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Independent System Operator

Balancing Intermittency Market Design

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Agenda

- Background
- Need Assessment for Additional Reserves
- Requirement Setting Methodology Evaluation
- Uncertainty Reserve Requirement Setting Process
- Appendix

Background

Background

- NYISO carried out the Grid In Transition Study* in 2022 through which it was concluded that the variability of renewables is not a concern at this point of time
- The Balancing Intermittency effort is focused on a different aspect of renewables and load i.e., the uncertainty of load and renewable forecasting.

*Grid In Transition Study 2022

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Background

- Leveraging the findings in the 2022 Grid in Transition Study, the Balancing Intermittency project is evaluating whether new market enhancements are necessary to continue reliably maintaining system balance, given a future grid characterized by large quantities of intermittent renewable resources, ESR, and DER.
  - The primary question 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?

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Need Assessment for Additional Reserves

Assessing Grid Needs Driven by Forecast Error

- 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 Day-Ahead 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 Day-Ahead net load forecast in roughly 50% of intervals on average.
  - Forecast error risk should be managed via market-based solutions.

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Assessing Grid Needs Driven by Forecast Error

- Analysis discussed on the coming slides indicates that the basis of the current reserve procurements is inadequate to sustain reliability in 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 that there is a grid need and that reserve market improvements are required to address this need.

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DAM Net Load Forecast Errors exceed the Size of the Largest Contingency

- The current NYCA reserve requirement is designed to protect against a specific contingency event, which will likely not always be the primary risk in the future.
  - Based on the historical analysis of 2021-2022 NYCA Net Load DAM Forecast Error data, there are several hourly instances where the DAM Net Load forecast errors exceed the size of the largest 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 fossil unit may not be able to procure fuel, and an ESR may be committed to a utility program, for example, during times of unexpected NYISO need.

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Multi-Hour DAM Forecasting Error Duration Analysis

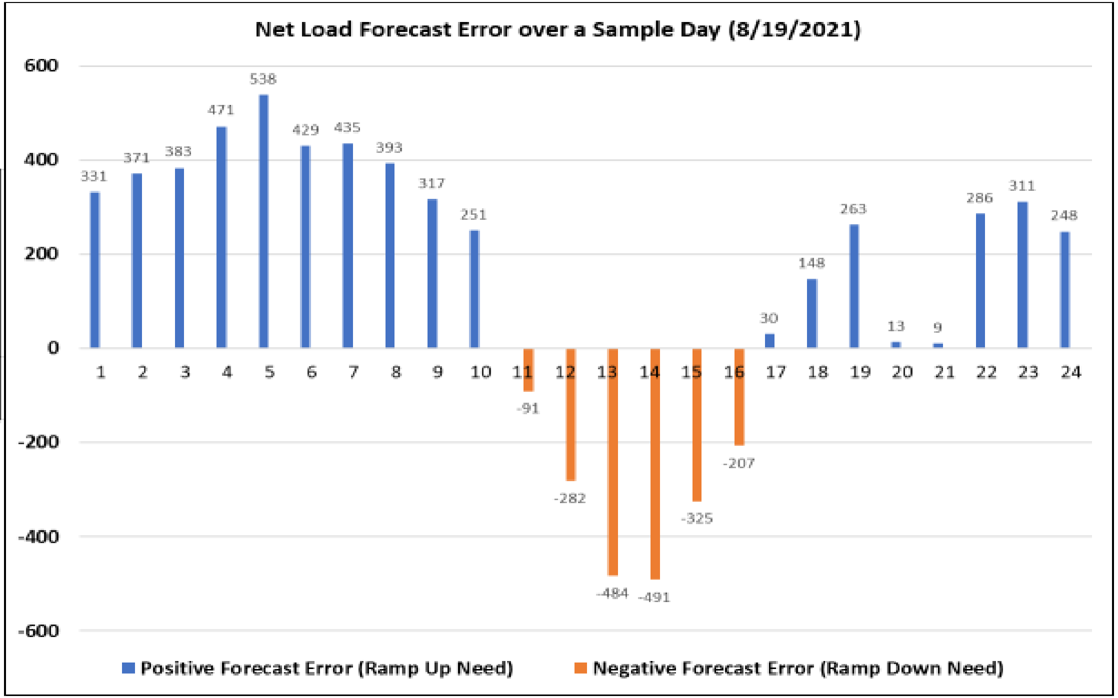
- The multi-hour DAM forecasting error duration is a rolling metric that is calculated based on the duration of consecutive forecast errors (ramp up/down) in the dataset.
  - The dataset is for the time period of 2021-2022.
  - The NYCA Net Load DAM Forecast and Actual values were calculated by removing the Wind + BTM Solar forecast and actual values from the Load forecast and actual values, respectively.
  - The rolling multi-hour forecast error and number of hours were calculated for the entire time period for 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 the duration of ramp up needs only.

Multi-Hour DAM Forecasting 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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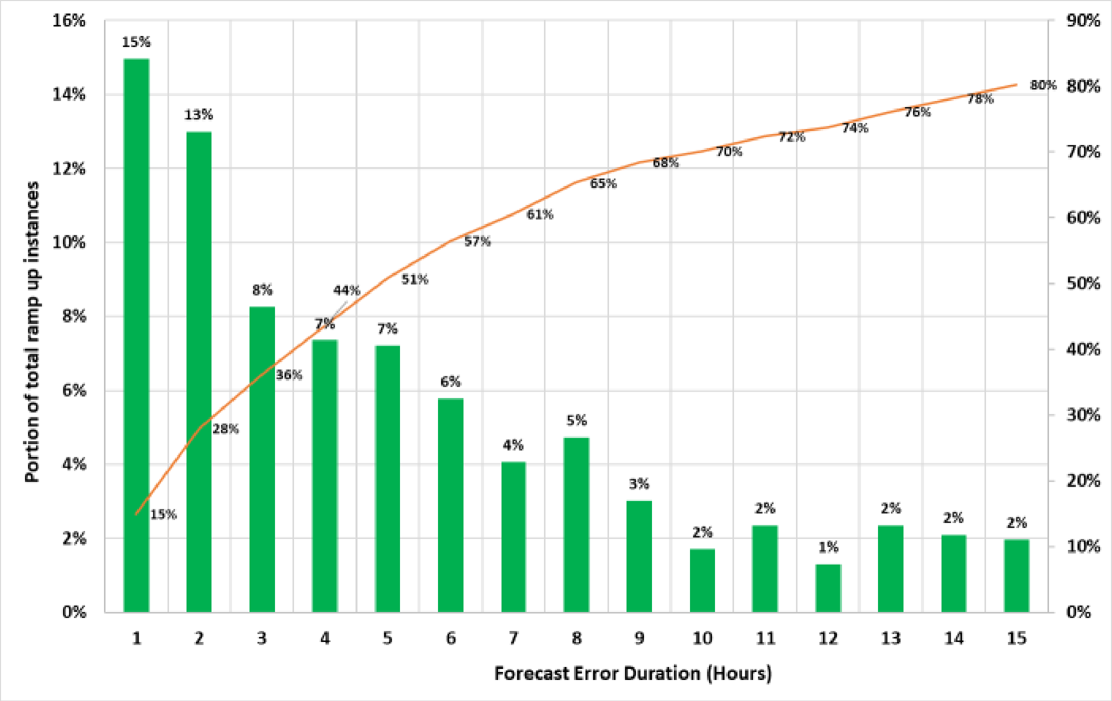
DAM Net Load Forecast Errors are Sustained for Several Consecutive Hours

- The 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 fossil fuel plant is limited (e.g., during winter conditions).

Net Load DAM Multi-Hour Forecast Error Duration Histogram with Cumulative %



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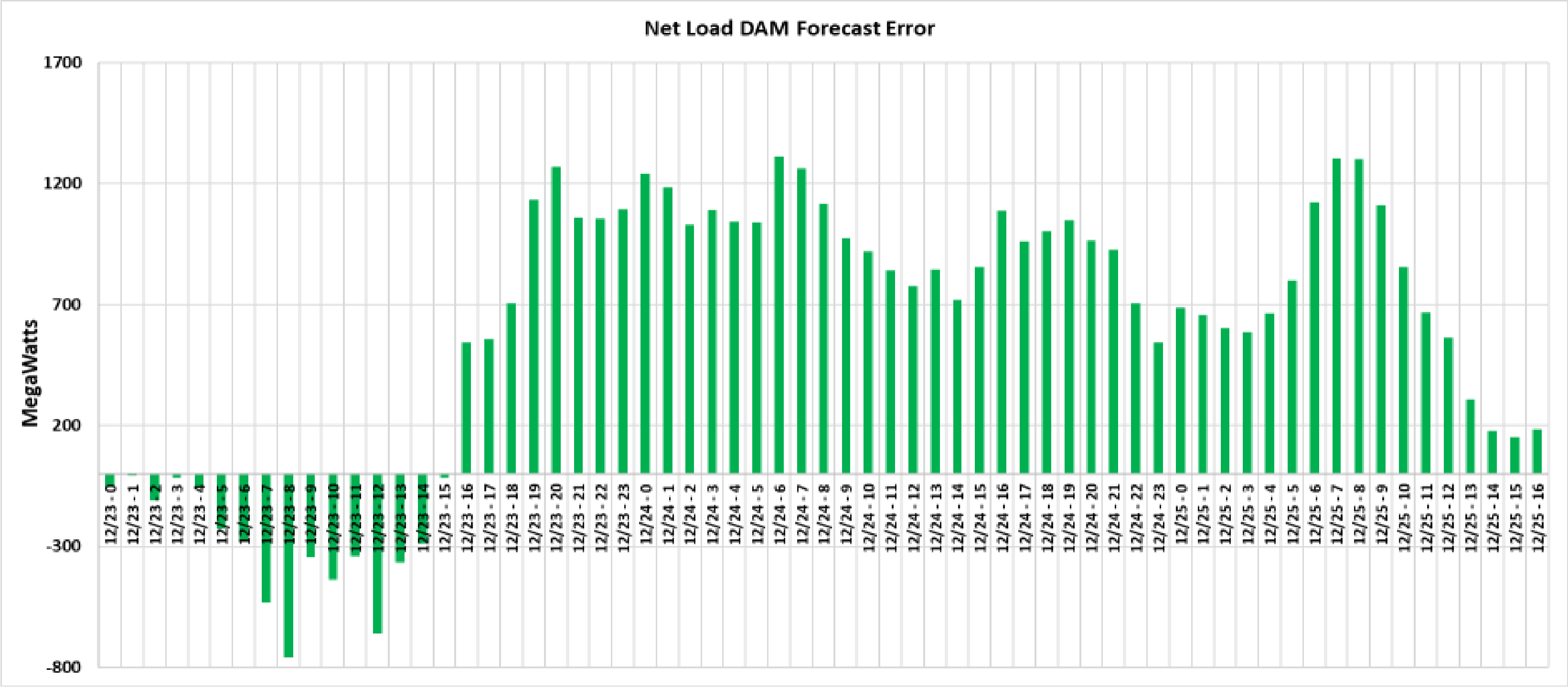
Extreme NYISO Grid Event (12/23/22 – 12/25/22)



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

Total Under-forecasting Error (Ramp Up Energy) MWh

Duration of Error (Hours)

	400	[illegible]	[illegible]	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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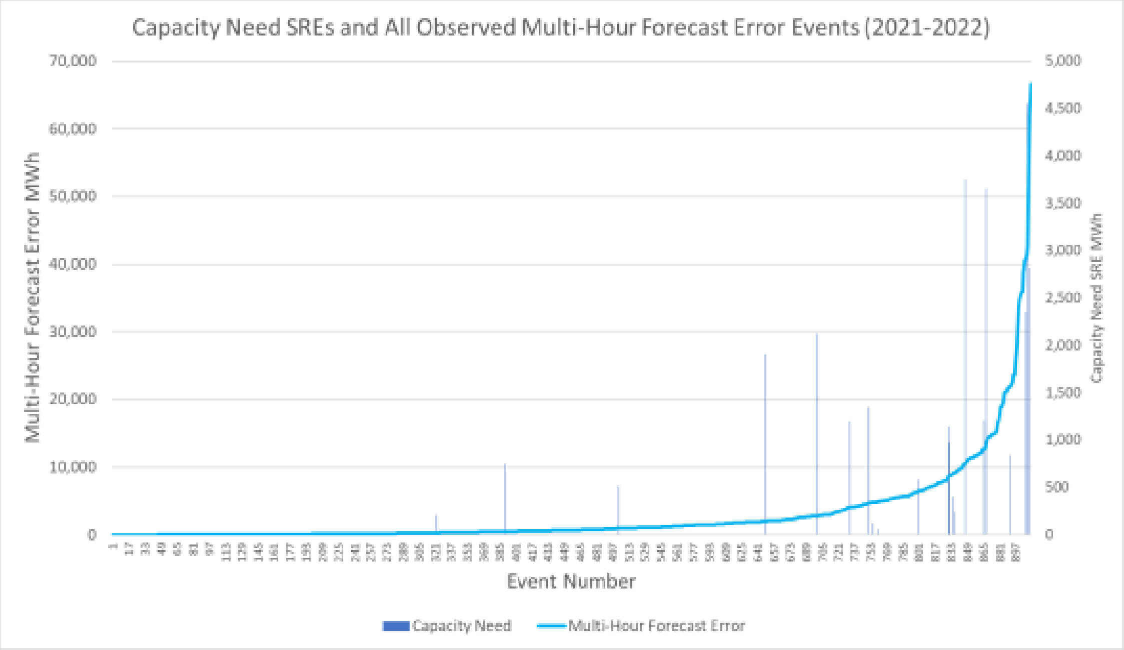
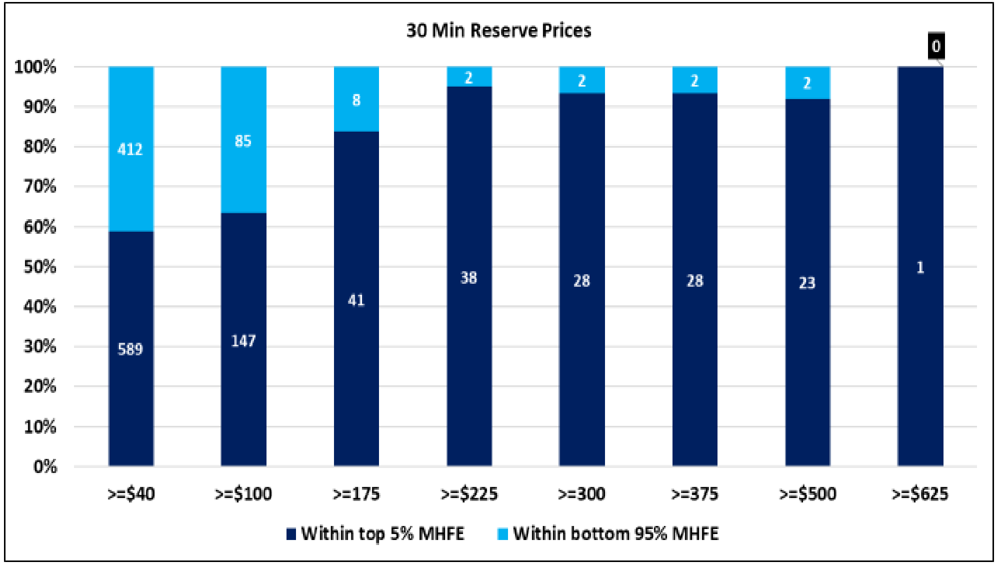
Correlation between Forecast Error and Operator Actions



- The NYISO does not currently issue SREs to explicitly compensate for net load forecast error, but we observe a strong correlation between SREs for "capacity need" and intervals of high forecast error.
  - SREs for capacity need 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.

Reserve Shortage Prices during High MHFE Events

- The durations of events with reserve shortage prices were mapped to the DAM Net Load Multi-Hour Forecast Error events to determine the frequency of reserve shortages during multi-hour forecast error events.
- For different reserve shortage price steps, the instances were counted to construct the stacked frequency chart on the right.
  - 30-min RT prices were studied.
- In total, there are 1827 MHFE events for 2021-2022.
- Two categories of multi-hour forecast error events were chosen:
  - Top 5% of Multi-Hour Forecast Error Events (91 events)
  - Bottom 95% of Multi-Hour Forecast Error Events (1736 events)
- It is observed that reserve shortages seem to occur more during events of high MHFE as is displayed in the chart on the right.



*In this section, Net Load is Load net of BTM Solar and Wind

Reserve Pickups during High MHFE

- During 2021 – 2022, there were 142 Reserve pickups.
  - Within the top 5% of MHFE events, there were 46 activations of reserve pick-ups.
    - The remainder occurred during the bottom 95% of the MHFE events.
      - This shows that 32% of the reserve pickups happened during the top 91 events of MHFE while the rest 68% occurred during bottom 1837 events of MHFE.
- Proportionally, a single reserve pickup activation seemed to occur for every 2 events from the top 5% of MHFE category while a single reserve pickup activation occurred for every 19 events from the bottom 95% of MHFE category.
- This data is not determinative of the cause of reserve pickups, it simply identifies that reserve pickups in 2021-2022 occurred more during high MHFE events.

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Requirement Setting Methodology Evaluation

Historical Method: Direct Observation

- NYISO performed an in-depth analysis of the Direct Observation option while Regression Analysis options were not selected for evaluation.
  - Regression Analysis was not selected after an initial review that determined forecast errors tend to be random (the intuition here is that if we could predict when our errors would occur and their magnitude, we would incorporate that knowledge into the forecast model and reduce the error.)
- The following slides discuss the NYISO's evaluation of setting uncertainty reserve requirements using the distribution of historically observed forecast error.
  - Additionally, as described in subsequent slides, the NYISO's proposed requirement-setting method will vary with Net Load forecast and wind forecast levels.
  - The evaluation of uncertainty reserve requirements were carried out separately for Wind and Net Load (Load with BTM Solar Impacts) since it has been observed that the Wind errors are not correlated with Load errors and so calculating reserve requirements of the Net* Load (Load with BTM Solar and Wind impacts) could be problematic.

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Evaluating the "Historical Analysis" Method

- NYISO developed uncertainty requirements using a sub-set of the historically observed forecast error data and then performed "out of sample testing" to evaluating the accuracy and stability of the uncertainty requirement. NYISO tested multiple sub-sets of historically observed forecast error data.
  - 7-day Requirement
    - Utilizing the forecast errors in the past 7 days to set the requirement for the current day.
  - 30-day Requirement
    - Utilizing the forecast errors in the past 30 days to set the requirement for the current day.
  - 90-day Requirement
    - Utilizing the forecast errors in the past 90 days to set the requirement for the current day.
  - Historic Like-Month Errors
    - Utilizing the forecast error observed in same month from the prior year to set the Uncertainty Reserve requirement for the current month.
  - Historic Annual Errors
    - Utilizing the forecast error from the entire previous year to set the Uncertainty Reserve requirement for the current year.

Evaluating a Combination of Historical Long-Term and Short-Term Error metrics

- Using shorter-term data allows model errors to reflect recent forecast performance, but potentially suffer from a small sample size that doesn't accurately characterize the overall error of the forecasts. Conversely, using longer-term data captures a large amount of data and reflects the overall error of the forecasts but will be unable to capture changes in recent forecast performance or system changes.
- NYISO also looked at blending historical long-term uncertainty requirements with historical short-term uncertainty requirements to capture benefits from both the worlds.
- For the historical long-term uncertainty requirement, NYISO is using the static historic annual error from the prior year while for the historical short-term uncertainty requirement, NYISO is using the last 2 months from the current month.
  - For example, for setting the uncertainty reserve requirement for the month of June 2022, NYISO would be using the static historic annual error from 2021 and the 2-month error metric from April-May 2022.
  - The short-term timeframe of 2 months was chosen against 30-day or 90-day timeframe since anomalies within a 30-day timeframe could skew the requirement for the next month while seasonal impacts from one season could be applied to the other season when choosing a 90-day metric.

Evaluating the Performance

- For each of the methods examined, we calculated requirements based on the 90th percentile of observed forecast errors to determine the best performance:
  - Performance is measured by calculating a requirement using the given historical period (training sample), and then applying that requirement to a different historical dataset (testing sample) to determine whether the requirement would procure enough uncertainty reserves to cover forecast errors in the out-of-sample testing dataset.
    - For example, using the historic annual calculation method, if the 95th percentile of observed errors in 2021 was 2% of the DAM Net Load Forecast, we set a 2% uncertainty reserve requirement for March-December 2022, and calculated the percentage of intervals in which a 2% uncertainty reserve requirement would procure adequate uncertainty reserves to cover the observed DAM Net Load Forecast errors in March-December 2022.

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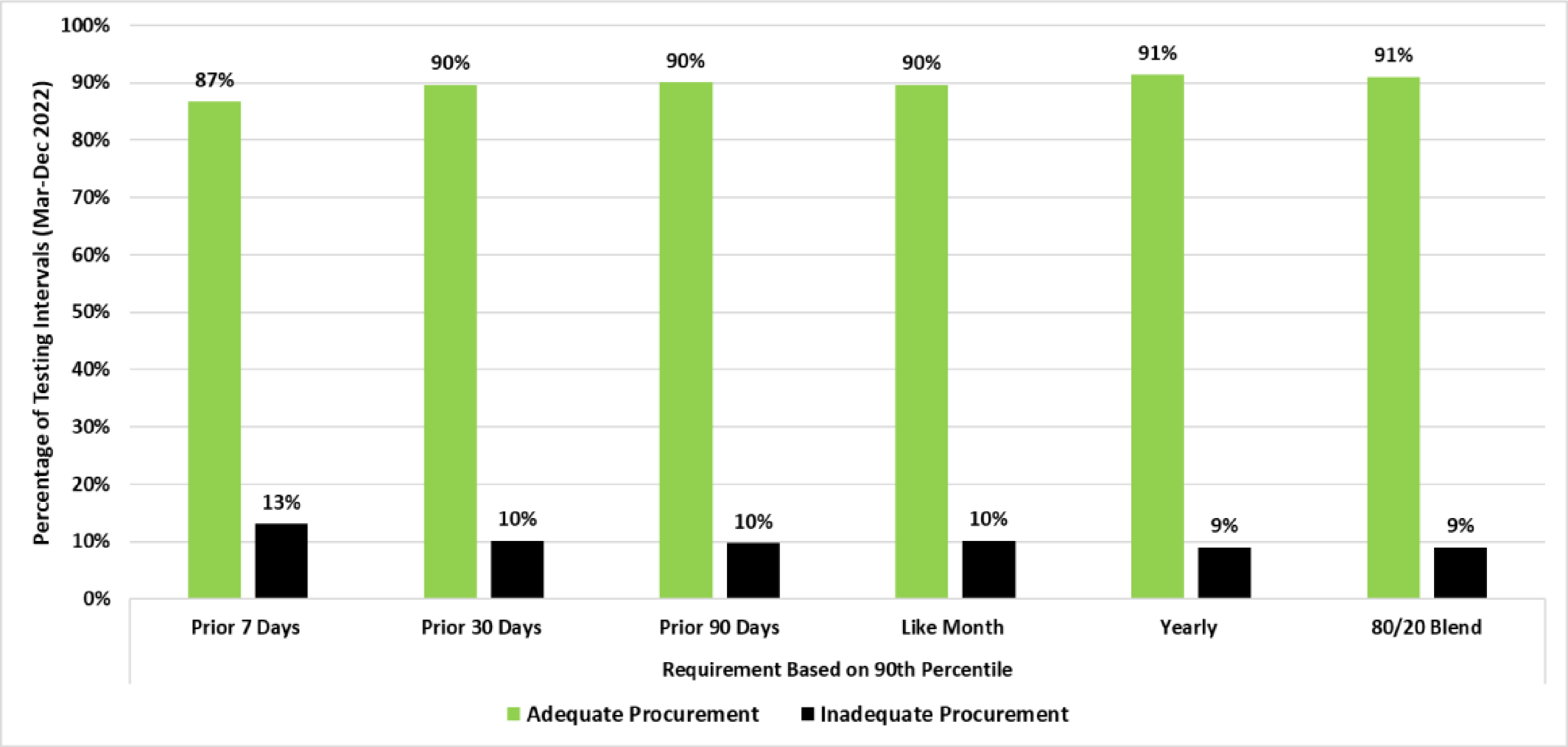
Historical DAM Requirement-Setting Performance - Net Load



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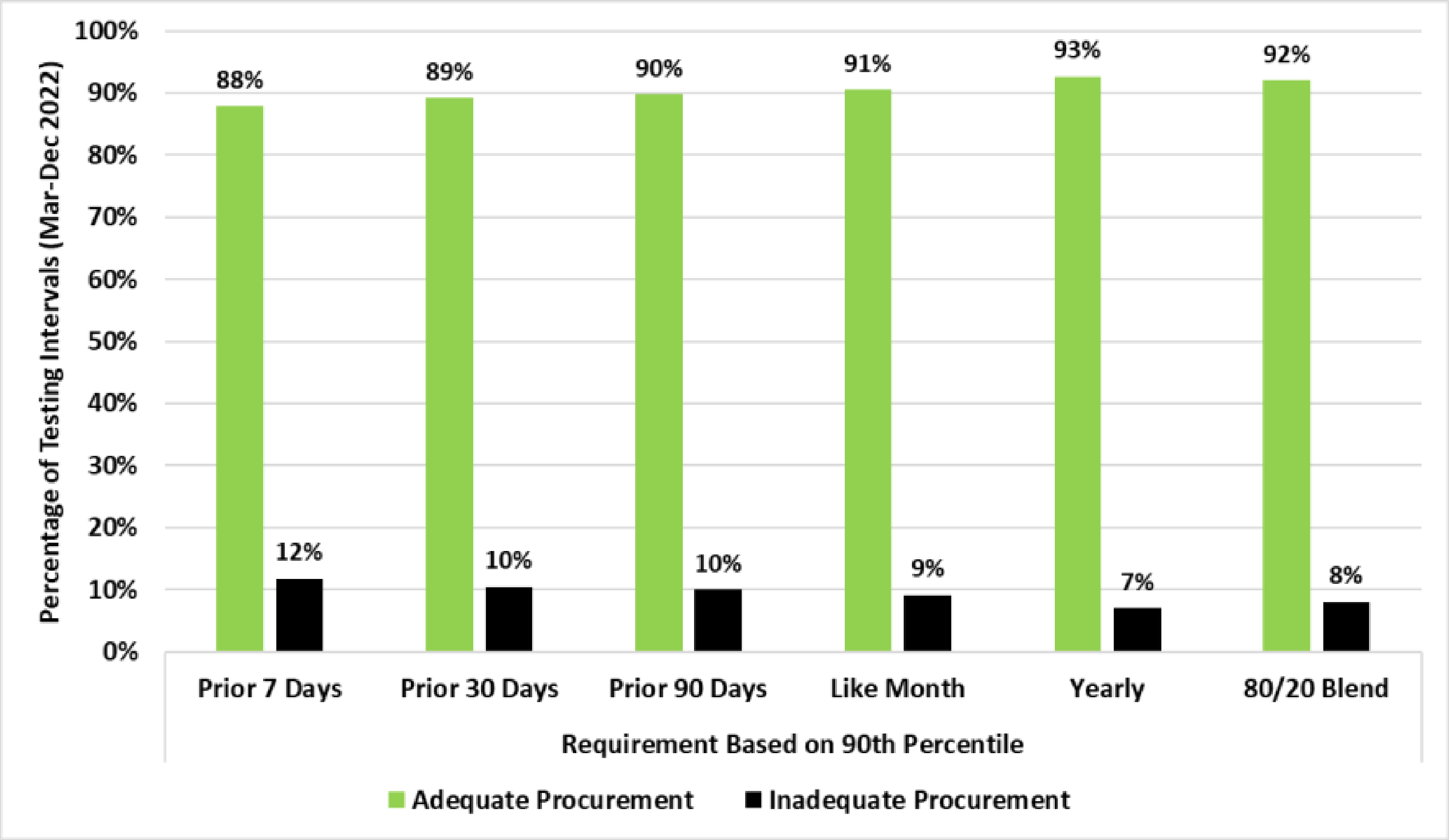
Historical DAM Requirement-Setting Performance - Wind



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Options Comparison

	Pros	Cons
Option 1: Historical, short-term	- Quickly updates to reflect changes in forecast error - Performed well in out-of-sample testing	- May not capture sufficient data to accurately represent forecast error
Option 2: Historical, long-term	- Captures sufficient data accurately to represent forecast error - Performed well in out-of-sample testing	- Will be slower to reflect recent changes in forecast errors
Option 3: Historical, blended	- Balances desire for accurate representation of forecast error and responsiveness to recent changes in forecast error/system - Performed well in out-of-sample testing	- Similar out-of-sample performance as other historical methods with greater administrative burden
Option 4: Forward-Looking	- May provide more granular and accurate expectations of net load uncertainty	- Software infrastructure is not currently available

Uncertainty Reserve Requirement Setting Overview

Uncertainty Reserve Requirement Setting Methodology

Uncertainty Reserve Requirement Setting Overview

- NYISO proposes to procure (through its DAM and RT markets) operating reserves to address these forecast uncertainties when and where they occur ("Uncertainty Reserve Requirement").
- NYISO proposes the Uncertainty Reserve Requirement to be additive with existing contingency reserve requirements, to deal with forecast uncertainties for every hour of the day for DA and RT markets and for every reserve region before the Day Ahead Market run.
- The components of the Uncertainty Reserve Requirements would be Net Load (Load net of Behind The Meter Solar), Land Based Wind, Offshore Wind, and Front The Meter Solar.
- The Uncertainty Reserve Requirements will be calculated by using the prior calendar year's forecast error percentage stats and DAM forecast information for the market day.

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Uncertainty Reserve Requirement Overview

- Uncertainty Reserve Requirements calculated for every reserve region will be nested.
  - For example, the requirement for N.Y.C. will nest into the requirements for Southern Eastern New York, Eastern New York, and NYCA.
- Uncertainty Reserve Requirements will be calculated for the 95th Percentile of uncertainty.
- The following inputs will be calculated as part of the annual calculation which will be used in the DA, RT 30-Minute, and RT 10-Minute Composite Uncertainty Reserve Requirement calculation:
  - Means and Standard Deviations for the prior calendar year's NYCA DA, 60-minute ahead, and 30-minute ahead Net Load forecast error percentages.
  - Means and Standard Deviations for each of the four bins for the prior calendar year's NYCA DA, 60-minute ahead, and 30-minute ahead Land Based Wind forecast error percentages.
  - Means and Standard Deviations for each of the four bins for the prior calendar year's NYCA DA, 60-minute ahead, and 30-minute ahead Offshore Wind forecast error percentages.
  - Means and Standard Deviations for each of the three bins for the prior calendar year's NYCA

Composite Uncertainty Reserve Requirement Calculation Overview

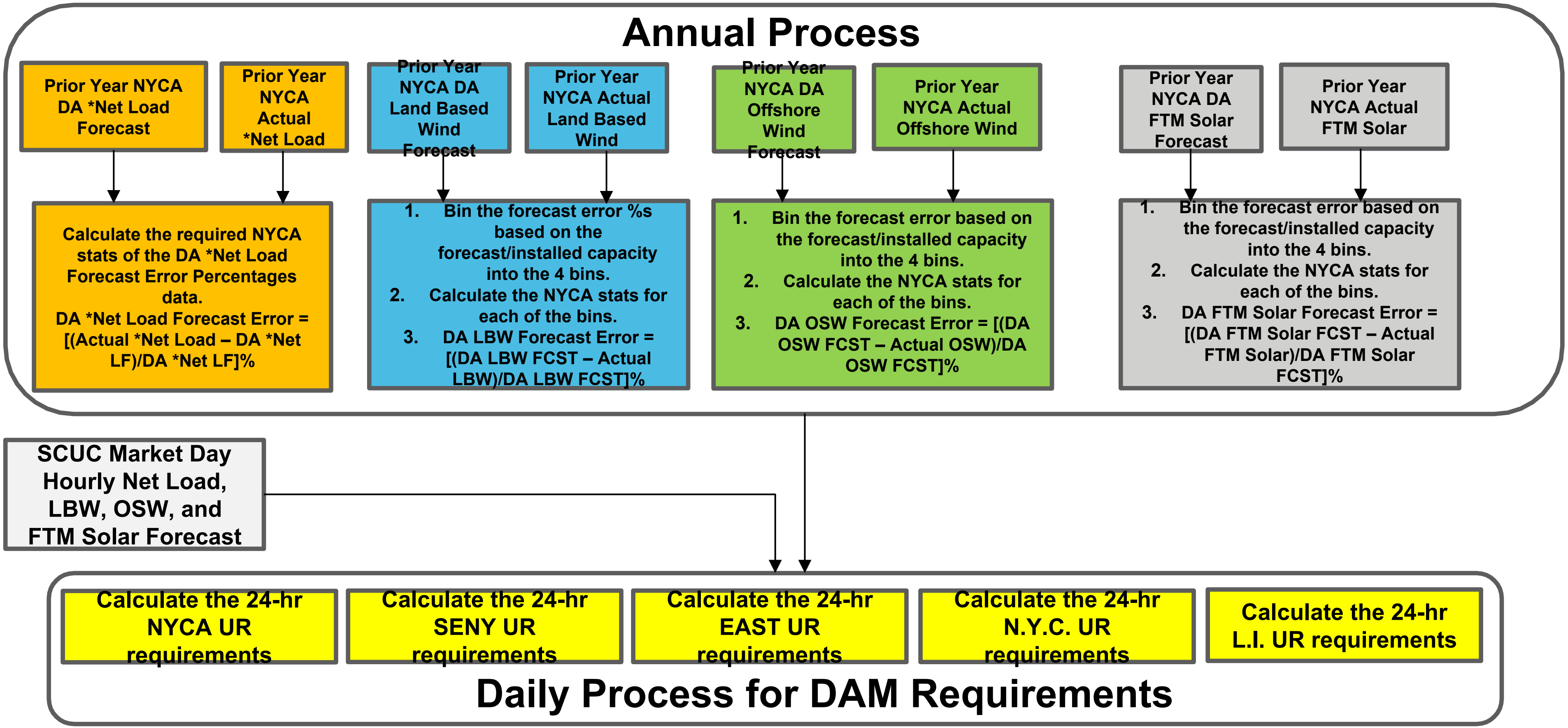
- We are proposing to use the formula shown in the appendix to calculate the total uncertainty.
  - The resulting uncertainty reserve requirement MW value will be calculated by considering the means, and standard deviations of the forecast error percentage distribution for Net Load, the associated bin's forecast error percentage distribution for Land Based Wind, the associated bin's forecast error percentage distribution for Offshore Wind, and the associated bin's forecast error percentage distribution for FTM Solar.
- This formula will be applied for every hour and for every reserve region to calculate the uncertainty reserve requirements for DAM and RT before the DAM run using the historical error metric stats and the DAM Forecast information.

Composite Uncertainty Reserve Requirement Calculation

- In reserve regions without Wind, the same formula would be applied.
  - With the Wind Forecast being zero for those reserve regions without Wind resources, the resulting formula would only utilize the net load forecast and FTM solar (if applicable) MW for the reserve region and the distributions stats for Net Load since the other terms would be cancelled out.
  - By incorporating this formula for reserve regions without Wind/FTM Solar, we would be equipped to address new entry to a reserve region which would make the Wind Forecast/FTM Solar Forecast term non-zero in the formula.
    - For example, new Offshore Wind connected to LI will impact the LI, EAST, SENY, and NYCA reserve regions which would in turn be reflected in the formulae.
- The DAM Requirement would be allocated to the 30-minute product only.
- The RT requirement for the 30-minute product will be calculated using the 60-min ahead forecast error distribution stats while the RT requirement for the 10-minute product will be calculated using the 30-min ahead forecast error distribution stats.

Uncertainty Reserve Requirement Calculation Process Flows

DAM Uncertainty Reserve Requirement Calculation Process (Occurs BEFORE DAM)



*Net Load – Load net of BTM Solar

Shortage Pricing

Proposed Shortage Pricing Levels for Uncertainty Reserves

- NYISO proposes to add the uncertainty reserve MWs for each interval to a lower pricing step than the existing pricing steps in the ancillary shortage pricing curves.
  - The lower price step indicates that the uncertainty reserves are of a lower priority than that of the contingency reserves.
- The price chosen for the additional uncertainty reserves added to the 30-min NYCA, 30-min East, and 30-min SENY reserve curves would be half of the lowest pricing step which would be $20.
- For the 10-min total shortage pricing curves where there is a single step, the price step of $40 will be created for the associated uncertainty reserve MWs.
- For N.Y.C. and Long Island, the price chosen for the additional uncertainty reserves added to the 10-min and 30-min reserve shortage curves would be $20.

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Overview of Proposed Enhancements

Reserve Region	Reserve Product	Current Reserve Reqt.	Proposed Reserve Reqt.	Demand curve ($/MWh)	
				Current	Proposed
NYCA	30-minute	2,620 MW	**2,620 MW + NYCA 30-min UR MW**	-	**NYCA 30-min UR MW at $20/MWh**
				200 MW at $40/MWh	200 MW at $40/MWh
				125 MW at $100/MWh	125 MW at $100/MWh
				55 MW at $175/MWh	55 MW at $175/MWh
				55 MW at $225/MWh	55 MW at $225/MWh
				55 MW at $300/MWh	55 MW at $300/MWh
				55 MW at $375/MWh	55 MW at $375/MWh
				55 MW at $500/MWh	55 MW at $500/MWh
				55 MW at $625/MWh	55 MW at $625/MWh
				1,965 MW at $750/MWh	1,965 MW at $750/MWh

UR – Uncertainty Reserves

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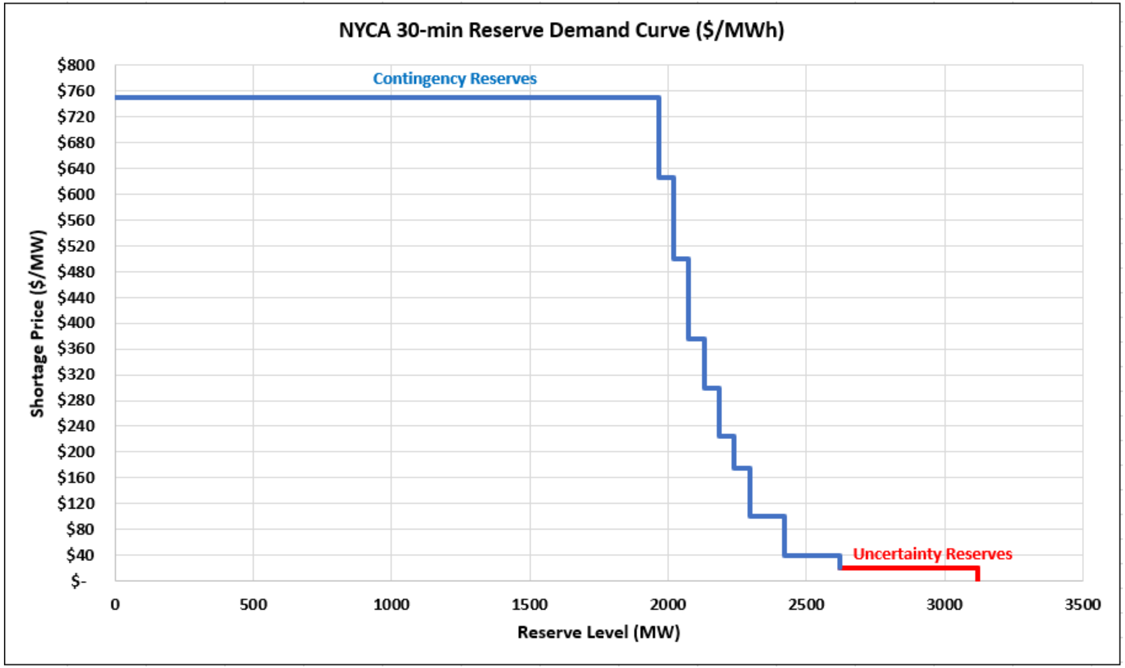
Example NYCA 30-min Reserve Demand Curve



Assuming 500 MW of NYCA 30-min Uncertainty Reserves at $20/MWh

Market Design Stakeholder Process

Market Design Stakeholder Process

- The Balancing Intermittency project has been unanimously approved by the Business Issues Committee and the Management Committee this October.

- This project will be presented to the Board of Directors on November 18th for their approval to go forward with the FERC filing.

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Questions?

Appendix

Uncertainty Reserve Requirement Setting Methodology

Composite DAM Uncertainty Reserve Requirement Calculation

$$\begin{aligned}
\textit{Composite DAM Uncertainty Reserve Req.} = {} & (\mu_{NL\ DA} \times \textit{Net Load DAM Forecast MW}) \\
& + (\mu_{LBW\ DA} \times \textit{Land Based Wind DAM Forecast MW}) \\
& + (\mu_{OSW\ DA} \times \textit{Offshore Wind DAM Forecast MW}) \\
& + (\mu_{FTMS\ DA} \times \textit{FTM Solar DAM Forecast MW}) \\
& + z - score \times \sqrt{\begin{gathered} ((\sigma_{NL\ DA})^2 \times (\textit{Net Load DAM Forecast MW})^2) + \\ ((\sigma_{LBW\ DA})^2 \times (\textit{Land Based Wind DAM Forecast MW})^2) + \\ ((\sigma_{OSW\ DA})^2 \times (\textit{Offshore Wind DAM Forecast MW})^2) + ((\sigma_{FTMS\ DA})^2 \times (\textit{FTM Solar DAM Forecast MW})^2) \end{gathered}}
\end{aligned}$$

where,

$\mu_{NL\ DA}$ is the Mean of the Historical DAM Net Load (Load net of BTM Solar) forecast error percentages,

$\mu_{LBW\ DA}$ is the Mean of the corresponding Bin's Historical DAM Land Based Wind Forecast Error percentages,

$\mu_{OSW\ DA}$ is the Mean of the corresponding Bin's Historical DAM Offshore Wind Forecast Error percentages,

$\mu_{FTMS\ DA}$ is the Mean of the corresponding Bin's Historical DAM FTM Solar Forecast Error percentages,

$\sigma_{NL\ DA}$ is the Standard Deviation obtained from the Historical DAM Net Load (Load net of BTM Solar) Forecast Error percentages

$\sigma_{LBW\ DA}$ is the Standard Deviation of the corresponding Bin's Historical DAM Land Based Wind Forecast Error percentages,

$\sigma_{OSW\ DA}$ is the Standard Deviation of the corresponding Bin's Historical DAM Offshore Wind Forecast Error percentages,

$\sigma_{FTMS\ DA}$ is the Standard Deviation of the corresponding Bin's Historical DAM FTM Solar Forecast Error percentages.

z-score is the z-score pertaining to the chosen percentile.

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DAM NYCA Example

Net Load Forecast = 20000 MW

LBW Forecast = 400 MW

OSW Forecast = 100 MW

FTM Solar Forecast = 80 MW

Net Load Forecast Error Mean = -0.01%
Net Load Forecast Error Std Dev = 1.95%

LBW Forecast Error Mean = 3%
LBW Forecast Error Std Dev = 45%

OSW Forecast Error Mean = 4%
OSW Forecast Error Std Dev = 35%

FTM Solar Forecast Error Mean = 1%
FTM Solar Forecast Error Std Dev = 20%

$$= (-0.01\% \times 20{,}000) + (3\% \times 400) + (4\% \times 100) + (1\% \times 80) + 1.645 \times \sqrt{\left((1.95\%)^2 \times (20{,}000)^2\right) + \left((45\%)^2 \times (400)^2\right) + \left((35\%)^2 \times (100)^2\right) + \left((20\%)^2 \times (80)^2\right)}$$

$$= 14.8 + 1.645 \times 431.26$$

$$= 724\ MW$$

Annual Metrics Day

Hourly Data for each Market

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Composite RT 30-min Uncertainty Reserve Requirement Calculation

$$Composite\ RT\ 30min\ Uncertainty\ Reserve\ Req. = (\mu_{NL\ RT60} \times Net\ Load\ DAM\ Forecast\ MW) + (\mu_{LBW\ RT60} \times Land\ Based\ Wind\ DAM\ Forecast\ MW) + (\mu_{OSW\ RT60} \times Offshore\ Wind\ DAM\ Forecast\ MW) + (\mu_{FTMS\ RT60} \times FTM\ Solar\ DAM\ Forecast\ MW) + z - score \times \sqrt{((\sigma_{NL\ RT60})^2 \times (Net\ Load\ DAM\ Forecast\ MW)^2) + ((\sigma_{LBW\ RT60})^2 \times (Land\ Based\ Wind\ DAM\ Forecast\ MW)^2) + ((\sigma_{OSW\ RT60})^2 \times (Offshore\ Wind\ DAM\ Forecast\ MW)^2) + ((\sigma_{FTMS\ RT60})^2 \times (FTM\ Solar\ DAM\ Forecast\ MW)^2)}$$

where,

$\mu_{NL\ RT60}$ is the Mean of the Historical RT 60-min ahead Net Load (Load net of BTM Solar) forecast error percentages,

$\mu_{LBW\ RT60}$ is the Mean of the corresponding Bin's Historical RT 60-min ahead Land Based Wind Forecast Error percentages,

$\mu_{OSW\ RT60}$ is the Mean of the corresponding Bin's Historical RT 60-min ahead Offshore Wind Forecast Error percentages,

$\mu_{FTMS\ RT60}$ is the Mean of the corresponding Bin's Historical RT 60-min ahead FTM Solar Forecast Error percentages,

$\sigma_{NL\ RT60}$ is the Standard Deviation obtained from the Historical RT 60-min ahead Net Load (Load net of BTM Solar) Forecast Error percentages

$\sigma_{LBW\ RT60}$ is the Standard Deviation of the corresponding Bin's Historical RT 60-min ahead Land Based Wind Forecast Error percentages,

$\sigma_{OSW\ RT60}$ is the Standard Deviation of the corresponding Bin's Historical RT 60-min ahead Offshore Wind Forecast Error percentages,

$\sigma_{FTMS\ RT60}$ is the Standard Deviation of the corresponding Bin's Historical RT 60-min ahead FTM Solar Forecast Error percentages.

z-score is the z-score pertaining to the chosen percentile.

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Composite RT 10-min Uncertainty Reserve Requirement Calculation

$$\begin{aligned} Composite\ RT\ 10min\ Uncertainty\ Reserve\ Req. = \ & (\mu_{NL\ RT30} \times Net\ Load\ DAM\ Forecast\ MW) \\ & + (\mu_{LBW\ RT30} \times Land\ Based\ Wind\ DAM\ Forecast\ MW) \\ & + (\mu_{OSW\ RT30} \times Offshore\ Wind\ DAM\ Forecast\ MW) \\ & + (\mu_{FTMS\ RT30} \times FTM\ Solar\ DAM\ Forecast\ MW) \end{aligned}$$

$$+ z - score \times \sqrt{\begin{gathered} ((\sigma_{NL\ RT30})^2 \times (Net\ Load\ DAM\ Forecast\ MW)^2) + \\ ((\sigma_{LBW\ RT30})^2 \times (Land\ Based\ Wind\ DAM\ Forecast\ MW)^2) + \\ ((\sigma_{OSW\ RT30})^2 \times (Offshore\ Wind\ DAM\ Forecast\ MW)^2) + ((\sigma_{FTMS\ RT30})^2 \times (FTM\ Solar\ DAM\ Forecast\ MW)^2) \end{gathered}}$$

where,

$\mu_{NL\ RT30}$ is the Mean of the Historical RT 30-min ahead Net Load (Load net of BTM Solar) forecast error percentages,

$\mu_{LBW\ RT30}$ is the Mean of the corresponding Bin's Historical RT 30-min ahead Land Based Wind Forecast Error percentages,

$\mu_{OSW\ RT30}$ is the Mean of the corresponding Bin's Historical RT 30-min ahead Offshore Wind Forecast Error percentages,

$\mu_{FTMS\ RT30}$ is the Mean of the corresponding Bin's Historical RT 30-min ahead FTM Solar Forecast Error percentages,

$\sigma_{NL\ RT30}$ is the Standard Deviation obtained from the Historical RT 30-min ahead Net Load (Load net of BTM Solar) Forecast Error percentages

$\sigma_{LBW\ RT30}$ is the Standard Deviation of the corresponding Bin's Historical RT 30-min ahead Land Based Wind Forecast Error percentages,

$\sigma_{OSW\ RT30}$ is the Standard Deviation of the corresponding Bin's Historical RT 30-min ahead Offshore Wind Forecast Error percentages,

$\sigma_{FTMS\ RT30}$ is the Standard Deviation of the corresponding Bin's Historical RT 30-min ahead FTM Solar Forecast Error percentages.

z-score is the z-score pertaining to the chosen percentile.

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Shortage Pricing

Overview of Proposed Enhancements

Reserve Region	Reserve Product	Current Reserve Reqt.	Proposed Reserve Reqt.	Demand curve ($/MWh)	
				Current	Proposed
NYCA	10-minute total	1,310 MW	**1,310 MW + NYCA 10-min UR MW**	-	**NYCA 10-min UR MW at $40/MWh**
				$750/MWh	$750/MWh
NYCA	10-minute spin	655 MW	655 MW	$775/MWh	$775/MWh
EAST	30-minute	1,200 MW	**1,200 MW + EAST 30-min UR MW**	-	**EAST 30-min UR MW at $20/MWh**
				$40/MWh	$40/MWh
EAST	10-minute total	1,200 MW	**1,200 MW + EAST 10-min UR MW**	-	**EAST 10-min UR MW at $40/MWh**
				$775/MWh	$775/MWh
EAST	10-minute spin	330 MW	330 MW	$40/MWh	$40/MWh
SENY	30-minute	1,300, 1,550 MW or 1,800 MW	**1,300, 1,550 MW or 1,800 MW + SENY 30-min UR MW**	-	**SENY 30-min UR MW at $20/MWh**
				500 MW at $40/MWh	500 MW at $40/MWh
				800 MW, 1,050 MW, or 1,300 at $500/MWh	800 MW, 1,050 MW, or 1300 MW at $500/MWh

UR – Uncertainty Reserves

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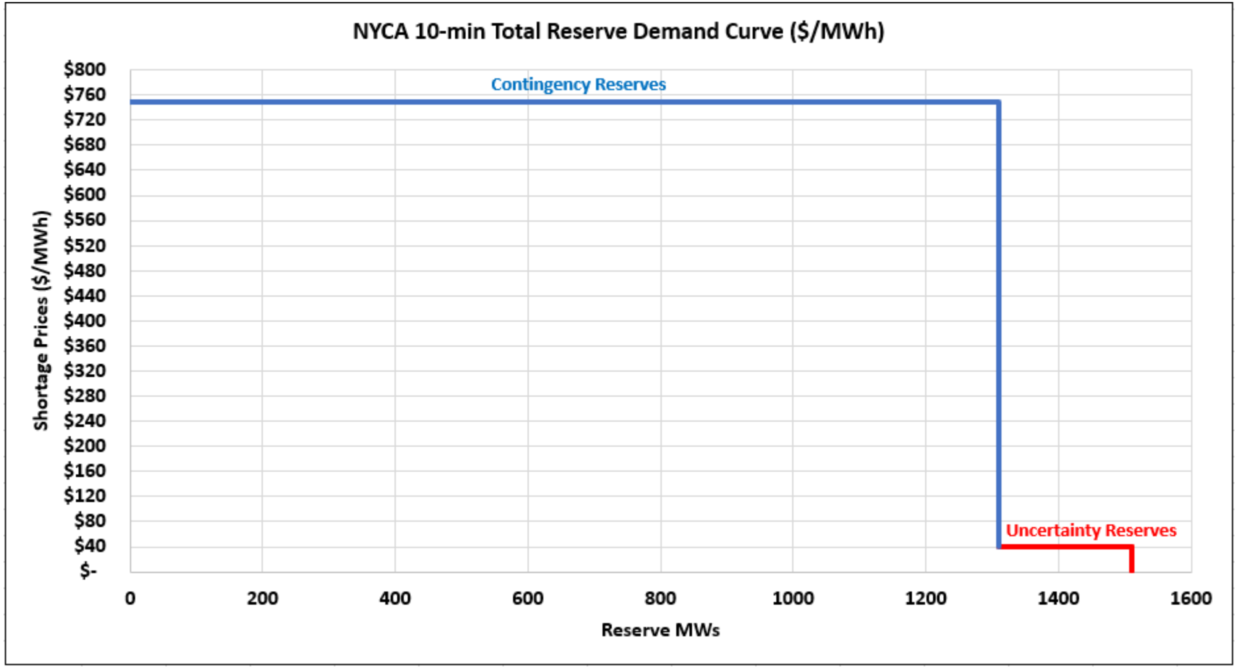
Example NYCA 10-min Total Reserve Demand Curve



Assuming 200 MW of NYCA 10-min total Uncertainty Reserves at $40/MWh

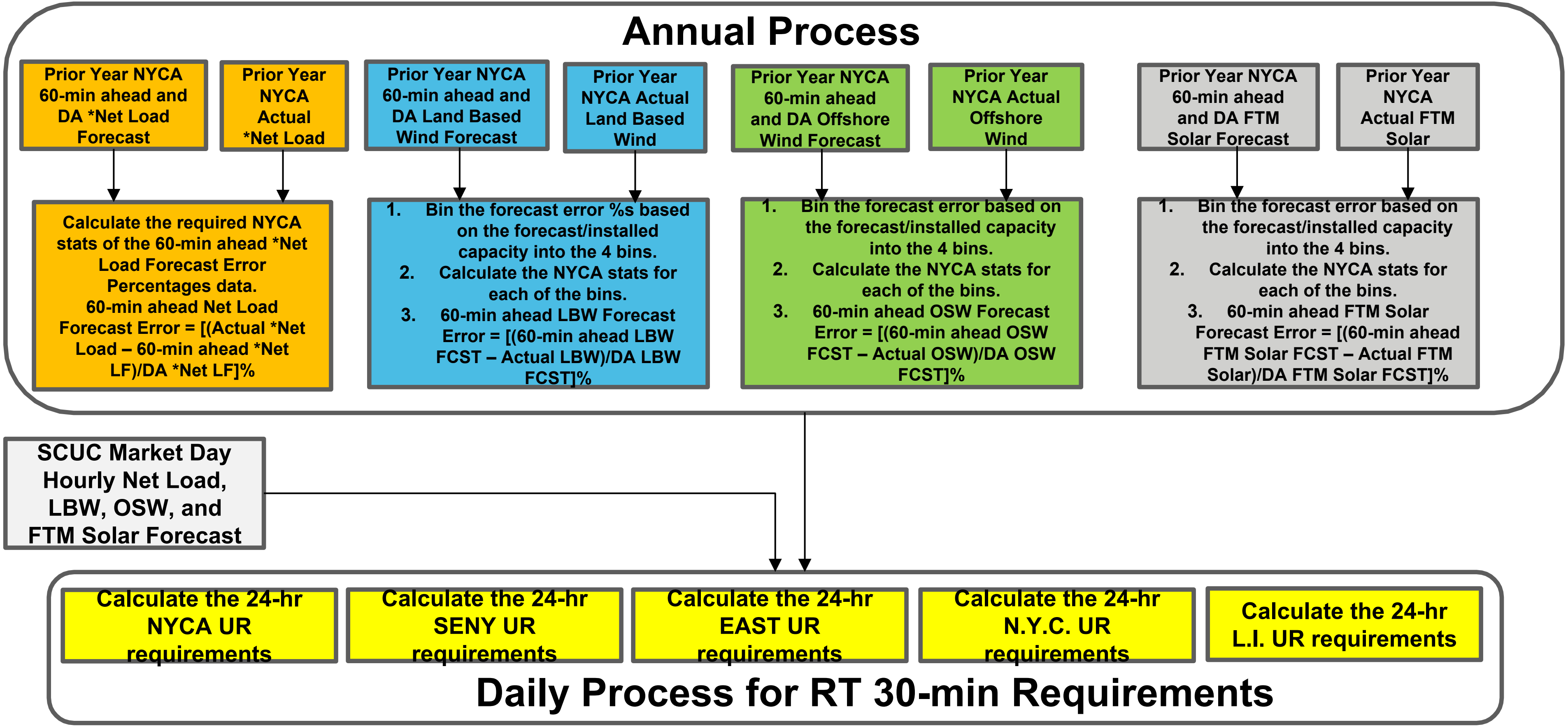
Overview of Proposed Enhancements

Reserve Region	Reserve Product	Current Reserve Reqt.	Proposed Reserve Reqt.	Demand curve ($/MWh)	
				Current	Addition to the Step/Reqt
NYC	30-minute	1,000 MW	**1,000 MW + NYC 30-min UR MW**	-	**NYC 30-min UR MW at $20/MWh**
				$25/MWh	$25/MWh
NYC	10-minute total	500 MW	**500 MW + NYC 10-min UR MW**	-	**NYC 10-min UR MW at $20/MWh**
				$25/MWh	$25/MWh
LI	30-minute	270-540 MW	**270-540 MW + LI 30-min UR MW**	-	**LI 30-min UR MW at $20/MWh**
				$25/MWh	$25/MWh
LI	10-minute total	120 MW	**120 MW + LI 10-min UR MW**	-	**LI 10-min UR MW at $20/MWh**
				$25/MWh	$25/MWh

UR – Uncertainty Reserves

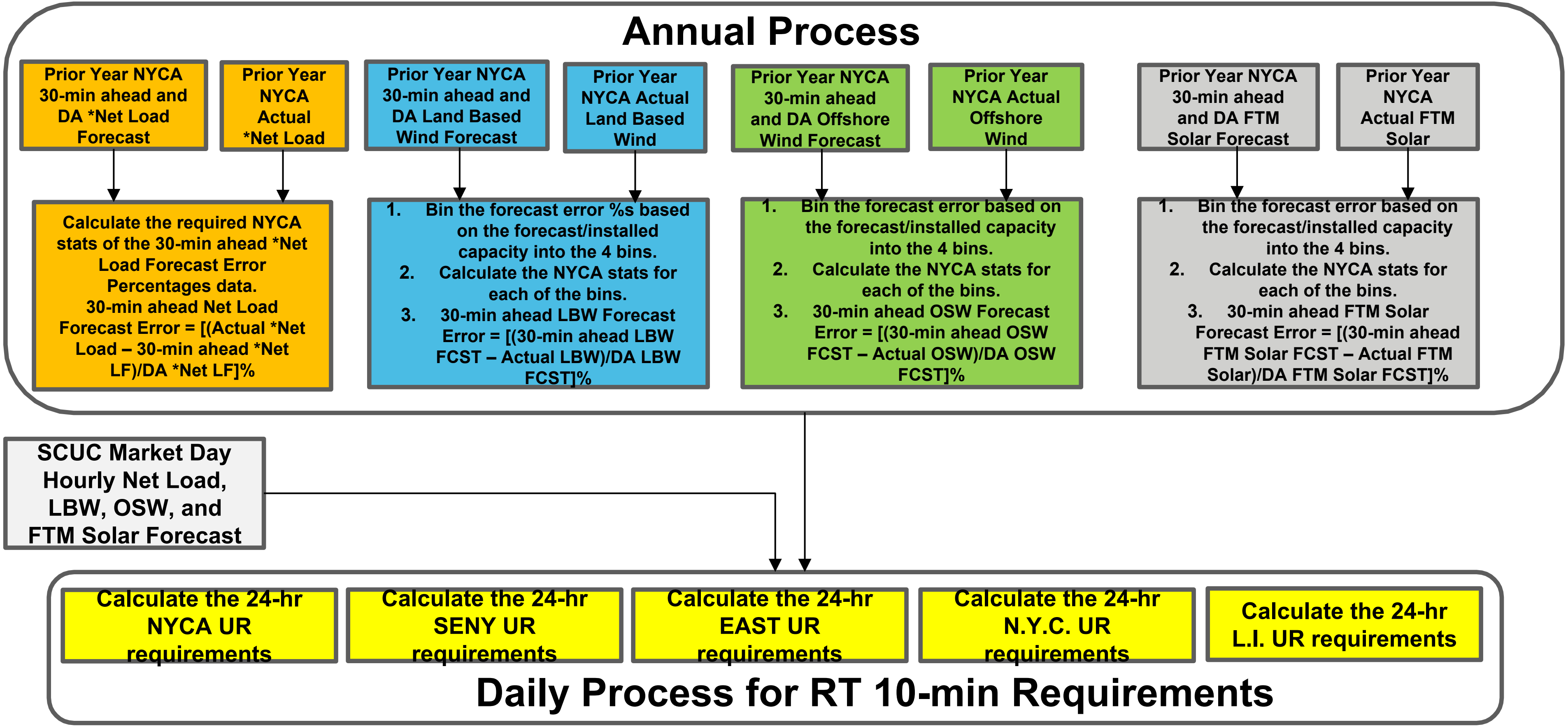
Uncertainty Reserve Requirement Calculation Process Flows

RT 30-min Uncertainty Reserve Requirement Calculation Process (Occurs BEFORE DAM)



*Net Load – Load net of BTM Solar

RT 10-min Uncertainty Reserve Requirement Calculation Process (Occurs BEFORE DAM)



*Net Load – Load net of BTM Solar

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Additional Presentations

Additional Presentations

Date	Working Group	Discussion Points and Links to Materials
09-10-2024	ICAPWG/MIWG	Balancing Intermittency: Market Design and Tariff Review https://www.nyiso.com/documents/20142/46865072/Balancing%20Intermittency_MIWG_09102024.pdf/b33ffa9f-f58b-c9ef-2c78-f24511953428
08-13-2024	ICAPWG/MIWG	Balancing Intermittency: Tariff Revisions Set 2 https://www.nyiso.com/documents/20142/46346732/Balancing%20Intermittency_MIWG_08132024_draft.pdf/110860aa-c9b4-877b-0292-1926ca0c41d4
08-01-2024	ICAPWG/MIWG	Balancing Intermittency: Locational Examples and Initial Tariff Revisions https://www.nyiso.com/documents/20142/46161626/6%20Balancing%20Intermittency_MIWG_08012024_draft.pdf/fa2c5571-b3b8-7714-5265-16a1ccf4e6ea
06-25-2024	ICAPWG/MIWG	Balancing Intermittency: Market Design Update https://www.nyiso.com/documents/20142/45442995/Balancing%20Intermittency_MIWG_06252024_final.pdf/dad8a46e-1713-bb43-9151-f136147745ff
03-04-2024	ICAPWG/MIWG	Balancing Intermittency: Percentiles and Shortage Pricing Curves https://www.nyiso.com/documents/20142/43315080/BI%202024%20MIWG_03042024_final.pdf/bbd5e0a7-3205-89b7-ed25-3672358fa761
01-25-2024	ICAPWG/MIWG	Balancing Intermittency 2024 Kick-off: https://www.nyiso.com/documents/20142/42590322/BI%202024%20MIWG%20Kick%20Off_final.pdf/ac2f0112-f542-f4da-3c9c-f43d0309868f
11-10-2023	ICAPWG/MIWG	Market Design Concept Proposed: https://www.nyiso.com/documents/20142/41130653/Balancing%20Intermittency_MDCP%20Presentation_final.pdf/ab912240-d021-0e7a-a02a-987a94928bf7

Additional Presentations

Date	Working Group	Discussion Points and Links to Materials
10-12-2023	ICAPWG/MIWG	1hr notification/4hr sustainability Reserves Product: https://www.nyiso.com/documents/20142/40342797/Balancing%20Intermittency_100323%20ICAPWG_MIWG_final.pdf/71269f5b-1e84-4bda-3219-b36a71a9be24
10-03-2023	ICAPWG/MIWG	Introductory Analysis regarding Uncertainty Reserve product : https://www.nyiso.com/documents/20142/40342797/Balancing%20Intermittency_100323%20ICAPWG_MIWG_final.pdf/71269f5b-1e84-4bda-3219-b36a71a9be24
09-18-2023	ICAPWG/MIWG	Analysis and proposal regarding Uncertainty Reserve requirement locational distribution: https://www.nyiso.com/documents/20142/40044890/3%20Balancing%20Intermittency_09182023%20ICAPWG_MIWG.pdf/0d0e82b7-1d3a-7af0-fef7-237dbf5c1b77
09-05-2023	ICAPWG/MIWG	Analysis and proposal regarding Uncertainty Reserve requirement calculation methodology: https://www.nyiso.com/documents/20142/39768278/6%20Balancing%20Intermittency_ICAPWG_MIWG_090523.pdf/23391d26-0559-5757-1289-d043e833e16c
07-19-2023	ICAPWG/MIWG	Initial analysis regarding the need to address net load uncertainty: https://www.nyiso.com/documents/20142/38852999/Balancing%20Intermittency%20Initial%20Analyses_ICAPWG_MIWG_071923_Final.pdf/c4adb509-3c09-0361-7f52-b52cae880997

New York ISO

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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