Dynamic Reserves

Ashley Ferrer

Market Design Specialist, Energy Market Design

ICAPWG/MIWG

May 11, 2022

Agenda

- Background
- Use of Forecast Load in Formulation
- Correlated Source Contingencies
- Intermittent Resource Contingencies
- Intermittent Resource Contingency Constraint: Application to Existing Facilities
- Next Steps

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Background

Previous Presentations

Title/Topic	Link
2021 RECA Study (Updated 2/2022)	https://www.nyiso.com/documents/20142/26734185/RECA(Dynamic%20Reserves)%20Study%20Report.pdf/27990919-e81b-76a4-12e1-57b9458b553d
2022 Project Kickoff	https://www.nyiso.com/documents/20142/28897222/Dynamic%20Reserves%20Kickoff%20MIWG%2003032022_Final.pdf/b2b5cd26-4740-ab35-015c-5e93bf3ca23e

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Project Background

- **The current static modeling of reserve regions and their associated requirements may not optimally reflect the varying needs of the grid to respond to changes in system conditions, such as considerations of the following:**
  - Scheduling economic energy above 1,310 MW from individual suppliers when sufficient reserves are available and/or
  - Shifting reserve procurements to lower-cost regions when sufficient transmission capability exists.
- **A more dynamic reserve procurement methodology could potentially improve market efficiency and better align market outcomes with how the power system is operated**

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Key Concepts

- **A Dynamic Reserve procurement will depend on two key concepts:**
  - Reserves should cover for the largest source contingency in a reserve region, less the available transmission headroom
  - Reserves should account for loss of transmission capability into a reserve region
- **These concepts reflect the reliability rules that drive the current static requirements for each reserve region**

Securing Reserve Area for the Loss of Generation

- **The first concept is that reserves should cover for the largest source contingency, less available headroom**
  - Available headroom would reflect the ability to import reserves into the reserve region
  - Currently, largest source contingency is determined by the maximum single generation schedule
- **In addition to the largest single-source contingency, NYISO is proposing additional constraints to be considered when evaluating the largest source contingency. These topics will be discussed today:**
  - Correlated loss of multiple generators: Multiple resources that share a single point of failure (transmission tower, gas regulator valve)
  - Intermittent resource contingencies: Resources in close geographic proximity that may be susceptible to a common weather pattern, which poses a risk of simultaneous loss or reduction of energy output

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Securing Reserve Area for the Loss of Transmission

- **The second concept is that reserves should account for the loss of transmission (energy imports) into a reserve area**
  - This evaluation calculates the difference between the post-contingency interface limits and the current flow, following the loss of the largest line on the interface

Tying Loss of Generation and Loss of Transmission Together

- The equations for the generation and transmission constraints would be co-optimized along with energy, reserves, and transmission
- The reserve requirements would be determined by the most restrictive equation for each reserve product in each reserve area
  - Would be dynamically determined in DAM and RTM

Use of Forecast Load in Formulation

Forecast vs. Bid Load in SCUC

- To determine the available transmission capability into a reserve area in the Day-Ahead Market (DAM), the 2021 RECA Study and prototype used the forecast load
  - The study noted that the forecast load had been selected rather than the bid load
  - Some stakeholders sought more information to support the use of the forecast load vs. the bid load
- Forecast load was selected as it does not include virtual transactions, which may not be representative of expected physical flows and generation in real time
- Dynamic reserves provide a reliability test against expected system conditions, which can not be guaranteed using the bid load
  - For example, virtual generation could represent energy that is either a) imported into a reserve area or b) generated within a reserve region – would not know until real time
- Prototyping completed in 2021 indicated that using bid load led to under securing reserves
- The NYISO proposes to continue the use of the forecast load to determine available transmission capability in the DAM

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Correlated Source Contingencies

Correlated Source Contingencies

- **The 2021 RECA Study included the following recommendation:**
  - Recommendation 6: Consider expanding the methodology definition of source contingency to ensure it includes correlated source contingencies, such as simultaneous reduction of offshore wind, as the largest source contingency
- **The NYISO is proposing a constraint that would account for the potential loss of multiple resources that share a single point of failure**
  - This constraint would be evaluated simultaneously against the loss of generation and loss of transmission equations, with the most restrictive (*i.e.*, largest MW at risk) constraint setting the applicable reserve requirement in each reserve region
  - The most limiting of all generator constraints (largest source, correlated loss, intermittent resources) would feed into any equation as the MaxGen

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Correlated Loss of Multiple Generators

- This constraint would capture the potential risk of losing multiple resources whose combined output may be the largest single source of generation in a reserve area
  - The definition of correlated loss of multiple generators includes a single tower or line contingency leaving a generation complex that would result in the loss of multiple generating resources simultaneously
- NYISO's proposal would allow generators to be linked such that their combined output would be evaluated in the standard form below:
  - $Res_{\mathrm{RA}_{a_i}}^{30Total} \geq Mult_{\mathrm{RA}_a}^{30Total} * \{\{gen_{\mathrm{A_i}} + gen_{\mathrm{B_i}}\}\} - RA_{aRes_{Capability_i}}$

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Correlated Loss of Multiple Generators: Definition

- **Applicable groups of generators are currently identified by NYISO**
  - This constraint may not apply to a reserve area if there is not a set resources that have been identified as correlated
  - There are currently less than 5 sets of resources that this constraint would apply to
    - The combined output of each resource set is less than the current single largest generator in NYCA (i.e., less than 1,310 MW)
    - In nested regions, correlated groups could meet the definition of largest generator

Intermittent Resource Contingencies

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Intermittent Resource Contingencies

- **The 2021 RECA Study included the following recommendation and consideration:**
  - Recommendation 6: Consider expanding the methodology definition of source contingency to ensure it includes correlated source contingencies, such as simultaneous reduction of offshore wind, as the largest source contingency.
  - Consideration: Interaction of dynamic reserve modeling with the intermittent resource contingencies, whether loss of single resource or the correlated loss of energy across multiple resources
- **The NYISO is proposing a constraint that would account for the potential risk of simultaneous loss (or reduction of energy output) of intermittent resources within a similar geographic area**

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Intermittent Resource Contingency Constraint

- This constraint would capture the potential risk of losing multiple intermittent resources whose combined output may be the largest single source of energy in a reserve area
  - For example, wind resources in close geographic proximity are susceptible to a common weather pattern, which poses a risk of simultaneous loss (or reduction of energy output) of many resources (which may not share a single interconnection point)
  - Wind resources that share a single point of interconnection would be considered a single generator
- This constraint would be evaluated simultaneously against the loss of generation and loss of transmission equations, with the most restrictive (*i.e.*, largest MW at risk) constraint setting the applicable reserve requirement in each reserve region
- The most limiting of all generator constraints (largest source, correlated loss, intermittent resources) would feed into any equation as the MaxGen

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Intermittent Resource Contingency: Proposal

- **Scheduling of wind resources is based on a Probability of Exceedance (POE) 50 forecast**
  - A POE(50) forecast represents a value that will be exceeded 50% of the time; in turn, observations will be below this value 50% of the time
- **NYISO's proposal would use a POE forecast greater than 50 to calculate the quantity of generation that may be at risk**
  - The use of a higher POE (higher confidence) forecast would provide greater certainty of expected output. At this time, NYISO has not determined what POE forecast that will be used for this constraint
    - For example, a POE(95) represents a value with a 95% chance of being exceeded. This value is less than a POE(50) value as there is higher confidence that the forecast will be above it
- **NYISO proposes to use the difference between the schedules (based on a POE50) and the forecasted values based on a higher POE, in the standard format:**

$$Res_{RA_{a_i}}^{30Total} \geq Mult_{\mathrm{RA}_a}^{30Total} * \left(\sum_{RA_{a_i}} IPP_{Schedule_i} - \sum_{RA_{a_i}} POEXX_{Forecast_i}\right) - RA_{aRes_{Capability_i}}$$

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Intermittent Resource Contingency: Example

- **Proposed formula:**

$$Res_{RA_{a_i}}^{30Total} \geq Mult_{\mathrm{RA}_a}^{30Total} * (\sum_{RA_{a_i}} IPP_{Schedule_i} - \sum_{RA_{a_i}} POEXX_{Forecast_i}) - RA_{aRes_{Capability_i}}$$

- **Example:**
  - Assume two intermittent resources with combined energy schedules of 1400 MW
  - Combined POE95 forecast for those resources of 1000 MW
  - Multiplier is 1.0, and headroom is 200 MW

$$200\ \mathrm{MW} \geq 1.0 * \left(\sum_{RA_{a_i}}(800 + 600) - \sum_{RA_{a_i}}(600 + 400)\right) - 200\ \mathrm{MW}$$

  - The resulting at risk energy would be 400 MW
  - The resultant reserve requirement would be 200 MW

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Intermittent Resource Contingency Constraint: Application to Existing Facilities

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Analysis of Existing Facilities: Method

- **The purpose of this analysis is to provide insight and gain an understanding of how a reserve requirement would be calculated using the Intermittent Resource Contingency constraint for existing wind facilities**
  - Contains a year of data (2020)
  - Assumes that all existing wind facilities are grouped (*i.e.*, in close geographic proximity and subject to same risks)
- **Created two different data sets:**
  - Joined DAM Forecast (which are based on a POE50 forecast), POE75 Forecast, POE90 Forecast
    - This yielded observations for every wind facility regardless of if it received a DAM schedule
    - This helps inform the difference in MW between POE forecasts of different confidence levels
  - Joined DAM Schedule, DAM Forecast (POE50), POE75 Forecast, POE90 Forecast
    - This yielded observations only for wind facilities that received a DAM Schedule
    - This helps to inform an understanding of the size of the reserve requirement based on the proposed constraint in the DAM

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Analysis of Existing Facilities: Results

- **Probability of Exceedance Comparison (includes all facilities)**
  - Sum of Forecast MW – Sum of POE 75
    - Max Hourly Difference: 457 MW; 21% of nameplate wind
  - Sum of Forecast MW – Sum of POE 90
    - Max Hourly Difference: 766 MW; 35% of nameplate wind
- **These results illustrate the difference between the forecast MW (based on POE50) and MWs of higher confidence POE's**
  - How many more MWs are "at risk" when using higher confidence POE's

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Analysis of Existing Facilities: Results

- **Schedule Comparison (includes only facilities with a schedule)**
  - Sum of Schedule MW – Sum of POE 75
    - Max Hourly Difference: 436 MW; 20% of nameplate wind
  - Sum of Schedule MW – Sum of POE 90
    - Max Hourly Difference: 551 MW; 25% of nameplate wind
- **These results illustrate the MW value that would be fed into the constraint, which is proposed to be calculated for each timestep in DAM and RTM**

$$Res_{RA_{a_i}}^{30Total} \geq Mult_{\mathrm{RA}_a}^{30Total} * \left(\sum_{RA_{a_i}} IPP_{Schedule_i} - \sum_{RA_{a_i}} POEXX_{Forecast_i}\right) - RA_{aRes_{Capability_i}}$$

Analysis of Existing Facilities: Conclusions

- **This analysis illustrates:**
  - The MW difference between a POE50 and a higher confidence POE
    - As expected, the higher POE forecast leads to a larger potential MW requirement
  - The quantity of reserves that could be procured based on this approach
    - The resulting reserve requirement would be evaluated alongside the other loss of generation and loss of transmission equations in setting the reserve requirement, with the most restrictive equation setting the requirement
    - The analysis looked at the maximum difference over the course of an entire year; this value would change in every interval

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Next Step: Intermittent Resource Contingencies

- **NYISO proposes this constraint as a method for accounting for the correlated loss of energy across intermittent power resources**
- **There are several components of the proposal to continue to evaluate:**
  - Determine Probability of Exceedance forecast to use in the constraint
    - As noted earlier, NYISO has not determined forecast will be used
  - Complete additional analyses as needed and as requested by stakeholders, which could include:
    - Evaluating higher confidence POE forecasts
    - Performing analysis of existing facilities in the Real-Time Market
  - Incorporate constraint into prototype development
  - Determine if this constraint would apply to all reserve products (10-Minute Spin, 10-Minute Total, and 30-Minute Total)

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Next Steps

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Next Steps: Q2

- **The NYISO will continue discussions at ICAP/MIWG in the coming months, targeting the following schedule:**
  - Q2 (May, June) – items in blue discussed at today's ICAPWG/MIWG
    - Correlated contingencies that might impact reserve requirements
    - Use of forecast load in mathematical formulation
    - Interaction of dynamic modeling with intermittent resource contingencies
    - Securing of reserves in export constrained areas (*e.g.*, Long Island)
    - Interplay between Thunderstorm Alerts (TSAs) and dynamic reserves
    - Process for posting of dynamic reserve requirements
    - LBMP formation (including cost allocation, pricing of virtual supply in DAM)

Next Steps: Q3 and Q4

- **The NYISO will continue discussions on the following topics at ICAP/MIWG in the coming months:**
  - Interaction of dynamic reserves with operating reserve demand curves
  - Interaction of dynamic reserves with transmission demand curves
  - Interplay between dynamic reserves scheduling and additional reserve requirements
  - Impacts on scarcity pricing logic
  - Interplay with current/future efforts: More Granular Operating Reserves, Long Island Constraint Pricing, Reserves for Congestion Management
  - Discussion of prototyping, which could include:
    - Impacts on day-ahead and real-time market solutions
    - Interaction with new resource models

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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Questions?

Appendix: Mathematical Formulation

Equations: Securing a Reserve Area for the Loss of Generation

Calculating Actual Energy Flows in a Reserve Area

$$RA_{a_{Flow_i}} = (RA_{a_{Load_i}} - RA_{a_{Gen_i}})$$

- $\mathrm{RA_a}$ **is the applicable reserve area**
- $\mathrm{RA}_{\mathrm{a}_{\mathrm{Flow}_\mathrm{i}}}$ **is the actual energy flow into or out of reserve area *a* for time step *i***
  - $RA_{a_{Flow_i}}$ is positive into reserve area *a*
  - $RA_{a_{Flow_i}}$ is negative out of reserve area *a*
  - Note: For the NYCA reserve area (Load Zones A-K), $RA_{a_{Flow_i}}$ value is equal to 0 MW because external proxies are evaluated as generators
- $\mathrm{RA}_{\mathrm{a}_{\mathrm{Load}_\mathrm{i}}}$ **is the forecasted load in reserve area *a* for time step *i* (Day-Ahead or real-time, as applicable)**
- $\mathrm{RA}_{\mathrm{a}_{\mathrm{Gen}_\mathrm{i}}}$ **is the sum of all energy schedules on resources inside reserve area *a* for time step *i***

Calculating the Available Transmission Headroom in a Reserve Area

$$RA_{aRes_{Capability_i}} = RA_{a_{Limit_i}} - RA_{a_{Flow_i}}$$

- $\mathrm{RA}_{\mathrm{aRes}_{\mathrm{Capability}_i}}$ is the capability to secure reserves external to reserve area *a* for time step *i*
- $\mathrm{RA}_{\mathrm{a}_{\mathrm{Limit}_i}}$ is the pre-contingency normal limit for the reserve area *a* for time step *i*
  - Note: For the NYCA reserve area (Load Zones A-K), the RA_{Limit} value is equal to 0 MW because external proxies are evaluated as generators

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Multipliers Determine Product Quality Ratios

$$Res_{RA_{a_i}}^{10Spin} \geq Mult_{\mathrm{RA}_a}^{10Spin} * \{\max_{\mathrm{k} \in \mathrm{Gen}_{RA_a}} \{gen_{k_i}\}\} - RA_{aRes_{Capability_i}}$$

$$Res_{RA_{a_i}}^{10Total} \geq Mult_{\mathrm{RA}_a}^{10Total} * \{\max_{k \in \mathrm{Gen}_{RA_a}} \{gen_{k_i}\}\} - RA_{aRes_{Capability_i}}$$

$$Res_{RA_{a_i}}^{30Total} \geq Mult_{\mathrm{RA}_a}^{30Total} * \{\max_{\mathrm{k} \in \mathrm{Gen}_{RA_a}} \{gen_{\mathrm{k_i}}\}\} - RA_{aRes_{Capability_i}}$$

- $\mathrm{Res_{RA}}_{a_i}^{\mathrm{10Spin}}$ is the 10 – minute spinning reserve requirement in reserve area a for time step i
- $\mathrm{Res_{RA}}_{a_i}^{\mathrm{10Total}}$ is the 10 – minute total reserve requirement in reserve area a for time step i
- $\mathrm{Res_{RA}}_{a_i}^{\mathrm{30Total}}$ is the 30 – minute total reserve requirement in reserve area a for time step i

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Securing a Reserve Area for the Loss of Transmission

Contingency Headroom on Interface

$$10minute_{PostCon_{Import_{RA_{a_i}}}} = Limit_{Emer_{RA_{a_i}}} - RA_{Flow_{a_i}}$$

$$30minute_{PostCon_{Import_{RA_{a_i}}}} = Limit_{Norm_{RA_{a_i}}} - RA_{Flow_{a_i}}$$

$$30minute_{PostDualCon_{Import_{RA_{a_i}}}} = Limit_{Emer\_Dual_{RA_{a_i}}} - RA_{Flow_{a_i}}$$

- $10\mathrm{minute}_{\mathrm{PostCon}_{\mathrm{Import}_{\mathrm{RA}_{\mathrm{a_i}}}}}$ is the applicable post-contingency transfer limit of reserve area *a* for time step *i* that the flow should be under within 10 minutes
- $30\mathrm{minute}_{\mathrm{PostCon}_{\mathrm{Import}_{\mathrm{RA}_{\mathrm{a_i}}}}}$ is the applicable post-contingency transfer limit of reserve area *a* for time step *i* that the flow should be under within 30 minutes
- $\mathrm{Limit}_{\mathrm{Emer}_{\mathrm{RA}_{\mathrm{a_i}}}}$ is the emergency transfer limit of reserve area *a* for time step *i*, depending on the applicable reliability rules to determine the need for 10 minute or 30-minutes reserves
- $\mathrm{Limit}_{\mathrm{Norm}_{\mathrm{RA}_{\mathrm{a_i}}}}$ is the normal transfer limit of reserve area *a* for time step *i*, depending on the applicable reliability rules to determine the need for 30-minutes reserves

Contingency Headroom on Interface

- The difference between the applicable transfer limit and the flow is the available import capability
  - When negative, this number represents a deficiency that needs to be held as reserves within the reserve area due to the lack of transmission headroom to import reserves.
- All limits will be calculated via an offline study by NYISO Operations

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Securing the RA for Loss of Transmission

$$Res_{RA_{a_i}}^{10Spin} \geq -Mult_{\mathrm{RA}_a}^{10Spin} * (10minute_{PostCon_{Import_{RA_{a_i}}}})$$

$$Res_{RA_{a_i}}^{10Total} \geq -(10minute_{PostCon_{Import_{RA_{a_i}}}})$$

$$Res_{RA_{a_i}}^{30Total} \geq -(30minute_{PostCon_{Import_{RA_{a_i}}}})$$

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Tying the Loss of Generation and Loss of Transmission Together

Simultaneous Constraints 10-Minute Spinning Reserves

- **Simultaneous Constraints for 10-minute spinning reserves:**

$$Res_{RA_{a_i}}^{10Spin} \geq Mult_{\mathrm{RA}_a}^{10Spin} * \{\max_{\mathrm{k}\in\mathrm{Gen}_{RA_a}} \{gen_{k_i} + res_{k_i}^{10SPin}\}\} - RA_{aRes_{Capability_i}}$$

$$Res_{RA_{a_i}}^{10Spin} \geq -\mathrm{Mult}_{\mathrm{RA_a}}^{\mathrm{10Spin}} * (10minute_{PostCon_{Import_{RA_{a_i}}}})$$

The more restrictive of the two equations will determine the applicable requirement for the reserve area.

Simultaneous Constraints 10-Minute Total Reserves

- **Simultaneous Constraints for 10-minute total reserves:**

$$Res_{RA_{a_i}}^{10Total} \geq Mult_{\mathrm{RA}_a}^{10Total} * \{\max_{\mathrm{k} \in \mathrm{Gen}_{RA_a}} \{gen_{k_i} + res_{k_i}^{10Total}\}\} - RA_{aRes_{Capability_i}}$$

$$Res_{RA_{a_i}}^{10Total} \geq -(10minute_{PostCon_{Import_{RA_{a_i}}}})$$

The more restrictive of the two equations will determine the applicable requirement for the reserve area.

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Simultaneous Constraints 30-Minute Total Reserves

- **Securing for loss of source contingency with a security multiplier:**

$$Res_{RA_{a_i}}^{30Total} \geq \mathrm{Mult}_{\mathrm{RA_a}}^{\mathrm{30Total}} * \{\max_{\mathrm{k \in Gen}_{RA_a}} \{\mathrm{gen}_{k_i} + res_{k_i}^{30Total}\}\} - RA_{aRes_{Capability_i}}$$

- **Securing for one source contingency and N-1 transmission contingency:**

$$Res_{RA_{a_i}}^{30Total} \geq \{\max_{\mathrm{k \in Gen}_{RA_a}} \{\mathrm{gen}_{k_i} + res_{k_i}^{30Total}\}\} - RA_{aRes_{Capability_i}} + \left(30minute_{PostCon_{Import_{RA_{a_i}}}} - 10minute_{PostCon_{Import_{RA_{a_i}}}}\right)$$

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Simultaneous Constraints 30-Minute Total Reserves (continued)

- **Secure transmission for N-1 to normal transfer capability:**

$$Res_{RA_{a_i}}^{30Total} \geq -\left(30minute_{PostCon_{Import_{RA_{a_i}}}}\right)$$

- **Secure transmission for N-1-1-0 to normal transfer capability (applies to NYC and NYC load pockets):**

$$Res_{RA_{a_i}}^{30Total} \geq -\left(30minute_{PostdualCon_{Import_{RA_{a_i}}}}\right)$$

- **Secure for loss of two elements within 30 minutes:**

$$Res_{RA_{a_i}}{}^{30Total} \geq -10minute_{PostCon_{Import_{RA_{a_i}}}} - \left\{\max_{\mathrm{k} \in \mathrm{Gen}_{\mathrm{RA_a}}} \{gen_{\mathrm{k_i}}\}\right\}$$

The more restrictive of the equations will determine the applicable requirement for the reserve area.

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