New York ISO
Independent System Operator

Balancing Intermittency: Initial Analyses

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Background

- **Leveraging the findings in the 2022 Grid in Transition Study, the Balancing Intermittency project is evaluating whether market enhancements are necessary to continue reliably maintain system balance on a future grid characterized by large quantities of intermittent renewable resources, ESR, and DER.**
  - The primary questions we are looking to answer with this project are:
    - Are there concerns with forecast error that could lead to operational concerns as the share of intermittent resources increases?
      - If so, are existing Ancillary Service products adequate to address them?
  - Separately, there was an investigation on the future impacts to Regulation Service requirements which was led by Operations and Planning.
  - The Dynamic Reserves Phase 2 project would consider whether and how to make dynamic any new products or enhancements proposed in the Balancing Intermittency project.

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Objective of Today's Discussion

- **Analysis discussed on the coming slides indicates that the basis of the current reserve procurements is inadequate to sustain reliability on the grid of the future.**
  - The analysis supports that reserve requirements need to be based on forecast error, in addition to the single largest contingency.
- **The NYISO believes there is a need to enhance reserve markets to facilitate grid reliability into the future.**

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Definitions

- DAM = Day-Ahead Market
- DAM Net load forecast = Day-Ahead Gross load forecast – Day-Ahead behind-the-meter (BTM) solar forecast – Day-Ahead wind forecast
- Net Load Actual = Observed real-time gross load – Observed real-time BTM solar output – observed real-time wind output
- DAM Net Load Forecast Error = DAM Net Load Forecast – Net Load Actual
- Reserve sustainability = The duration (number of hours) that reserve providers can sustain energy output upon conversion from reserves to energy. The current reserve sustainability requirement in the NYISO markets is 1 hour. This characteristic will be defined further in upcoming project presentations.

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Assessing Grid Needs Driven by Forecast Error

- **DAM net load forecast errors can increase RT energy needs relative to the DAM solution**
  - These RT energy needs must be met to ensure reliability.
- **While the tools for forecasting load and intermittent resources are highly sophisticated, there will always be some amount of error that cannot be eliminated.**
  - Forecast errors are expected to be larger and more impactful in the future with more intermittent resources.
  - The analysis on the following slides examines the instances in 2021 and 2022 where the DAM net load forecast (load forecast net of wind and solar forecasts) underestimates the real-time net load.
    - These circumstances represent times of increased generation need in real-time as compared to the Day-Ahead expectation.
    - Real-time net load exceeds DAM net load forecast in roughly 50% of intervals on average.
  - Forecast error risk should be managed via market-based solutions.

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DAM Net Load Forecast Errors Are Significant in Magnitude and Duration

- **The current NYCA reserve requirement is designed to protect against a specific contingency event, which is not the only system risk.**
  - Based on the historical analysis of 2021-2022 NYCA DAM Net Load Forecast Error data, there are several hourly instances where the DAM Net Load forecast errors exceed the size of the largest generator contingency.
- **Currently, NYISO manages forecast uncertainty by out-of-market actions, such as SREs, to commit additional resources, and procuring energy from resources without DA Energy or Reserves schedules (Latent Reserves).**
  - Latent reserves are expected to decline with increased levels of intermittent generation and duration-limited resources, as well as with retirement of upward-flexible fossil-fueled resources.
    - Currently approximately 75% of eligible non-spin MW are fossil-based resources, and approximately 78% of eligible spinning reserve MW are fossil-based resources.
  - We do not have certainty today that latent reserves can be available if needed, since without a reserves schedule, a dispatchable unit may not be available.

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Multi-Hour DAM Net Load Forecast Error Duration Analysis

- **The multi-hour DAM Net Load forecast error duration is a rolling metric that is calculated based on the duration of consecutive forecast errors (ramp up/down) in the dataset.**
  - The dataset is for the time period of 2021-2022.
  - The NYCA DAM Net Load Forecast is calculated by removing the DAM Wind Forecast values from the DAM Load forecast (which already includes the BTM Solar Forecast impacts)
    - DAM Net Load forecast = Gross DAM Load Forecast (includes BTM Solar forecast impact) – DAM Wind Forecast
  - Actual Net Load values were calculated by removing the actual Wind values from the actual load values, respectively.
    - Net Load Actuals = Actual Load (includes BTM Solar actuals impact) – Actual Wind
  - The rolling multi-hour forecast error and number of hours were calculated for the entire time period for Wind, BTM Solar, and Net Load.
  - For example, during a 12-hr time period, for Net Load forecast error, there could be two instances of 1 hour under-forecasting, three instances of 2 consecutive hours of over-forecasting, and one instance of 4 consecutive hours of over-forecasting.
  - The following analysis is focused on net load under-forecasting scenarios only.

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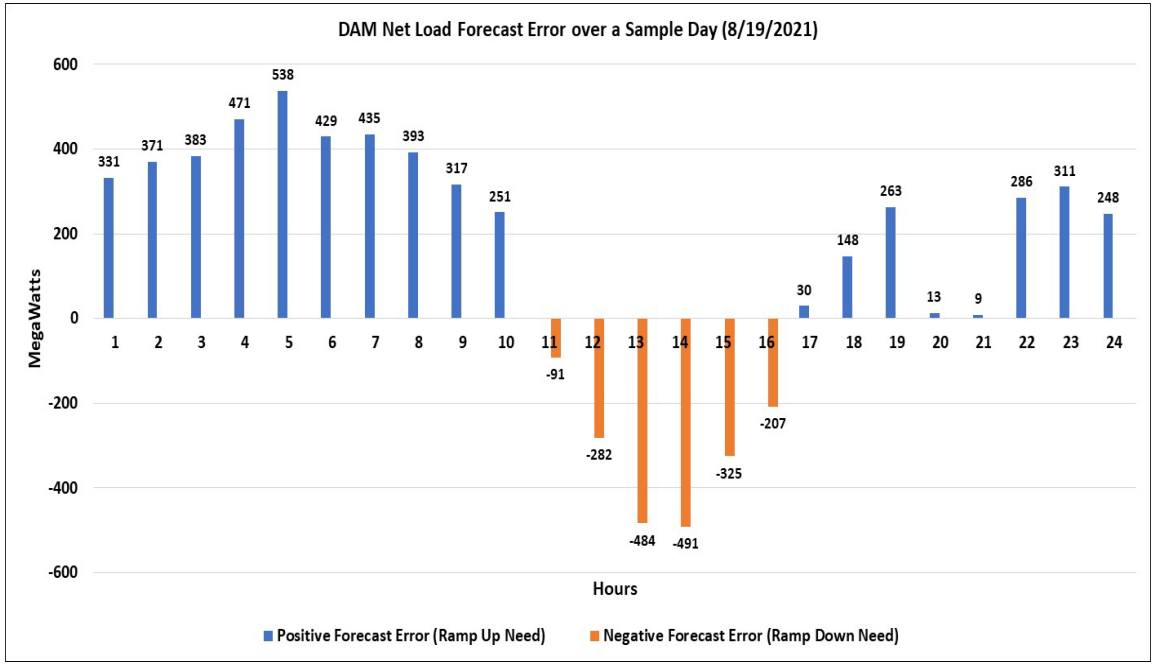
Multi-Hour DAM Net Load Forecast Error Duration Analysis Sample Day

Sample Day Statistics

Number of Forecast Error Events	Durations of Forecast Error Events (Hours)	Number of Ramp up events	Number of Ramp down events	Magnitudes of the Ramp up events (GWh)	Magnitudes of the Ramp down events (GWh)
3	10, 6, and 8	2	1	4 (10hr) & 1.3 (8 hr)	1.9 (6hr)



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Multi-Hour DAM Net Load Forecast Error Duration Analysis Sample Calculation

Time Interval	DAM Net Load Forecast (MW) (A)	Net Load Actual (MW) (B)	DAM Net Load Forecast Error (MW) (B – A)	Multi-Hour DAM Net Load Forecast Error (MWh)	Duration of Multi-Hour DAM Net Load Forecast Error (Hrs)
HB 01	80	100	20	80	4
HB 02	90	110	20		
HB 03	100	120	20		
HB 04	110	130	20		
HB 05	145	135	-10	-10	1
HB 06	135	145	10	10	1

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DAM Net Load Forecast Errors are Sustained for Several Consecutive Hours

- **The DAM net load forecast error can exceed the size of the most severe contingency and last for several consecutive hours.**
  - This added complexity of sustained forecast error could result in reserve shortages across longer durations if the state of charge for an ESR or fuel for a dispatchable supplier is limited (*e.g.*, during winter conditions).
    - Hence, it becomes important to study the energy MWh needs across a certain duration in addition to the MW needs.
      - Other ISOs/RTOs are also observing the importance of a MWh requirement
      - PJM's recent Winter Storm Elliot outage analysis emphasized the importance of energy unavailability (MWh) in addition to MW unavailability.

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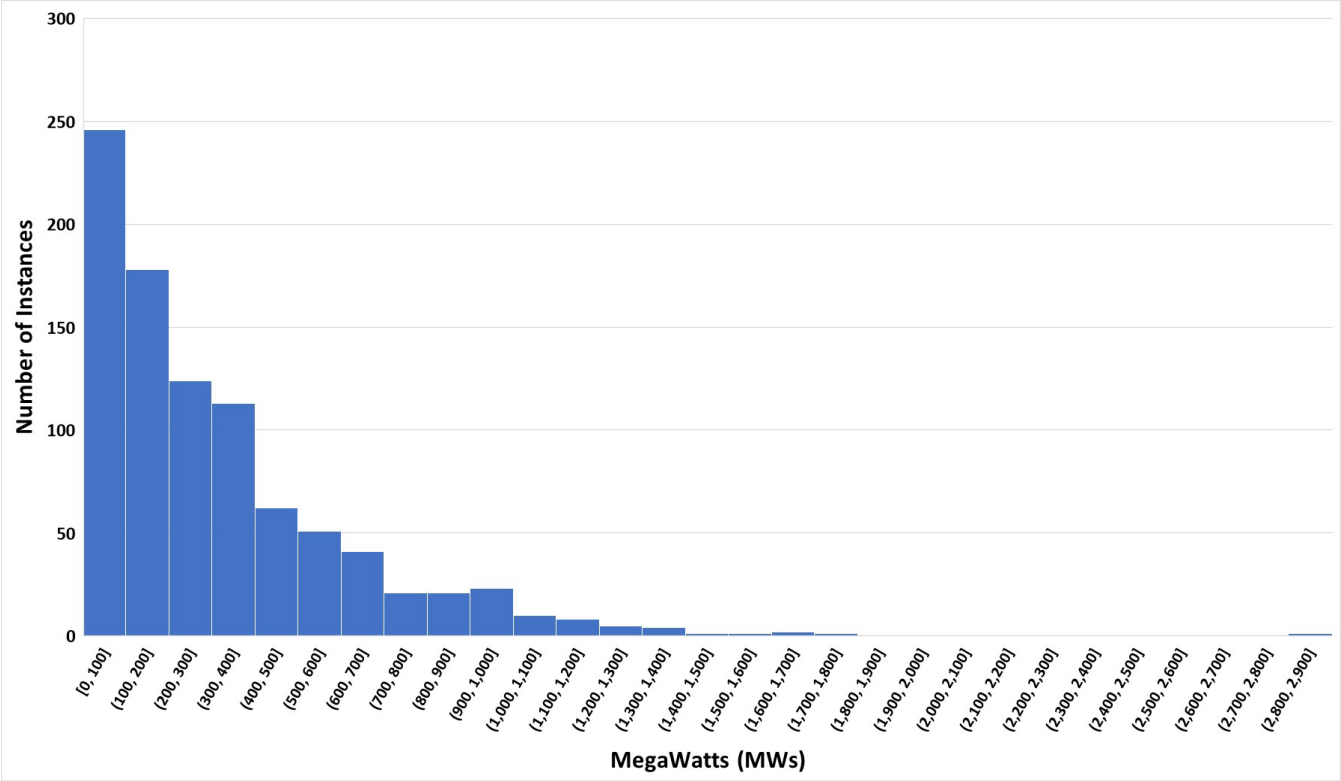
Multi-Hour DAM Net Load Maximum Forecast Error Frequency Analysis (2021-2022)



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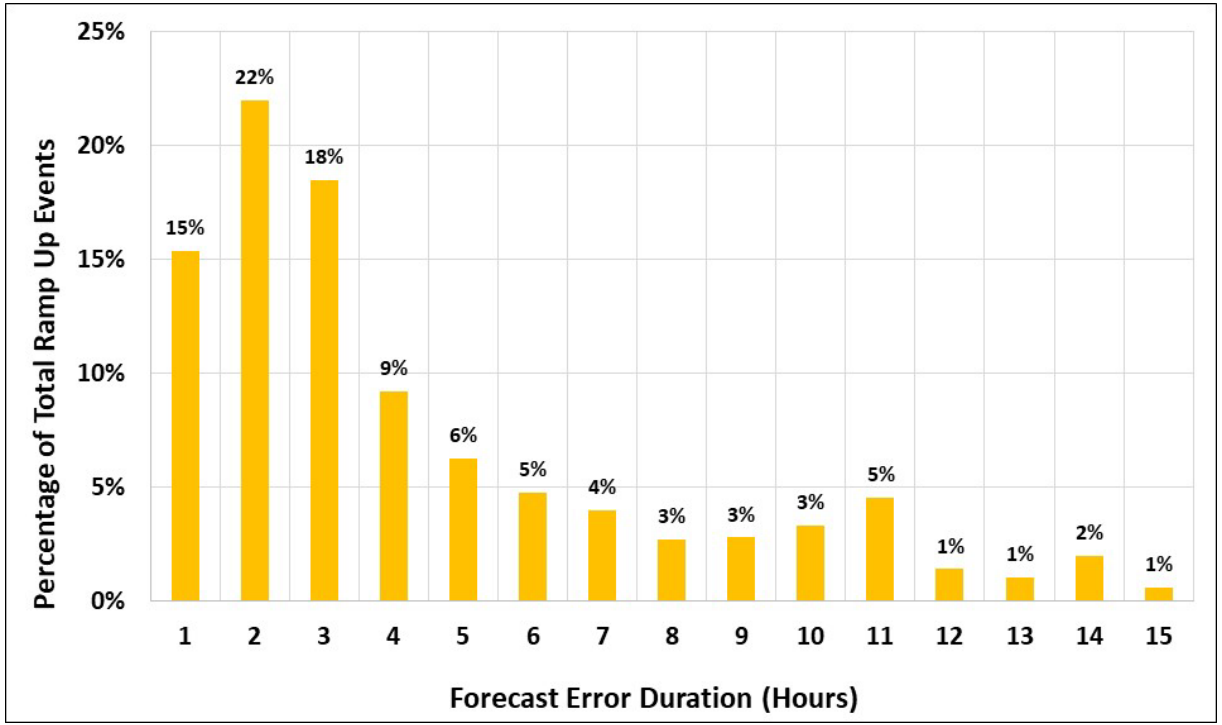
Multi-Hour DAM BTM Solar Forecast Error Duration Histogram



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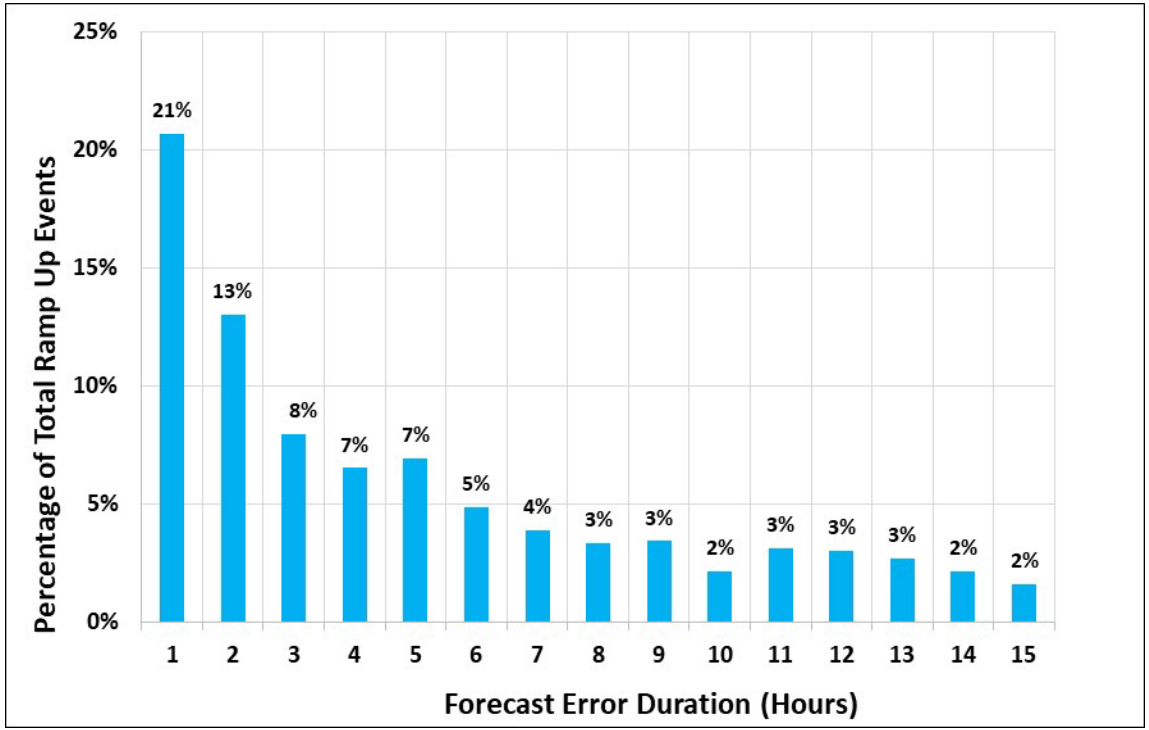
Multi-Hour DAM Wind Forecast Error Duration Histogram



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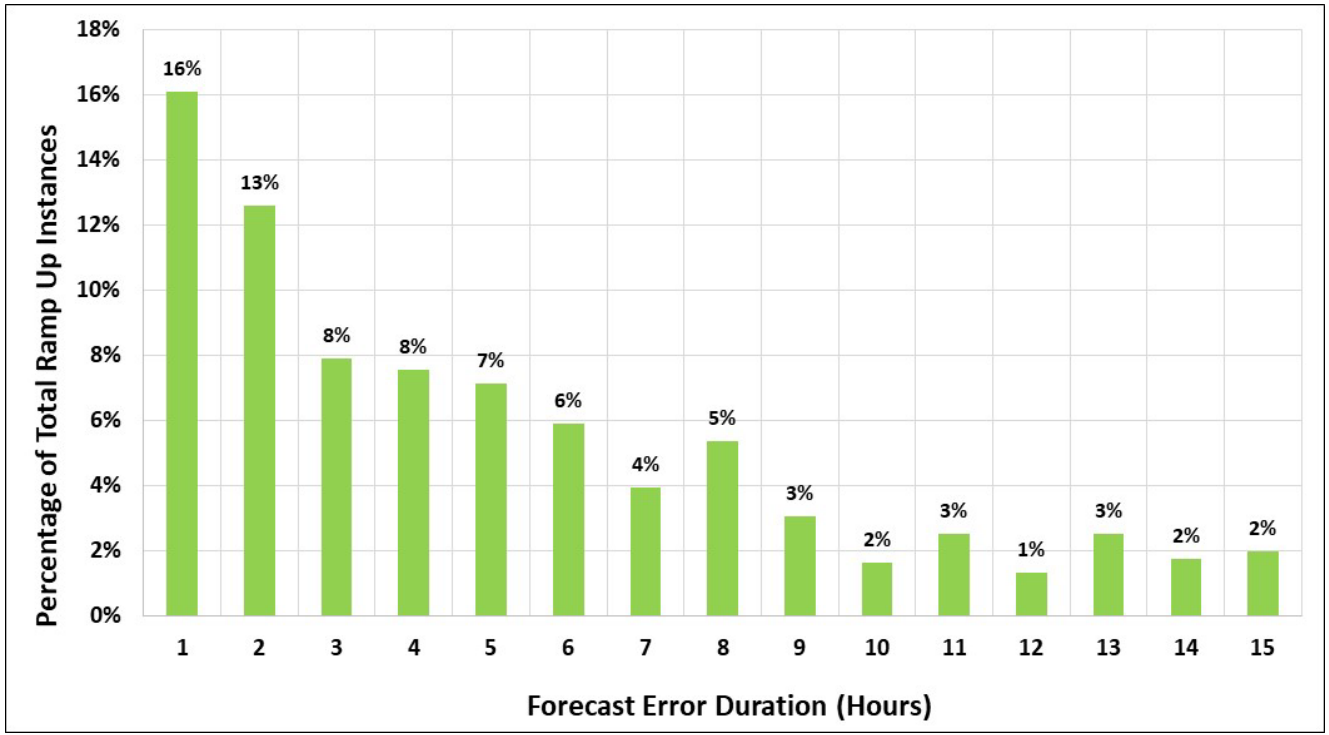
Multi-Hour DAM Net Load Forecast Error Duration Histogram



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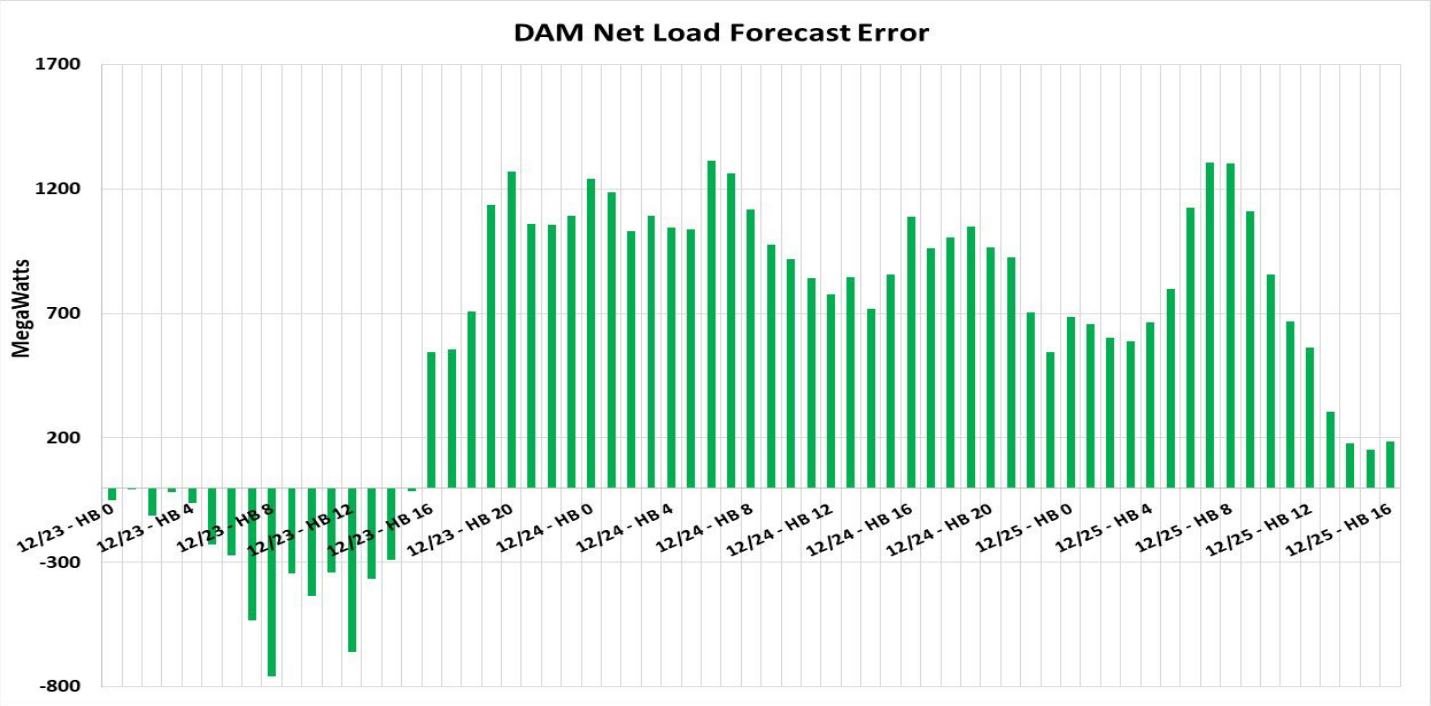
Notable NYISO Grid Event (12/23/22 – 12/25/22)



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Multi-Hour DAM Net Load Forecast Error Heat Map (2021-2022)

Total Under-forecasting Error (Ramp Up Energy) MWh

Duration of Error (Hours)

	400	800	1310	1600	2000	2620	3000	4000	6000	10000	14000
1	147	0	0	0	0	0	0	0	0	0	0
2	110	5	0	0	0	0	0	0	0	0	0
3	57	14	1	0	0	0	0	0	0	0	0
4	26	34	8	1	0	0	0	0	0	0	0
5	12	30	17	2	3	1	0	0	0	0	0
6	5	20	21	5	3	0	0	0	0	0	0
7	1	11	11	6	4	2	0	1	0	0	0
8	1	8	13	4	11	7	2	2	1	0	0
9	0	4	6	4	3	5	2	3	1	0	0
10	0	0	0	9	3	2	0	0	0	1	0
11	0	0	1	2	8	10	0	1	1	0	0
12	0	0	1	2	2	1	1	2	2	1	0
13	0	1	0	2	1	4	8	2	2	2	1
14	0	0	0	3	2	1	1	0	5	4	0
15	0	0	0	1	1	1	1	3	9	2	0
16	0	0	1	0	0	1	2	0	4	2	1
17	0	0	0	0	0	3	2	1	4	3	0
18	0	0	1	0	0	0	0	2	10	3	1
19	0	0	0	0	0	1	1	2	3	3	0
20	0	0	0	0	0	0	2	0	10	2	0
21	0	0	0	0	0	0	0	0	2	6	2
22	0	0	0	0	0	0	1	0	2	4	2
23	0	0	0	0	0	0	0	0	2	1	0
24	0	0	0	0	0	0	0	0	0	2	1

For e.g., there are 10 instances of 18-hour forecast error with a magnitude ranging from 4,000-6,000 MWh (hourly avg range of 222-333 MWh).

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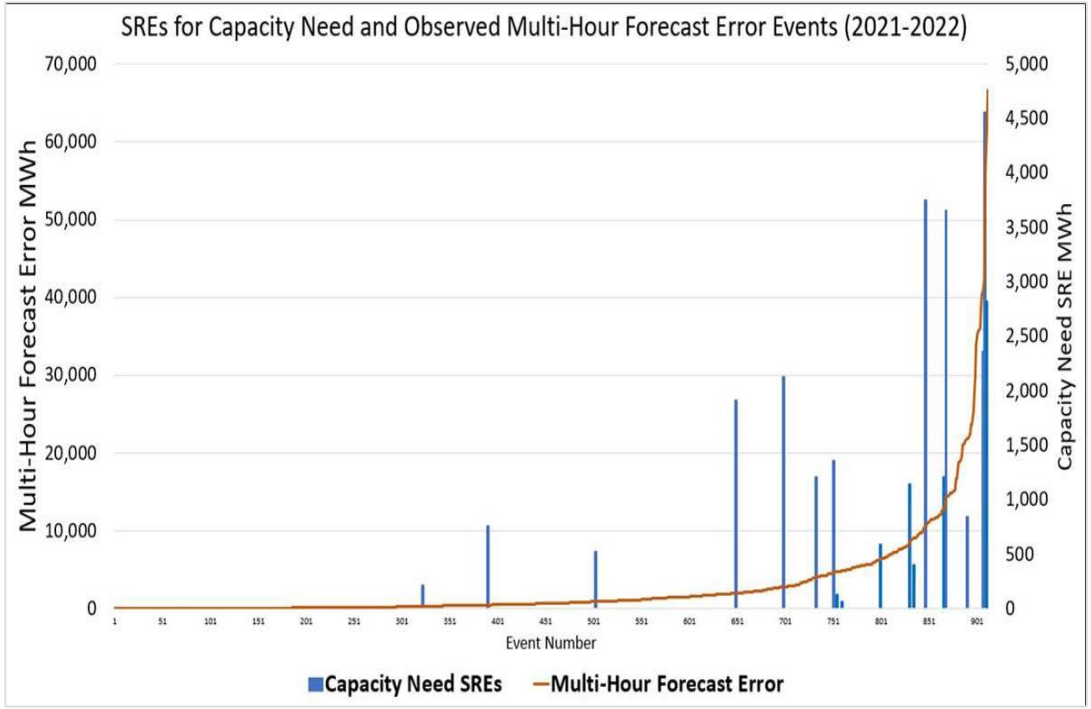
Correlation between DAM Net Load Forecast Error and Operator Actions



- **The NYISO does not currently issue SREs to explicitly address net load forecast error, but we observe a strong correlation between SREs and high forecast error.**
  - SREs issued for more capacity are 10 times more likely to occur during the top 10% of observed forecast error events as compared with the bottom 90%.
  - Operator actions are only expected to become more prevalent with continued additions of intermittent resources.

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Takeaways

- **The NYISO believes that enhancements to the reserves market are necessary in order to continue to promote reliability both today and in a future where forecast errors will become more impactful.**
  - Near-term enhancements should be pursued to bolster reserve procurements given the forecast errors that we observe today.
  - Longer-term enhancements could involve a more significant market change to create a specific reserves product aimed at balancing forecast uncertainty and improving reserves sustainability.
- **NYISO Balancing Intermittency MDCP will**
  - Propose a near-term increase in reserve requirements to ensure sufficient RT energy is available to accommodate current load and intermittent resource uncertainty.
  - Propose a reserve product structure, that may include a new reserve product (e.g., 60min or 90min reserves), that efficiently procures uncertainty reserves
  - Review reserve sustainability needs given the long duration of DAM net load forecast errors and potentially propose an increase in reserve sustainability requirements

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Other ISOs are Implementing Uncertainty Market Products

- **CAISO is implementing an Imbalance Reserve Product that will be based on forecast differences between the day-ahead and fifteen-minute market.[1]**
  - This product is designed to meet the largest historic risk and provide a more efficient solution than the currently frequent manual operator actions, such as load bias adjustments.
  - Uncertainty reserves are procured for both upward and downward capability.
  - CAISO runs scenarios to ensure that energy and all reserves are deliverable at once.
  - Product awards are capped at each unit's 15-minute ramping capability.
- **SPP is implementing an Uncertainty Product that procures reserves capability for 1 hour, driven by the addition of intermittent resources.[2]**
  - Their study found that procuring existing market-defined products leaves "little to no residual flexibility available to respond to system needs not explicitly procured with a defined market product."
- **ERCOT has implemented two longer-term reserves products:[3,4]**
  - A 4-hour sustainability product, with 30-minute lead time ("non-spin").
  - A 2-hour sustainability product, with 10-minute lead time ("ECRS").

1. CAISO Imbalance Reserve Design
2. SPP Uncertainty Reserve Design
3. ERCOT Non Spin Product
4. ERCOT ECRS Product

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Next Steps

- **August**
  - Return to ICAPWG/MIWG to continue discussions on necessary enhancements to the reserves market.
- **2023 Project Milestone: Q4 Market Design Concept Proposed**
- **Continue to evaluate the shortage pricing curves.**
- **Evaluate appropriate scheduling of reserves that are geared towards addressing net load forecast error by considering the supplier's energy costs.**

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Our Mission & Vision

Mission

Ensure power system reliability and competitive markets for New York in a clean energy future

Vision

Working together with stakeholders to build the cleanest, most reliable electric system in the nation

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