PJM's Perspective on Approaches to Address Uncertainty

Keyur Patel

Principal Market Design Specialist

Reserve Certainty Senior Task Force

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Focus of today's discussion

Overview of Identified Reforms

Challenges to be Addressed

- The Day-Ahead Energy Market does not procure sufficient reserves to manage operational risk, leading to out-of-market reliability actions.
- PJM's markets do not procure flexibility to manage forecast uncertainty (i.e., load, wind, solar, interchange and forced outage rates).
- PJM's real-time dispatch engine does not account for flexibility and ramping needs forecasted in future intervals.
- PJM's ORDCs are based on an old market design.
- The cost of advanced fuel arrangements and other availability measures to provide reserves may at times be unrecoverable through PJM's existing market constructs.

Proposed Solutions to Explore

Enhancements to Existing Reserve Markets

- Updates to PJM's ORDCs
- Changes to resource offer rules into reserve markets to enable cost recovery
- IT SCED enhancements to better manage upcoming flexibility needs
- Performance evaluation and incentives to ensure alignment with operational needs
- Incentives to follow PJM dispatch
- Locational procurement of reserves for reliability

New Reserve Products

- Day-ahead reserve product(s) to better align with day-ahead operational needs
- Ramping/uncertainty reserve products to manage growing operational uncertainty

PJM's Uncertainty Needs are Not Accurately Reflected in Our Existing Markets.

PJM's markets do not procure flexibility to manage forecast uncertainty (i.e., load, wind, solar, interchange and forced outage rates).

- Reliability needs dictate that PJM manage uncertainties that are not reflected in its markets.
- This leads to a clear misalignment between PJM's operational needs and its market design.
- As more wind, solar and behind-the-meter generation enter the system, forecast uncertainty will grow, introducing new reliability risks, and exacerbating these existing issues.

CAISO, NYISO, MISO, SPP, and ERCOT have all designed their reserve markets to manage net-load forecast uncertainty.

Uncertainty in PJM Markets

Today, PJM ensures that we have sufficient reserves available to manage our uncertainty reserve needs through Day-Ahead Scheduling Reserves (DASR).

DASR = PJM Load Forecast x (Avg. Load Forecast Error + Avg. Gen. Forced Outage Rate)

DASR is used day-ahead in operations to pre-position the system for reliability in real-time. However, it is not reflected in PJM's markets.

As the energy transition progresses, PJM anticipates needing reserves to manage new and growing uncertainties, such and wind and solar forecast uncertainty, in addition to the load forecast and generator forced outage uncertainties included in DASR today.

PJM sees a need to develop new market constructs to reflect these uncertainty reserve needs in its market.

Solutions for Addressing Uncertainty in Other ISOs

MISO

Has implemented a 30-minute Short-Term Reserve product in both the DAM and RTM, which is in part designed to manage uncertainties associated with net-load forecast error.

CAISO

Has implemented Imbalance Reserves in the DAM and a Flexible Ramping Product in the RTM to address net-load uncertainty.

NYISO

Intends to add its net-load uncertainty to its existing 10- and 30-minute reserve requirements and to implement a new 60-minute uncertainty reserve product. NYISO will carry more reserves day-ahead than in real-time.

SPP

Has implemented Ramp Capability and Uncertainty Reserve products to manage both forecasted ramping needs and net-load forecast uncertainty.

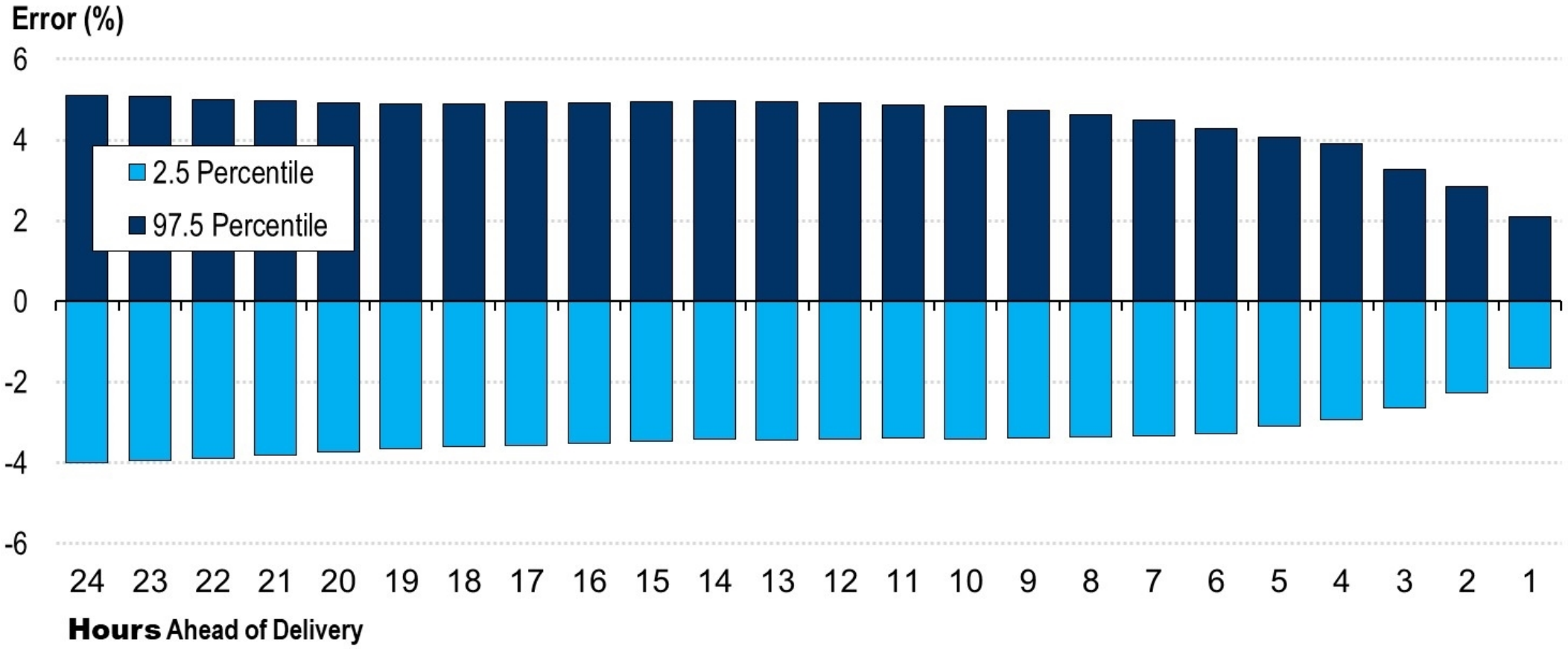
	Uncertainty Reserves
PJM	
MISO	✓
CAISO	✓
ISO-NE	
NYISO	✓
SPP	✓
ERCOT	✓

Uncertainty Factors

- Net-load forecast error
  - Load forecast error
  - Solar forecast error
  - Wind forecast error
- Generator forced outage rates
- Net interchange error

Uncertainty Evolves Over Time

Figure: 2.5 and 97.5 Percentile Net-Load Forecast Percent Error One to 24 Hours Ahead of Delivery Time During the 2023/2024 Delivery Year



How does PJM Envision Utilizing Uncertainty Reserves?

- Uncertainty Reserves would be “deployed” through normal energy dispatch, and the performance obligation would entail being ***available for dispatch*** and ***following dispatch instructions***.

- **Availability:** Resources would be expected to be available to provide energy if needed.

- **Dispatchability:** Resources would be expected to follow energy dispatch instructions.

Reserve Product Definitions

- PJM's operational experience supports using a 30-Minute Reserve product to manage uncertainty.
- Many of the other ISOs have determined that a 10-minute product is also valuable in providing the needed flexibility in shorter time frames to provide uncertainty and ramping services.
- A broader set of products, potentially including longer lead time products, provides the ability to procure flexibility services across a broader set of resources, which could promote market efficiency. This needs to be weighed against any additional complexity introduced by developing new products.
- Uncertainty reserve product definitions and requirements should ultimately be driven by quantified reliability risk and the characteristics of the generation fleet.

PJM's Existing 30-Minute Reserves

PJM is evaluating re-purposing its existing 30-Minute Reserve product to manage uncertainty. This would require re-evaluating aspects of PJM's existing reserve market design.

- Locational deliverability needs may be different than they are today.
- Procurement quantities would be driven by uncertainty and risk factors, rather than as a function of largest single contingency.
- Resource eligibility requirements may need to be updated to support utilizing these reserves for uncertainty (e.g., minimum run time, duration, etc.)
- Reforms may be needed to performance evaluation and consequences for resource non-performance.

Locational Procurement

- Procurement of uncertainty reserves needs to align with how the system must be positioned for reliable operations

- Because uncertainty reserves would be deployed economically through normal dispatch procedures to serve load, PJM anticipates needing to procure these reserves locationally to ensure deliverability.

Resource Offers for Uncertainty Reserves

- Any avoidable availability costs should be recoverable through PJM markets and reflected in resource offers. These costs could include fuel arrangement, charging or settlement risks as appropriate to the market design.
- The quantity of reserves that could be cleared would be based on energy offer parameters.
- Avoidable costs to resources for providing reserves may be different day-ahead than in real-time, which may need to be considered in the market design.

Settlement Considerations

- In PJM's existing reserve constructs, such as 30-Minute Reserves, the day-ahead reserve assignment is settled against a corollary real-time reserve assignment which is generally similar in quantity.
- Because uncertainty tends to attenuate as the time of delivery approaches, PJM expects to need to carry more uncertainty reserves day-ahead than during real-time.
- NYISO's market design will allow their day-ahead requirements to be consistently higher than their real-time requirements.
- PJM is evaluating this approach but has open questions about whether there could be implications for resource performance incentives.

Performance and Settlement

Performance Evaluation	Settlement Consequences for Non-Performance
1. Evaluate whether the resource is available 2. Evaluate whether the resource follows dispatch instructions	Possible options: • Claw back of uncertainty reserve revenue • Payment for replacement energy based on real-time LMP • Others?

Who should pay for the cost of procuring uncertainty reserves?

Based on who causes the need for uncertainty reserves

- In general, load, net exports, generation deviation (including renewable generation resources) and generation forced outage rates cause the need for the uncertainty reserves.
- Very complex to identify and incorporate into rate design.

Based on who primarily benefits from the product

- In general, load plus exports are the primary beneficiaries of uncertainty reserve products.
- Other transactions may benefit from these products but their accrued benefit (and resultant allocation) relative to load and export may not be significant enough to justify the complexity of identifying and incorporating them into the rate structure.

Forecast Ramp Need

PJM's markets do not procure ramping capability to manage expected ramping/flexibility needs in the near term.

- Because PJM's RTSCED is a single interval dispatch, flexible ramping needs to manage net-load ramp beyond the target interval are currently met by introducing load biases to dispatch solutions.
- This impacts real-time prices without sending the correct flexibility signals.
- As more wind, solar and behind-the-meter generation enter the system, ramping needs will grow. If not addressed through market reforms this may require more operator intervention and result in further misalignment between PJM's reliability needs and its markets.

MISO and SPP have both designed ramping products to manage both expected and unexpected ramping needs.

Multi-Interval Dispatch

Multi-Interval Dispatch in the Real-Time Market can address forecasted ramping needs by allowing pre-ramping of resources to maximize economic use of available capability by trading off the costs between intervals. In other words, we might want to ramp a slower ramping resource *now* because we are going to need them in *future intervals*.

- Multi-interval dispatch is used in CAISO and NYISO, but only the first interval is settled, which can lead to unintuitive pricing outcomes and the dispatching of resources out of merit order in the priced interval.

- Multi-interval dispatch coupled with a rolling settlement could help address these challenges but would require a very complex settlement implementation.

PJM's perspective on forecasted ramp need

- PJM is currently not evaluating multi-interval dispatch because of the challenges associated with aligning resource incentives with following PJM's dispatch instructions and the complexities in settlement and implementation.

- PJM is evaluating whether we need to procure the flexibility to meet the forecasted ramp through a reserve product(s) similar to the approach taken by other ISOs.

Summary

1. PJM believes that uncertainty products are needed to procure reserves to manage the reliability risks associated with wind, solar, and load forecast error as well as generator forced outage rates.

2. PJM is considering market designs that would repurpose our existing 30-Minute reserve product to address these uncertainty needs.

3. PJM is evaluating whether additional new products are needed, such as a 10-minute uncertainty product and/or longer lead-time products.

4. PJM is also evaluating whether forecasted ramping needs should be added as a component of existing or new reserve product requirement(s).

Contact

Facilitator:
Lisa Morelli, Lisa.Morelli@pjm.com

Secretary:
Amanda Egan, Amanda.Egan@pjm.com

SME/Presenter:
Keyur Patel, Keyur.Patel@pjm.com

PJM's Perspective on Solutions to Address Uncertainty

Member Hotline

(610) 666 – 8980

(866) 400 – 8980

custsvc@pjm.com

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