New York ISO
Independent System Operator

Balancing Intermittency: Market Design Update

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ICAPWG/MIWG

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Agenda

- Background
- Review of Market Design Updates
- Additional Details for Existing Market Design Elements
- Next Steps

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Background

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Previous Presentations

Date	Working Group	Discussion Points and Links to Materials
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
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

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2023 Market Design Concept Proposal Summary

- **Phase 1: Uncertainty Reserve Requirement on existing 10- and 30-minute reserve products**
  - The NYISO proposes to establish locational Uncertainty Reserve requirements using percentages calculated from historical data, which will be individually applied to net load, land-based wind, and offshore wind forecasts.

- **Phase 2: New 60-minute, 4-hour reserve product**
  - The features of the proposed new reserve product include a longer Notification Time and a longer Duration Availability Requirement, which aim to address needs driven by uncertainty that arises further in advance.

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Key Stakeholder Feedback from March 4 MIWG

- A request to provide more information on what would be included in the tariff with regards to the assessment of these reserves and how often would we update the percentiles/shortage prices.
  - NYISO continues to consider this feedback
- A request to investigate seasonal shortage prices to deal with scenarios when we have high gas prices, and therefore the system would go short on uncertainty reserves more often due to its lower shortage prices.
  - We have proposed to include this as part of the Ancillary Service Shortage Pricing Update proposal as part of this year's project prioritization process to investigate the entire pricing curves

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Overview of Today's Presentation

- **Review market design changes**
  - Periodicity of Uncertainty Reserve Requirement Input % Calculation, FTM Solar component, and Percentile Selection.
- **Additional Details for Existing Market Design Elements**
  - Discuss the inputs and calculation processes for the Uncertainty Reserve Requirement in DAM and RT.
  - Discuss the Wind and Solar forecast error distribution bins.

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Review of Market Design Updates

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Proposed updates

- NYISO proposes three design updates relative to the current Uncertainty Reserve Requirement Design
  - Blended to Annual – discussed on slides 10-12
    - Measuring forecast error annually, instead of monthly, retains (and may increase) accuracy of error measurements while simplifying the administration and increasing transparency of reserve requirements for the marketplace
  - FTM Solar – discussed on slide 13
    - Separating FTM solar into an individual component allows reserve requirements to be estimated with greater granularity
  - Uncertainty percentile - The updated uncertainty percentile proposal is further discussed on slides 14-17.

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1. Blended → Annual Calculation

- The first consideration is to move from the blended calculation (80% prior year/20% prior two months) of the DAM and RT Uncertainty Reserve Requirement percentages to the annual calculation (100% prior year).
  - It has been observed that the performance of annual calculation of the Uncertainty Reserve Requirement and the blended method (80% annual and 20% two month) is similar, as is illustrated in the following slides which were presented to the stakeholders during the 9/5/2023 stakeholder presentation.
- The monthly calculations based on the prior two months' data can be laborious and software intensive while performing the calculations once a year based on the prior year can be less impactful on NYISO's systems.
- Monthly calculation would also require monthly validation and review processes to ensure that the values are reasonable which would be an added administrative burden.

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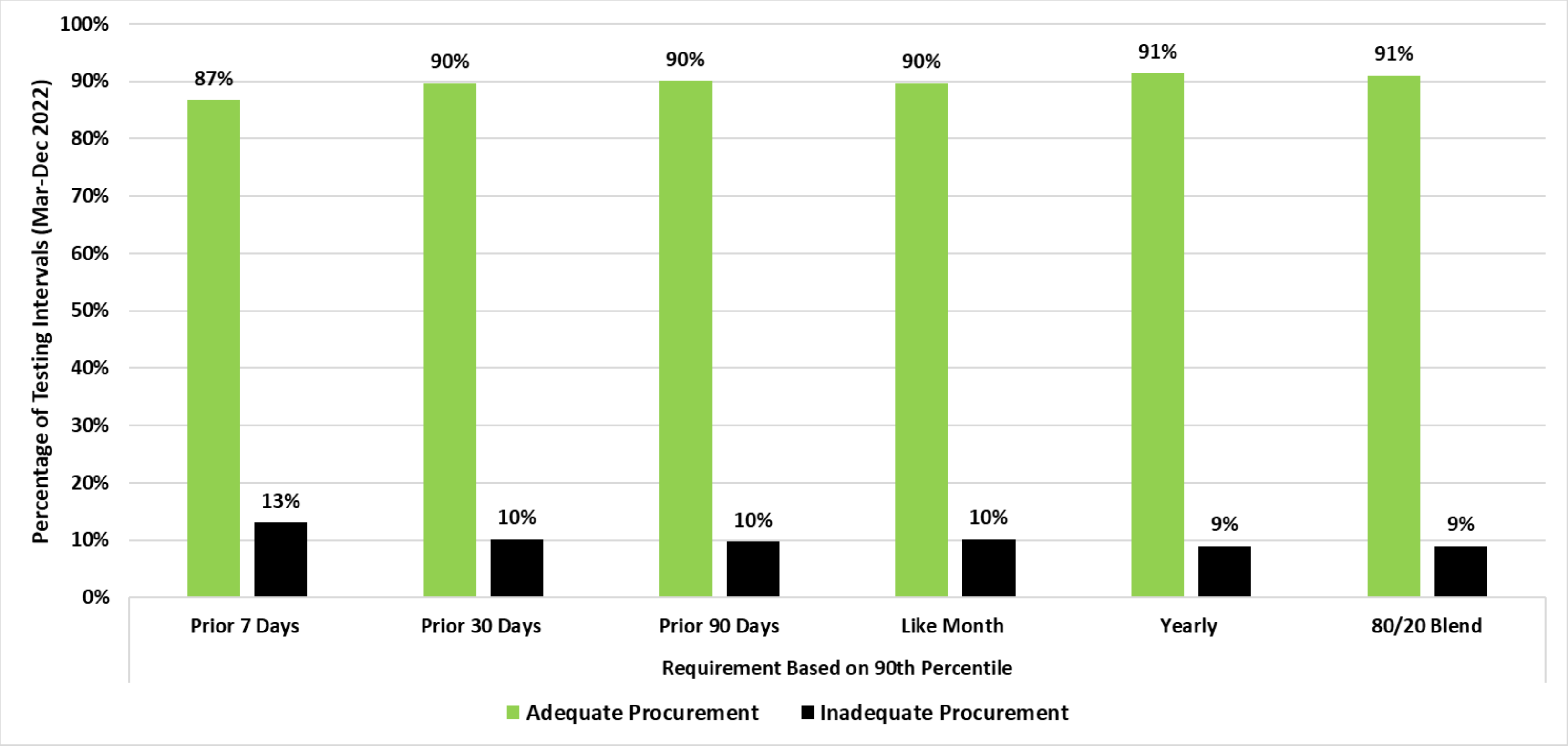
Historical DAM Requirement-Setting Performance - Net Load



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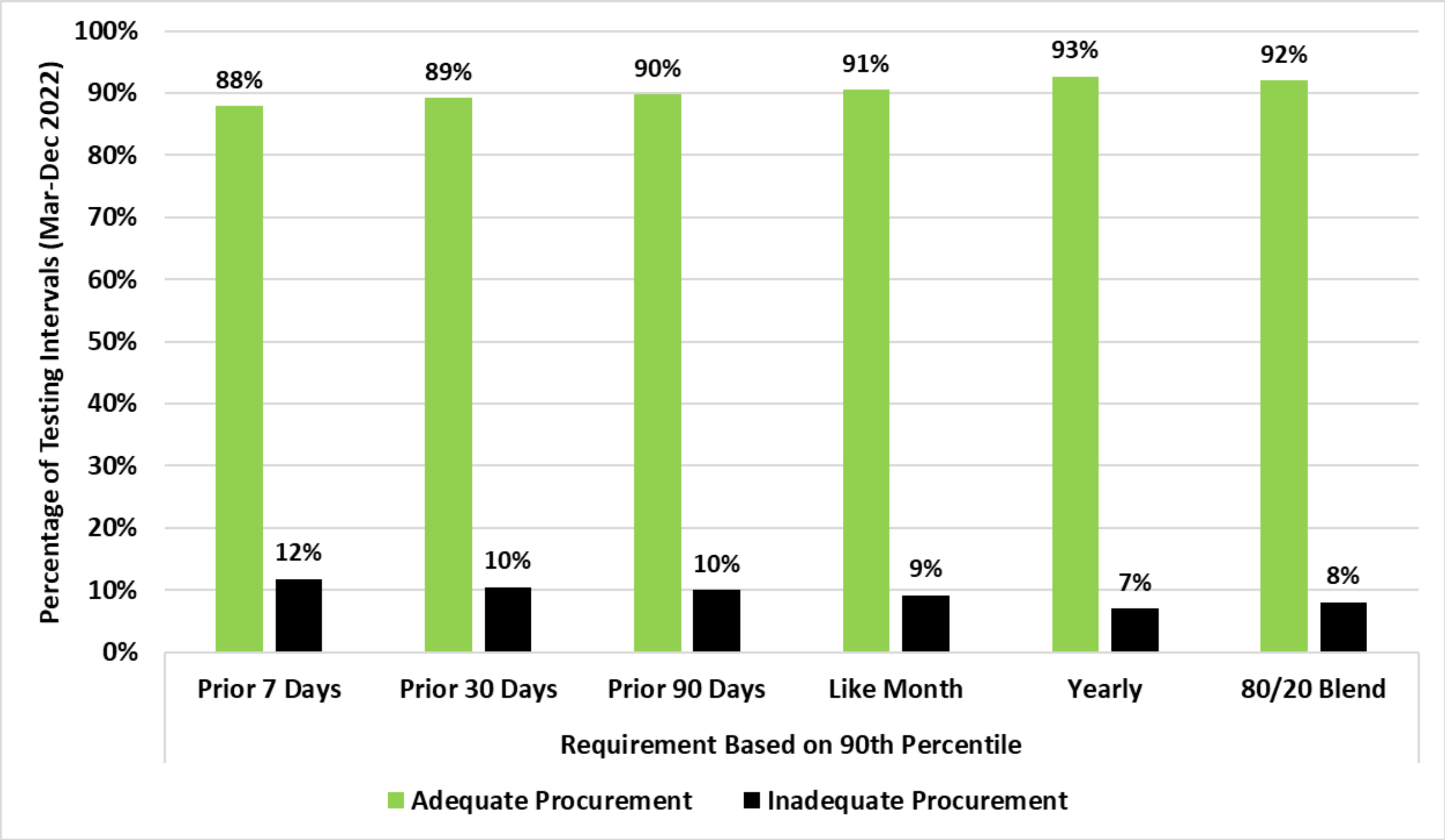
Historical DAM Requirement-Setting Performance - Wind



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2. Separate FTM Solar Component

- **The second consideration is to have the FTM Solar Component as a separate component which is different from our original design of having FTM Solar as part of the Net Load Error component.**
- **This is due to a couple of reasons:**
  - By having FTM Solar separated out, we can attribute the requirements to the specific reserve region where the FTM Solar is being installed rather than attributing the requirements to the entire NYCA region since the requirement percentages are calculated NYCA wide.
  - Separate component would help in capturing the system changes as the forecast error bins are modeled as forecast as a share of installed capacity.

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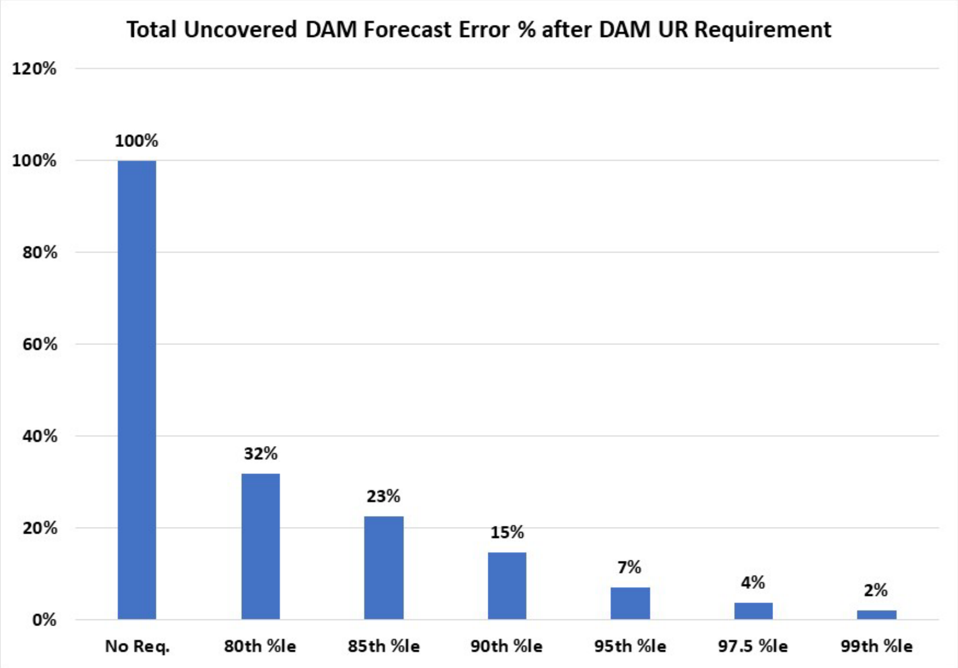
3. Percentiles

- The NYISO is considering the 95th percentile over the previously proposed 90th percentile for calculating the DAM and RT Uncertainty Reserve requirements pertaining to the Net Load (Load net of BTM Solar), Land based Wind, Offshore Wind, and FTM Solar Forecast Error based on stakeholder feedback from the last presentation and internal discussions.
- The DAM Uncertainty Reserve requirements based on Net Load (Load net of BTM Solar) Forecast Error metrics were calculated for March 2022 – December 2022.
- The Total Uncovered DAM Forecast Error % refers to the percentage of the total DAM forecast error that is not covered after applying the DAM UR requirements over the entire test period during the instances when the Actual Net Load is greater than the Forecasted Net Load.
- "No Req." refers to No Uncertainty Reserve Requirements in the graph.



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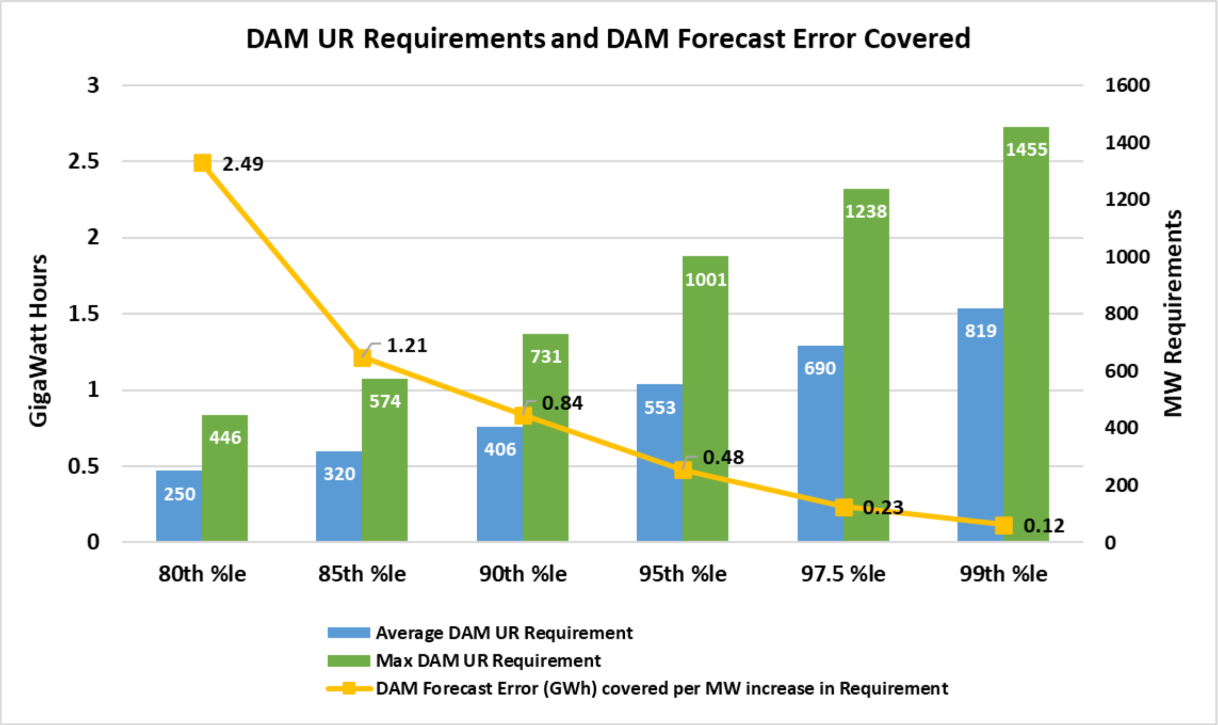
Percentiles

- The Average Requirement refers to the average of the Uncertainty Reserve Requirements calculated over a particular percentile.
- The Max Requirement refers to the maximum of the Uncertainty Reserve Requirements calculated over a particular percentile.
- The DAM Forecast Error Covered per MW increase in Requirement refers to the value gained from increasing the requirement by a MW when the requirements are increased by moving to a higher percentile from the lower percentile.
    - For example, from the graph, 0.84 GWh of DAM Forecast Error Energy is covered per MW increase in requirement from the 85th percentile requirements to the 90th percentile requirements and the 86 MW is the increase in the requirements on average from 85th to the 90th %le.
- It is observed that the value gained per MW increase in requirement decreases as the requirements are increased from one percentile to the other and it is observed that beyond 95th percentile, the value gained is half of the prior value gained.



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2022 NYCA DAM Uncertainty Reserve Requirement Statistics

	Mean	Maximum	Minimum	Standard Deviation
90th Percentile	516	872	332	80
95th Percentile	657	1104	424	102

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Justification for 95th Percentile

- SPP and CAISO utilize the 97.5 percentile on historical forecast error for setting requirements for their products that are equivalent to NYISO's Uncertainty Reserve Requirements.
- Extreme weather events and outages tend to be correlated as seen in extreme weather events like the impacts of Winter Storm Uri faced by ERCOT and the impacts of Winter Storm Elliot faced by several ISO/RTOs and thus a combination of contingency and uncertainty reserves are needed to deal with these correlated events.
- Efforts like Dynamic Reserves would tend to push the reserve requirements to adequate levels for contingency reserves but could limit the ability to deal with uncertainty events making it important for NYISO to procure uncertainty reserves at the 95th percentile to deal with uncertainty events.

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Additional Details for Existing Market Design Elements

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Inputs for DA UR Requirement Calculation

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Inputs for DA Uncertainty Reserve Requirement Calculation – Net Load (Load net of BTM Solar)

- **The historical NYCA DA Net Load Forecast Error percentages over each hour for the prior year will be calculated as per the formula below:**

$$\text{NYCA } DA\ Net\ Load\ Forecast\ Error\ \%\ (for\ a\ particular\ hour) = \frac{NYCA\ Actual\ Net\ Load - NYCA\ DA\ Forecast\ Net\ Load}{NYCA\ DA\ Forecast\ Net\ Load} \times 100$$

- **The Means and Standard Deviations of the historical prior year's NYCA DA Net Load Forecast Error percentages will be calculated annually.**
  - These static values will be used to calculate the Composite DAM Uncertainty Reserve Requirements which will be discussed in the Composite Uncertainty Reserve Requirement Calculation section.

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Inputs for DA Uncertainty Reserve Requirement Calculation – Land Based Wind and Offshore Wind

- The historical NYCA DAM Land Based Wind and Offshore Wind Forecast Error percentages over each hour for the prior year will be calculated as per the formula below:

$$\text{NYCA } DAM\ Land\ Based\ Wind\ Forecast\ Error\ \%\ (for\ a\ particular\ hour) = \frac{NYCA\ DAM\ Land\ Based\ Wind\ Forecast - NYCA\ Actual\ Land\ Based\ Wind\ Output}{NYCA\ DAM\ Land\ Based\ Wind\ Forecast} \times 100$$

$$\text{NYCA } DAM\ Offshore\ Wind\ Forecast\ Error\ \%\ (for\ a\ particular\ hour) = \frac{NYCA\ DAM\ Offshore\ Wind\ Forecast - NYCA\ Actual\ Offshore\ Wind\ Output}{NYCA\ DAM\ Offshore\ Wind\ Forecast} \times 100$$

- These hourly forecast error percentages are grouped into each of the forecast/installed capacity bins that are listed in a later section.
- The Means and Standard Deviations for each forecast/installed capacity bin of the historical prior year's DAM Land Based Wind and Offshore Wind Forecast Error percentages will be calculated annually.
  - These static values will be used to calculate the Composite DAM Uncertainty Reserve Requirements which will be discussed in the Composite Uncertainty Reserve Requirement Calculation section.

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Inputs for DA Uncertainty Reserve Requirement Calculation – FTM Solar

- The historical NYCA DAM FTM Solar Forecast Error percentages over each hour for the prior year will be calculated as per the formula below:

$$\text{NYCA}\ DAM\ FTM\ Solar\ Forecast\ Error\ \%\ (for\ a\ particular\ hour) = \frac{NYCA\ DAM\ FTM\ Solar\ Forecast - NYCA\ Actual\ FTM\ Solar\ Output}{NYCA\ DAM\ FTM\ Solar\ Forecast} \times 100$$

- These hourly forecast error percentages are grouped into each of the forecast/installed capacity bins that was listed in the previous section.
- The Means and Standard Deviations for each forecast/installed capacity bin of the historical prior year's DAM FTM Solar Forecast Error percentages will be calculated annually.
  - These static values will be used to calculate the Composite DAM Uncertainty Reserve Requirements which will be discussed in the Composite Uncertainty Reserve Requirement Calculation section.

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Inputs for RT UR Requirement Calculation

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Inputs for RT Uncertainty Reserve Requirement Calculation – Net Load (Load net of BTM Solar)

- The historical NYCA RT 60-min ahead Net Load Forecast Error percentages (used for calculating the 30-min UR requirements) over each hour for the prior year will be calculated as per the formula below:

$$\text{NYCA } RT \text{ 60 min } ahead\ \ Net\ \ Load\ \ Forecast\ \ Error\ \%\ (for\ a\ particular\ hour) = \frac{NYCA\ Actual\ Net\ Load - NYCA\ 60\ \text{min}\ ahead\ Forecast\ Net\ Load}{NYCA\ DAM\ Forecast\ Net\ Load} \times 100$$

- The historical NYCA RT 30-min ahead Net Load Forecast Error percentages (used for calculating the 10-min UR requirements) over each hour for the prior year will be calculated as per the formula below:

$$\text{NYCA } RT \text{ 30 min } ahead\ \ Net\ \ Load\ \ Forecast\ \ Error\ \%\ (for\ a\ particular\ hour) = \frac{NYCA\ Actual\ Net\ Load - NYCA\ 30\ \text{min}\ ahead\ Forecast\ Net\ Load}{NYCA\ DAM\ Forecast\ Net\ Load} \times 100$$

- The Means and Standard Deviations of the historical prior year's NYCA RT 60-min and RT 30-min Net Load Forecast Error percentages will be calculated annually.
    - These static values will be used to calculate the Composite RT Uncertainty Reserve Requirements which will be discussed in the Composite Uncertainty Reserve Requirement Calculation section.

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Inputs for RT Uncertainty Reserve MW Requirement Calculation – Land Based Wind and Offshore Wind

- The historical NYCA RT 60-min ahead (used for calculating the 30-min UR requirements) and 30-min ahead (used for calculating the 10-min UR requirements) Land Based Wind and Offshore Wind Forecast Error percentages over each hour for the prior year will be calculated as per the formula below:

$$\text{NYCA}\ RT\ 60\,\text{min}\ Ahead\ Wind\ Forecast\ Error\ \%\ (for\ a\ particular\ hour) = \frac{NYCA\ RT\ 60\ \text{min}\ Ahead\ Wind\ Forecast - NYCA\ Actual\ Wind\ Output}{NYCA\ DAM\ Wind\ Forecast} \times 100$$

$$\text{NYCA}\ RT\ 30\,\text{min}\ Ahead\ Wind\ Forecast\ Error\ \%\ (for\ a\ particular\ hour) = \frac{NYCA\ RT\ 30\ \text{min}\ Ahead\ Wind\ Forecast - NYCA\ Actual\ Wind\ Output}{NYCA\ DAM\ Wind\ Forecast} \times 100$$

- These hourly forecast error percentages for Land Based Wind and Offshore Wind under RT 60 min ahead forecast error and 30 min ahead forecast error metrics are grouped into each of the forecast/installed capacity bins that was listed in the previous section.
- The Means and Standard Deviations for each forecast/installed capacity bin of the historical prior year's RT 60-min and 30-min Land Based Wind and Offshore Wind Forecast Error percentages will be calculated annually.
    - These static values will be used to calculate the Composite RT Uncertainty Reserve Requirements which will be discussed in the Composite Uncertainty Reserve Requirement Calculation section.

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Inputs for RT Uncertainty Reserve MW Requirement Calculation – FTM Solar

- The historical NYCA RT 60-min ahead (used for calculating the 30-min UR requirements) and 30-min ahead (used for calculating the 10-min UR requirements) FTM Solar Forecast Error percentages over each hour for the prior year will be calculated as per the formula below:

$$\text{NYCA } RT\ 60\,\text{min}\, Ahead\ FTM\ Solar\ Forecast\ Error\ \%\ (for\ a\ particular\ hour) = \frac{NYCA\ RT\ 60\ \text{min}\ Ahead\ FTM\ Solar\ Forecast - NYCA\ Actual\ FTM\ Solar\ Output}{NYCA\ DAM\ FTM\ Solar\ Forecast} \times 100$$

$$\text{NYCA } RT\ 30\,\text{min}\, Ahead\ Wind\ Forecast\ Error\ \%\ (for\ a\ particular\ hour) = \frac{NYCA\ RT\ 30\ \text{min}\ Ahead\ Wind\ Forecast - NYCA\ Actual\ Wind\ Output}{NYCA\ DAM\ FTM\ Solar\ Forecast} \times 100$$

- These hourly forecast error percentages are grouped into each of the forecast/installed capacity bins that was listed in the previous section.
- The Means and Standard Deviations for each forecast/installed capacity bin of the historical prior year's DAM FTM Solar Forecast Error percentages will be calculated annually.
  - These static values will be used to calculate the Composite DAM Uncertainty Reserve Requirements which will be discussed in the Composite Uncertainty Reserve Requirement Calculation section.

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Composite Uncertainty Reserve Requirement Calculation

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Composite Uncertainty Reserve Requirement Calculation

- **The standard deviation of a joint distribution is not the sum of the standard deviations of the underlying distributions, which requires a statistical formula to estimate the total Uncertainty Reserve Requirement from the underlying distributions**
- **We are proposing to use the formula shown in the following slide 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.**

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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.**

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Composite DAM Uncertainty Reserve Requirement Calculation

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

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

Hourly Data for each Market Day

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Composite RT 30-min Uncertainty Reserve Requirement Calculation

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

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

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

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

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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Uncertainty Reserve Requirement Calculation Process Flows

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DAM Uncertainty Reserve Requirement Calculation Process (Occurs BEFORE DAM)

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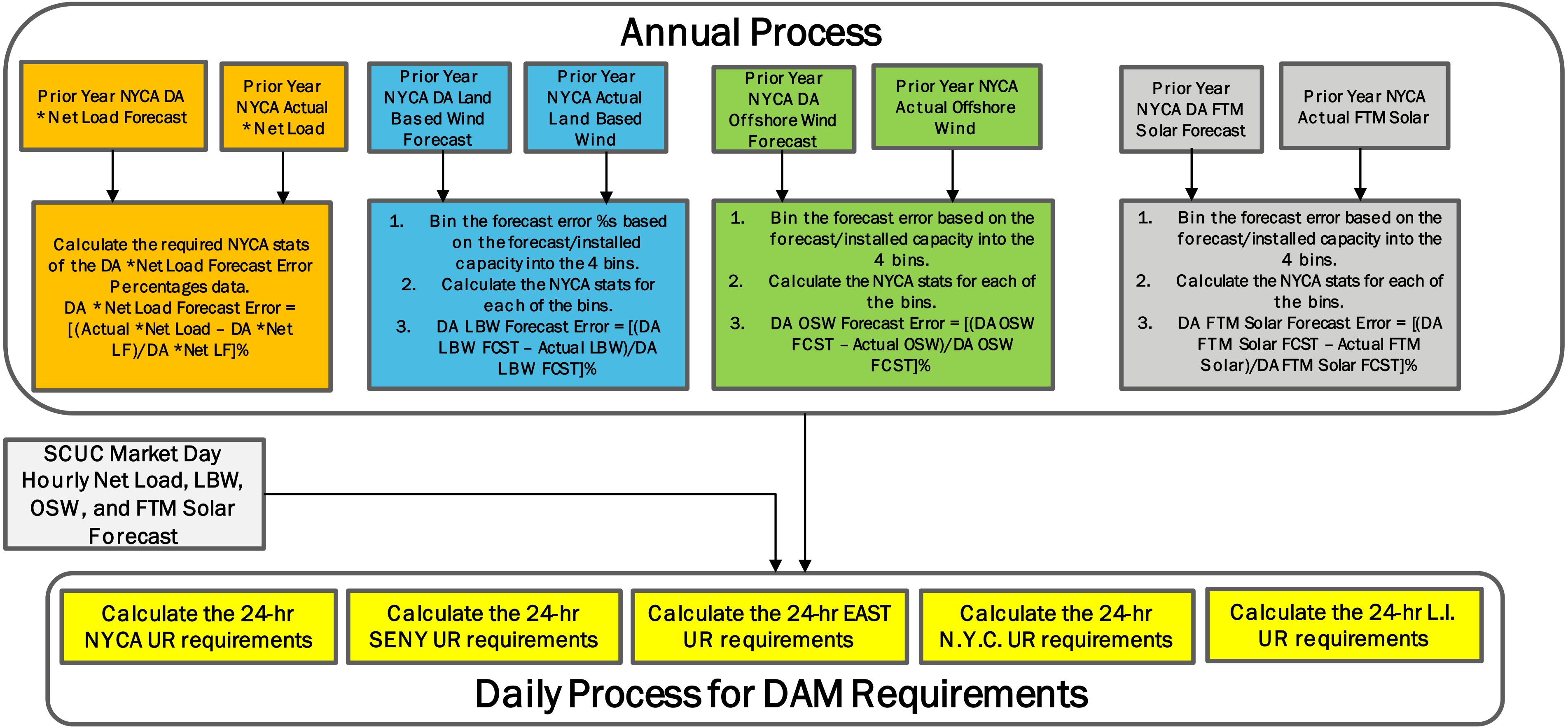

*Net Load – Load net of BTM Solar

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

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Annual Process

Prior Year NYCA 60-min ahead and DA *Net Load Forecast

Prior Year NYCA Actual *Net Load

Calculate the required NYCA stats of the 60-min ahead *Net Load Forecast Error Percentages data. 60-min ahead Net Load Forecast Error = [(Actual *Net Load – 60-min ahead *Net LF)/DA *Net LF]%

Prior Year NYCA 60-min ahead and DA Land Based Wind Forecast

Prior Year NYCA Actual Land Based Wind

1. Bin the forecast error %s based on the forecast/installed capacity into the 4 bins.
2. Calculate the NYCA stats for each of the bins.
3. 60-min ahead LBW Forecast Error = [(60-min ahead LBW FCST – Actual LBW)/DA LBW FCST]%

Prior Year NYCA 60-min ahead and DA Offshore Wind Forecast

Prior Year NYCA Actual Offshore Wind

1. Bin the forecast error based on the forecast/installed capacity into the 4 bins.
2. Calculate the NYCA stats for each of the bins.
3. 60-min ahead OSW Forecast Error = [(60-min ahead OSW FCST – Actual OSW)/DA OSW FCST]%

Prior Year NYCA 60-min ahead and DA FTM Solar Forecast

Prior Year NYCA Actual FTM Solar

1. Bin the forecast error based on the forecast/installed capacity into the 4 bins.
2. Calculate the NYCA stats for each of the bins.
3. 60-min ahead FTM Solar Forecast Error = [(60-min ahead FTM Solar FCST – Actual FTM Solar)/DA FTM Solar FCST]%

SCUC Market Day Hourly Net Load, LBW, OSW, and FTM Solar Forecast

Calculate the 24-hr NYCA UR requirements

Calculate the 24-hr SENY UR requirements

Calculate the 24-hr EAST UR requirements

Calculate the 24-hr N.Y.C. UR requirements

Calculate the 24-hr L.I. UR requirements

Daily Process for RT 30-min Requirements

*Net Load – Load net of BTM Solar

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

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Annual Process

Prior Year NYCA 30-min ahead and DA *Net Load Forecast and **Prior Year NYCA Actual *Net Load** →

Calculate the required NYCA stats of the 30-min ahead *Net Load Forecast Error Percentages data. 30-min ahead Net Load Forecast Error = [(Actual *Net Load – 30-min ahead *Net LF)/DA *Net LF]%

Prior Year NYCA 30-min ahead and DA Land Based Wind Forecast and **Prior Year NYCA Actual Land Based Wind** →

1. Bin the forecast error %s based on the forecast/installed capacity into the 4 bins.
2. Calculate the NYCA stats for each of the bins.
3. 30-min ahead LBW Forecast Error = [(30-min ahead LBW FCST – Actual LBW)/DA LBW FCST]%

Prior Year NYCA 30-min ahead and DA Offshore Wind Forecast and **Prior Year NYCA Actual Offshore Wind** →

1. Bin the forecast error based on the forecast/installed capacity into the 4 bins.
2. Calculate the NYCA stats for each of the bins.
3. 30-min ahead OSW Forecast Error = [(30-min ahead OSW FCST – Actual OSW)/DA OSW FCST]%

Prior Year NYCA 30-min ahead and DA FTM Solar Forecast and **Prior Year NYCA Actual FTM Solar** →

1. Bin the forecast error based on the forecast/installed capacity into the 4 bins.
2. Calculate the NYCA stats for each of the bins.
3. 30-min ahead FTM Solar Forecast Error = [(30-min ahead FTM Solar FCST – Actual FTM Solar)/DA FTM Solar FCST]%

SCUC Market Day Hourly Net Load, LBW, OSW, and FTM Solar Forecast

Daily Process for RT 10-min Requirements

- Calculate the 24-hr NYCA UR requirements
- Calculate the 24-hr SENY UR requirements
- Calculate the 24-hr EAST UR requirements
- Calculate the 24-hr N.Y.C. UR requirements
- Calculate the 24-hr L.I. UR requirements

*Net Load – Load net of BTM Solar

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Wind and FTM Solar Forecast Error Distribution Bins

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Proposed Uncertainty Reserve Wind Bins

DAM Forecast MW (% of Wind Capacity) Bin	Mean of 2021 Errors	Standard Deviation of 2021 Errors
<= 20%	18.3%	47.5%
20% - 40%	4.5%	28.5%
40% - 60%	1.1%	19.3%
> 60%	2.5%	12.4%

- **The proposed bins aim to capture the observed variation in error percentage at lower forecast levels compared to higher forecast levels.**
- **Bin percentages (far left column) will be static year-to-year, but the requirement Mean and Standard deviation percentages will change each year to year based on the prior year's wind forecast error data.**
  - We will establish a similar bin structure for offshore wind once more of these resources enter service.

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Proposed Uncertainty Reserve FTM Solar Bins

DAM Forecast MW (% of FTM Solar Capacity) Bin	Mean of 2021 Errors	Standard Deviation of 2021 Errors
<= 30%	4%	50%
30% - 45%	-1%	23%
> 45%	1%	17%

- The proposed bins aim to capture the observed variation in error percentage at lower forecast levels compared to higher forecast levels.
- Bin percentages (far left column) will be static year-to-year, but the requirement Mean and Standard deviation percentages will change each year to year based on the prior year's FTM Solar forecast error data.

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Scarcity Pricing and Uncertainty Reserves

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Scarcity Pricing

- Scarcity pricing is a mechanism employed by the NYISO that establishes a price when reliability-based Demand Response events are deployed
  - Supplement generation when Operating Reserves are forecast to be short or when there is an actual Operating Reserve Deficiency.
  - Scarcity pricing rules apply to the SCR and EDRP events.
  - Ensures EDRP/SCR resource participation in a reliability-based event is factored into calculating the Real Time prices.
- RTD and RTC procure additional 30-minute reserves during EDRP/SCR activations (Scarcity Reserve Requirement)
- Revised 30-minute Reserve Requirement = 2620 MW + Scarcity Reserve Requirement

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Scarcity Pricing Interaction with Uncertainty Reserves

- Revised 30-minute Reserve Requirement = 2620 MW + Maximum (Scarcity Reserve Requirement, NYCA RT 30-minute Uncertainty Reserve Requirement)
- Example 1: Scarcity Reserve Requirement Exceeds the NYCA RT 30-minute Uncertainty Reserve Requirement
  - Contingency Reserve Reqt. = 2,620 MW, Scarcity Reserve Reqt. = 280 MW, RT 30-minute Uncertainty Reserve Reqt. = 200 MW
  - Revised 30-minute Reserve Reqt. = 2,620 + MAX(280, 200) = 2,900 MW
- The NYCA 30-minute demand curve in RT during SCR/EDRP activations results in the following demand curve:
  - $750/MWh "step" up to and including 1,965 MW
  - $625/MWh "step" beyond 1,965 through 2,020 MW
  - $500/MWh "step" beyond 2,020 MW through (2,620 + applicable Scarcity Reserve Reqt.) [beyond 2,020 MW through 2,900 MW]

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Scarcity Pricing Interaction with Uncertainty Reserves

- Revised 30-minute Reserve Requirement = 2620 MW + Maximum (Scarcity Reserve Requirement, NYCA RT Uncertainty Reserve Requirement)
- Example 2: NYCA RT 30-minute Uncertainty Reserve Requirement Exceeds the Scarcity Reserve Requirement
  - Contingency Reserve Reqt. = 2,620 MW, Scarcity Reserve Reqt. = 280 MW, RT 30-minute Uncertainty Reserve Reqt. = 380 MW
  - Revised 30-minute Reserve Requirement = 2,620 + MAX(280, 380) = 3,000 MW
- The NYCA 30-minute demand curve in RT during SCR/EDRP activations results in the following demand curve:
  - $750/MWh "step" up to and including 1,965 MW
  - $625/MWh "step" beyond 1,965 through 2,020 MW
  - $500/MWh "step" beyond 2,020 MW through (2,620 + applicable Scarcity Reserve Reqt.) [beyond 2,020 MW through 2,900 MW]
  - $20/MWh "step" beyond (2,620 + Scarcity Reserve Reqt.) through ((2,620+ Scarcity Reserve Reqt) + (NYCA RT 30-minute Uncertainty Reserve Reqt. - Scarcity Reserve Reqt.)) [beyond 2,900 MW up to and including 3,000 MW]

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Next Steps

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Next Steps (Phase 1)

- Q3
  - Initial Tariff Revisions
  - Consumer Impact Analysis Results
  - Final Tariff Revisions
  - BIC/MC Vote
- Q4
  - Filing date TBD pending tariff/BIC/MC/NYISO Board of Directors

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Questions?

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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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