Consumer Impact Analysis Methodology: Reserve Enhancements for Constrained Areas (Dynamic Reserves)

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Agenda

- Background
- Study Approach
- Consumer Impact Methodology
- Next Steps
- Appendix

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Background

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Operating Reserves Overview

- **Protection against contingencies**
  - Sudden loss of a generator
  - Trip of network equipment (e.g., transmission line or transformer)
- **Locational reserve requirements**
  - Requirements for EAST (Load Zones F-K), SENY (Load Zones G-K), NYC (Load Zone J) and Long Island (Load Zone K) help ensure reserves are located where needed due to limitations on the transmission system
- **Existing reserve requirements are essentially static**

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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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Study Approach

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Study Approach

- **The study is evaluating the feasibility of dynamically scheduling reserves in the SCUC, RTC and RTD intervals**
  - Studying the impact with current reserve products (10-minute spin, 10-minute total, 30-minute total)
  - Studying the ability to apply to all current reserve regions and potential future reserve regions (e.g., certain NYC load pockets)
- **The study is comprised of two primary phases:**
  - Formulation phase
  - Prototyping phase

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Formulation Phase

- **The NYISO started with a theoretical approach by developing a generalized mathematical formulation to facilitate solving the procurement of operating reserves dynamically.**
    - The NYISO sought feedback from external consultants on the feasibility of the formulation
- **The detailed mathematical formulation was presented at the August 19th ICAPWG/MIWG[1]**
    - Based on stakeholder feedback received at the October 12th ICAPWG/MIWG, some changes have been made to the mathematical formulation noted in 'red' text in the Appendix of today's presentation

1. https://www.nyiso.com/documents/20142/23946370/02 RECA MIWG 08192021.pdf/75dde96a-a02d-fa5b-bc34-0e6fb8cc871a

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Prototyping Phase

- The NYISO is in the process of prototyping the mathematical formulation to study the feasibility of the prototype on the Day-Ahead Market solution
- The NYISO is currently stress testing the prototype under various scenarios and analyzing the accuracy of the results to test the effectiveness of incorporating it into the market software and its impacts on the market solution
  - These scenarios will also be used in performing the Consumer Impact Analysis (CIA) and will be included in the study report

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Consumer Impact Methodology

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Consumer Impact Methodology for Study

- The NYISO proposes to perform a simplified version of the Consumer Impact Analysis for this phase of the project
  - Typically, CIAs are performed prior to the Market Design Complete phase
  - The focus will be on Cost Impact/Market Efficiencies
- Use the Dynamic Reserves prototype that was developed to run a few SCUC scenarios to demonstrate the applicability of dynamic scheduling of reserves and its impact~~s~~ on market efficiency

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Consumer Impact Methodology; Contd.

- **Using the market software, establish a base case by re-running a select number of Day-Ahead Market (DAM) days, based on the current static reserve requirements**
- **Using the market software, re-run the same DAM days using the dynamic reserves prototype**
  - All the dynamic reserve constraints are detailed in the Appendix of this presentation
- **Use specific test cases for the dynamic reserves re-runs that will be activated incrementally for the different reserve areas**
  - Allows for trade-offs between the dynamic reserve constraints and the static reserve requirements
  - The test cases are outlined on Slide 13
- **A comparison of the reruns based on the dynamic reserve prototype with the base case will result in several outputs of the analysis**
  - The output of the analysis will include total production cost changes, LBMP changes, operating reserve clearing price changes, and changes in consumer costs

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Consumer Impact Methodology- Test Cases

Case 1
- Will activate dynamic reserve constraints for only NYCA wide reserve products (i.e., 10-minute spin, 10-minute total, 30-minute total)

Case 2
- Will activate dynamic reserve constraints for only SENY 30-minute reserve product

Case 3
- Will activate dynamic reserve constraints for all NYCA wide reserve products and SENY 30-minute reserve product

Case 4
- Will activate dynamic reserve constraints for all current reserve areas and reserve products (i.e., NYCA, EAST, SENY, NYC and LI)

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Approach used to select DAM days for re-runs

- **Select multiple days based on hot weather conditions during recent months (July through August 2021) to ensure the simulations are based on updated software and market rules.**
  - For each day-ahead case, first run a base case with the current static operating reserve requirements active for all 24 hours.
  - Next, run the case with dynamic reserve constraints active for all 24 hours

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Next Steps

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Next Steps

- Continue work on Prototype
- Present Study Findings and Recommendations
  - Current Target: November 2021
- Present Consumer Impact Analysis (TENTATIVE)
  - Current Target: December 2021
- Publish Study Report
  - Current Target: December 2021

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Appendix I: Mathematical Formulation

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Equations: Securing a Reserve Area for the Loss of Generation

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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
- $\mathrm{RA_{a_{Flow_i}}}$ 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
- $\mathrm{RA_{a_{Load_i}}}$ is the forecasted load in reserve area *a* for time step *i* (Day-Ahead or real-time, as applicable)
- $\mathrm{RA_{a_{Gen_i}}}$ is the sum of all energy schedules on resources inside reserve area *a* for time step *i*

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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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Securing the Reserve Area for the Loss of a Generator

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

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

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

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

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Securing the Reserve Area for the Loss of a Generator

- $\max_{k \in \mathrm{Gen}_{RA_a}} \{gen_{k_i} + res_{k_i}^{10Spin}\}$ is the resource in reserve area a for time step i with the largest energy plus 10-minute spin reserve schedule; except NYCA, where it is the resource with the largest schedule (i.e., energy + reserves + regulation)
- $\max_{k \in \mathrm{Gen}_{RA_a}} \{gen_{k_i} + res_{k_i}^{10Total}\}$ is the resource in reserve area a for time step i with the largest energy plus 10-minute total reserve schedule; except NYCA, where it is the resource with the largest schedule (i.e., energy + reserves + regulation)
- $\max_{k \in \mathrm{Gen}_{RA_a}} \{gen_{k_i} + res_{k_i}^{30Total}\}$ is the resource in reserve area a for time step i with the largest energy plus 30-minute total reserve schedule; except NYCA, where it is the resource with the largest schedule (i.e., energy + reserves + regulation)
- $\mathrm{Mult}_{\mathrm{RA_a}}^{10\mathrm{Spin}}$ is the 10 – minute spin multiplier for reserve area a applied to the largest schedule where applicable, e. g., 0.5
- $\mathrm{Mult}_{\mathrm{RA_a}}^{10\mathrm{Total}}$ is the 10 – minute total multiplier for reserve area a applied to the largest schedule where appicable, e. g., 1.0
- $\mathrm{Mult}_{\mathrm{RA_a}}^{30\mathrm{Total}}$ is the 30 – minute total multiplier for reserve area a applied to the largest schedule where applicable, e. g., 2.0

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Securing a Reserve Area for the Loss of Transmission

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Contingency Headroom on Interface

$$10minute_{PostCon_{Import_{RA_{a_i}}}} = Limit_{Emer(N-1)_{RA_{a_i}}} - RA_{Flow_{a_i}}$$

$$30minute_{PostdualCon_{Import_{RA_{a_i}}}} = Limit_{Norm\,(N-1-1-0)_{RA_{a_i}}} - RA_{Flow_{a_i}}$$

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

- $\mathrm{10minute}_{\mathrm{PostCon}_{\mathrm{Import}_{\mathrm{RA}_{\mathrm{a_i}}}}}$ is the applicable post-contingency transfer limit of reserve area *a* for time step *i* that the flow should be under within 10 minutes
- $\mathrm{30minute}_{\mathrm{PostCon}_{\mathrm{Import}_{\mathrm{RA}_{\mathrm{a_i}}}}}$ is the applicable post-contingency transfer limit of reserve area *a* for time step *i* that the flow should be under within 30 minutes
- $30minute_{PostdualCon_{Import_{RA_{a_i}}}}$ is the applicable post dual contingency transfer limit of reserve area *a* for time step *i* that the flow should be under within 30 minutes
- $\mathrm{Limit}_{\mathrm{Emer(N-1)}_{\mathrm{RA}_{\mathrm{a_i}}}}$ is the emergency transfer limit for single contingency 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
- $\mathrm{Limit}_{\mathrm{Emer(N-1-1)}_{\mathrm{RA}_{\mathrm{a_i}}}}$ is the emergency transfer limit for dual contingency of reserve area *a* for time step *i*, depending on the applicable reliability rules to determine the need for 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

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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

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Simultaneous Constraints 10-Minute Spinning Reserves

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

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

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

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Simultaneous Constraints 10-Minute Total Reserves

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

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

- 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:

$$Res_{RA_{a_i}}^{30Total} \geq Mult_{RA_a}^{30Total} * \{\max_{k \in Gen_{RA_a}} \{gen_{k_i} + res_{k_i}^{30Total}\}\} - RA_{aRes_{Capability_i}}$$

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

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

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

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

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

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

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

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- Maintaining and enhancing regional reliability
- Operating open, fair and competitive wholesale electricity markets
- Planning the power system for the future
- Providing factual information to policymakers, stakeholders and investors in the power system

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