronized Reserves are no longer nested with 30-Min Reserves, SR will no longer be nested with any other product.

- Today, if PJM is short Synchronized Reserve, Primary Reserve and 30-Minute Reserves at the $850/MWh penalty factor, all three of those penalty costs could additively appear in LMP.*

- In an unnested design, Synchronized Reserve resources will ONLY meet the Synchronized Reserve Requirement, meaning that the Synchronized Reserve penalty factor will not add to another reserve penalty factor in LMP.

***PJM administratively caps the System Energy Price at $3,700.**

Shortage Pricing Outcomes in the Nested Design

In today's nested design, Synchronized Reserves meet the Synchronized Reserve Requirement, the Primary Reserve Requirement and the 30-Min Reserve Requirement:

- Synchronized Reserves >= Synchronized Reserve Requirement
- Synchronized Reserves + Non-Synchronized Reserves >= Primary Reserve Requirement
- Synchronized Reserves + Non-Synchronized Reserves + Secondary Reserves >= 30-Min Reserve Requirement

If all three of the above optimization constraints are binding at the $850/MWh penalty factor, and the marginal energy resource could provide Synchronized Reserves (i.e., clearing one more MW of energy would cause an additional MW of Synchronized Reserve shortage), then the shadow price of all three of those reserve constraints will appear in the System Marginal Energy Price.

Shortage Pricing Outcomes in the Unnested Design

If the reserve products are not nested, a MW of Synchronized Reserves will only meet the Synchronized Reserve Requirement.

- Synchronized Reserves >= Synchronized Reserve Requirement
- 10-Min RUR >= 10-Min RUR Requirement
- 30-Min RUR >= 30-Min RUR Requirement

If all three of the above optimization constraints are binding, the next MW of energy from the marginal energy resource can now only meet *one* of these requirements. Assuming that the Synchronized Reserve Requirement is binding at the highest penalty factor, clearing one more MW of energy would cause an additional MW of Synchronized Reserve shortage), and so the shadow price of that constraint (and only that constraint) would appear in the System Marginal Energy Price.

Additional Considerations for Eliminating Primary Reserves

- If Primary Reserves are removed from PJM’s Energy and Ancillary Service Markets, a new trigger for Performance Assessment Intervals (PAIs) will likely need to be selected. PAIs could, for instance, trigger on Synchronized Reserve shortages instead.

- There would be no product in PJM’s reserve markets that explicitly values 10-minute or less time to start resources (though these resources could still clear in 30-minute time to start products). PJM believes this is reasonable since there is currently no performance evaluation in practice that measures whether 10-minute time to start resources come online within 10 minutes when called upon.

Proposed Changes to Synchronized Reserve Locational Procurement

Locational Needs for Synchronized Reserves

- Synchronized and Primary Reserves are deployed under emergency conditions, such as the loss of a large unit.
- Under these conditions, power flows can temporarily exceed transmission facility limits while PJM dispatchers work to re-dispatch the system and bring flows back under normal operating limits.
- Today, PJM models reactive interfaces that represent deliverability into PJM's active reserve sub-zone.
- While temporary exceedances of thermal facility limits are in general acceptable for a limited time following a unit loss, specific interfaces that have critical limits (such Interconnection Reliability Operating Limits or IROLs) need to be modeled for Synchronized Reserves because, if violated, PJM risks system instability and cascade.

Locational Design for Synchronized Reserves

- Initially, PJM proposed maintaining the status quo reserve sub-zones for PJM's Synchronized Reserve locational procurement design.
- PJM is now proposing to leverage the same locational reserve structure proposed for some of its other, new reserve products targeted at this specific set of interfaces.
- PJM believes this would have similar reliability benefits to the sub-zone structure used today while providing a more granular representation of the resource-by-resource impact on the interface(s) of concern and without requiring a sub-zone definition and ORDC. This would provide consistency across PJM's reserve markets.

What might the new locational procurement of Synchronized Reserves look like?

- The same interface definitions used today could be used to represent the locational deliverability need under the new locational design.

- Rather than defining a “sub-zone” these interface definitions could be used in a Synchronized Reserve congestion constraint for SR deliverability, leveraging the same structure that was discussed in the Locational Procurement presentation from the November 18th RCSTF.

- If this deliverability constraint binds, this would lead to nodal Synchronized Reserve prices.

For Synchronized Reserve procurement, PJM would utilize a congestion constraint.

PJM would represent energy and reserve congestion across the specific interface(s) of concern with an optimization constraint in the dispatch engine as below:

$$-Tx\ limit \leq \sum [(Gen_e + Gen_{SR}) \times DFAX] - \sum [Load_e \times DFAX] \leq Tx\ limit$$

Where:

- $Tx\ limit$: Transmission facility flow limit
- Gen_e: Generator energy dispatch at the target interval
- Gen_{SR}: Generator Synchronized Reserve assignment
- $Load_e$: Load withdrawal at the target interval
- $DFAX$: Generator or load distribution factor for the reactive interface(s)

Additional Reforms to Synchronized Reserves

PJM may additionally bring forward reforms to Synchronized Reserves in the following areas.

Consequences for non-performance during a Synchronized Reserve Event

How PJM quantifies the largest contingency

Status Quo Consequences for Synchronized Reserve Non-Performance

- If a resource with a Synchronized Reserve assignment fails to fully convert the procured Synchronized Reserves to energy during a Synchronized Reserve Event, the resource must pay for the Synchronized Reserve Credits for the MW short fall at the real-time Synchronized Reserve Market Clearing Price in every interval in which it cleared during both:
  - The day of the event (including five-minute intervals outside of the event)
  - Over the immediate past interval, which is equal to the lesser of:
    - The average number of days between events OR
    - The number of days since resource’s last non-performance
- If the event duration is less than 10 minutes, there is no obligation to refund credits due any shortfall.
- See section 6.3.3 of M28: https://www.pjm.com/-/media/documents/manuals/m28.ashx

Why is PJM considering changes to the consequences for Synchronized Reserve Non-Performance?

- PJM has a reliability obligation to recover from a unit loss within 15 minutes. To ensure compliance with this NERC Requirement, PJM's objective is to recover within 10 minutes. Given the importance of this reliability obligation, PJM believes that incentives to perform during a Synchronized Reserve Event should be meaningful.

- PJM increases the Synchronized Reserves it provisions based on resource performance. Today, PJM is carrying an additional 20%. This increases the cost of reserves, which is allocated to load.

- As presented to the RCSTF in 2024, the $/MW penalties today for different resources providing Synchronized Reserves varies significantly resource to resource even though resources are providing the same critical reliability service and the failure to provide that service has the same impact to the system.

- PJM is considering approaches that will (1) result in more consistent and transparent financial consequences (in $/MW) for non-performance for each resource for the same event and (2) more accurately reflect the cost incurred to the system to provision the reserve service.

Status Quo Quantification of PJM's Largest Contingency

- When calculating the largest contingency on the system to set its Synchronized Reserve Requirement, PJM considers the largest resource on the system at any given time.
  - In the Day-Ahead Market, PJM's SR Requirement is equal to the economic maximum of this largest available unit.
  - In the Real-Time Market, PJM's SR Requirement is set based on the largest online unit. The quantity is equal to the greater of 1) this unit's economic maximum or 2) its current output.

- See section 4.3 of M11: https://www.pjm.com/-/media/DotCom/documents/manuals/m11.ashx

Why is PJM considering changes to how the largest contingency is quantified?

- PJM is considering whether only considering the largest resource committed to the system continues to be the best approach or whether we should consider moving to setting the SR Requirement based on the resource with the greatest output.

- This would remove the lower bound on the SR Requirement based on the largest resource’s economic maximum. This could reduce the amount of reserves PJM needs to carry if the largest resource is operating below its economic maximum value.

- This could also open the door to allowing the optimization to evaluate the trade-off between the cost of carrying more reserves and the cost of energy dispatch.

- NYISO is moving toward a more dynamic approach to setting their reserve requirements through their Dynamic Reserve initiative, and PJM is interested in learning from the work they are doing and evaluating whether a similar approach would be beneficial and practical in our region.

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Acronyms

Acronym	Term & Definition
SR	**Synchronized Reserves** are reserves provided by resources that are synchronized to the grid and can respond within 10 minutes.
PR	**Primary Reserves** are reserves provided by resources that are either synchronized or not synchronized to the grid and can respond within 10 minutes.


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