New York ISO
Independent System Operator

Dynamic Reserves Market Design

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Agenda

- Background
- Review of Market Design
- Tariff
- Next Steps

Background

Previous Presentations

Title/Topic	Link
March 7, 2023 MIWG	https://www.nyiso.com/documents/20142/36639552/Dynamic%20Reserves%20-%2020230307%20MIWG_final.pdf/a29ccf5d-4c26-5cbf-0103-5bece7edb276
March 31, 2023 MIWG	https://www.nyiso.com/documents/20142/36828420/MIWG%20March%2031%20Dynamic%20Reserves%20Postings%20and%20LMP.pdf/81c35384-2438-1e03-e021-6e7ecc18f9d7
September 5, 2023 MIWG	https://www.nyiso.com/documents/20142/39768278/2%2020230905%20MIWG%20-%20Dynamic%20Reserves.pdf/d58e28ab-de87-7a86-4296-a8c21f7c764f
September 14, 2023 MIWG	https://www.nyiso.com/documents/20142/40004830/20230914%20MIWG%20-%20Dynamic%20Reserves.pdf/a1c6d806-5b67-a8fc-9d04-a1669a926f54
September 18, 2023 MIWG	https://www.nyiso.com/documents/20142/40044890/5%2020230918%20MIWG%20-%20Dynamic%20Reserves.pdf/0b1b7e63-737d-5bee-4abc-be65c234aa3b
September 26, 2023 MIWG	https://www.nyiso.com/documents/20142/40204141/4%2020230926%20MIWG%20-%20Dynamic%20Reserves.pdf/90e8c0b2-aeaf-0935-5c4e-bd260c948f3c
October 3, 2023 MIWG	https://www.nyiso.com/documents/20142/40342797/20231003%20MIWG%20-%20Dynamic%20Reserves.pdf/51657652-ac7e-c9e2-ed5f-85b52e7e49f7
October 12, 2023 MIWG	https://www.nyiso.com/documents/20142/40559142/Dynamic%20Reserves.pdf/a17ba0a7-8e59-53b9-e028-4942f595c2f1

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Previous Presentations

Title/Topic	Link
October 19, 2023 MIWG	https://www.nyiso.com/documents/20142/40696384/20231019%20MIWG%20-%20Dynamic%20Reserves.pdf/ef4371c2-5bff-7adb-5871-1d77d6fa98eb
November 8, 2023 MIWG	https://www.nyiso.com/documents/20142/41049783/20231108%20MIWG%20-%20Dynamic%20Reserves.pdf/e38b6d72-aa3f-69f3-b43f-8b3591b0e314
November 17, 2023 MIWG	https://www.nyiso.com/documents/20142/41273741/20231117%20MIWG%20-%20Dynamic%20Reserves_final.pdf/d18195bc-c940-1a1f-51c1-3220a02c23bd
November 27, 2023 MIWG	https://www.nyiso.com/documents/20142/41393553/20231127%20MIWG%20-%20Dynamic%20Reserves.pdf/ec047167-4bcb-2610-4e15-2a57565d9d18
December 4, 2023 MIWG	https://www.nyiso.com/documents/20142/41570800/20231204%20MIWG%20-%20Dynamic%20Reserves.pdf/44492075-1cfb-2446-99eb-3427b28a23c7

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Project Background

- **The concept of Dynamic Reserves was first discussed in the 2021 Reserve Enhancements for Constrained Areas (RECA) study**
  - That initiative determined that 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 consideration 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
- **The RECA study concluded that dynamically setting operating reserves requirements based on the single largest contingency system wide and using available transmission headroom was a feasible concept**
  - To dynamically set these requirements, the RECA study proposed formulations that were also considered during the 2022 Market Design Concept Proposed

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Project Background (con't)

- On December 6th, 2022, the NYISO presented its Market Design Concept Proposal
  - This proposal continued to explore and build upon the formulations from the RECA study; the fundamental formulations had not changed since first introduced during the RECA study
- During 2023, the NYISO enhanced its MDCP to include nodal reserve scheduling and compensation for suppliers
  - NYISO has presented market design concepts and tariff language to support the nodal design approach, as well as examples demonstrating pricing, scheduling, and settlements

2023 Progress

- At today's MIWG and the December 13th 2023 BIC, the NYISO will present the Market Design for Dynamic Reserves
  - The NYISO's proposal for Dynamic Reserves is a cost-effective solution for dynamically determining reserve requirements based on grid conditions and topology
    - Dynamic Reserves, at its core, maximizes social benefit by allowing a new degree of freedom for the co-optimization to minimize total production cost by considering reserve schedules against energy and transmission
    - NYISO will continue prototyping and testing the proposed functionality into 2024 and will return to stakeholders should any issues be identified
- At the December 13th 2023 BIC, the NYISO intends to bring forward a presentation for consideration. The purpose of this presentation is to determine if stakeholders are comfortable with the design approach so that the NYISO may continue prototyping efforts and implementation testing. Concurrent with the prototyping and testing in 2024, the NYISO intends to continue discussions on issues not relevant to prototyping (i.e., cost allocation, congestion revenue, TCC allocations).

NYISO Dynamic Reserves Proposal: Executive Summary

Dynamic Reserves Proposal

- **The NYISO proposes a Dynamic Reserves market design that will transition current static reserve requirements to dynamic, market and grid conditions-based requirements. Key features of this design include:**
  - Concept 1: Dynamically determining NYCA Operating Reserve requirements based on the largest source contingencies
  - Concept 2: Establishing dynamic locational reserve requirements that ensure post-contingency transmission flows satisfy relevant reliability criteria
  - Concept 3: Utilizing individual generator shift factors for reserve scheduling to reflect suppliers' ability to satisfy locational reserve requirements
  - Concept 4: Identifying and monitoring transmission elements which make up key interfaces across NYCA and factor into reserve area definitions
  - Concept 5: Establish Operating Reserve requirements considering the NYISO's DAM Forecast Load to facilitate reliability through market mechanisms
- **This core design will impact, and in some cases require accommodating changes, to other existing market structures and processes. These structures and processes will be discussed in relevant sections throughout this presentation. Each section references one or more of the above concepts to provide context to the need for the identified change**

Concept 1: Establishing Dynamic NYCA Operating Reserve Requirements

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Securing Reserves for Largest Source Contingencies in NYCA

- **Current, static NYCA Operating Reserve requirements are based on the largest single source contingency**
- **A key feature of a dynamic reserve procurement is the ability to set reserve requirements based on the largest NYCA generation source contingency in the current market interval as well as the ability to limit output when procuring required reserves is uneconomic**
- **Dynamically securing reserves for the largest source contingency ensures that reserve requirements will meet the current needs of the grid**
  - NYISO's existing static requirements do not consider the real-time possibility of the largest source contingency changing based on current online generation or the current system topology
  - Accurately reflecting the system conditions allows the reserve requirements to directly reflect the cost of maintaining system reliability
- **The constraints for NYCA-wide reserve requirements would be:**
  - 10-Minute Spin: Equal to one-half of the NYCA 10-Minute Total requirement
  - 10-Minute Total: Equal to the output of most severe contingency (i.e., largest generator schedule)
  - 30-Minute Total: Equal to the output of the Largest Generator + Second Largest Generator + max(0,(Forecast Load – Scheduled Load))

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Concept 2: Establishing Dynamic Locational Reserve Requirements

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Establishing Dynamic Locational Requirements

- **Current, static locational reserve requirements are based on reliability requirements and criteria set by New York State Reliability Council (NYSRC), Northeast Power Coordinating Council (NPCC), and North American Electric Reliability Corporation (NERC) standards. These requirements ensure sufficient Operating Reserves are scheduled to restore post-contingency transmission flows to applicable limits**
  - Static locational reserve requirements are designed for stressed grid conditions, which assume that the transmission system is fully scheduled
- **Dynamic Reserves will integrate reserve constraints into the optimization models (DAM, RT) that capture reliability requirements and criteria following N-1 and N-1-1 contingencies**
  - For Loss of Transmission, the defined contingencies would ensure that flows across transmission lines satisfy applicable limits (including limits post-contingency), considering energy supplier, reserve supplier, and load shift factors.
  - For Loss of Generation, the defined contingencies would ensure that flows across transmission lines satisfy applicable limits (including limits post-contingency), considering energy supplier, reserve supplier, and load shift factors.

Establishing Dynamic Locational Requirements (continued)

- **Dynamic Reserves will allow the optimization to more precisely calculate the tradeoffs between energy and reserves compared to the static reserve area approach, as well as to more accurately calculate the amount of MW needed to relieve post-contingency flows**
  - The formulations allow energy to flow above post-contingency limits if there are sufficient reserves to back flows down to applicable limits following a contingency, when allowed per applicable reliability rules
  - Similarly, the optimization may schedule zero reserves if energy flows will not exceed applicable limits post-contingency or if the cost of reserves exceeds the production cost savings of increasing energy flows
- **The general formulation for the 10-Minute and 30-Minute reserve constraints to solve for location reserve requirements are:**
  - 10-Minute:
    - $\sum Sf_l * Gen + \sum Sf_l * (FixedLoad_{ZN} + PCL_{ZN} + VL_{ZN} - VS_{ZN}) + \sum_{Sf_l<0} Sf_l * Reserves \leq Line\ Limit$
  - 30-Minute:
    - The constraint considering Bid Load will be defined as: $\sum Sf_l * Gen + \sum Sf_l * (FixedLoad_{ZN} + PCL_{ZN} + VL_{ZN} - VS_{ZN}) + \sum_{Sf_l<0} Sf_l * Res \leq Line\ Limit$

Concept 3: Utilizing Generator Shift Factors

Utilizing Generation Shift Factors

- **Modeling reserve constraints to explicitly represent reliability requirements associated with post-contingency power-flow requires the optimization model to know the effect of post-contingency reserve deployment on post-contingency energy flow**
- **Dynamic Reserves will utilize individual Operating Reserve supplier shift factors to reflect suppliers' abilities to affect post-contingency flow and thus satisfy reserve requirements. This provides several key benefits:**
  - Appropriately modeling the relief that each individual generator could provide against each constraint from their energy and/or reserve schedule, as a generator's shift factor measures the precise relief that a generator can provide based on current system conditions
  - Pricing the locational value of reserves from each generator and its contribution to post contingency congestion relief
  - Dynamic reserves will only consider negative shift factors for reserves so that only resources which would provide relief for the constraint would be evaluated
- **This design will result in a nodal reserve price, the Locational Marginal Operating Reserve Price (LMORP), that reflects the locational value of a resource's reserve schedules at each generator node**
  - Operating Reserve constraints that can be resolved by either energy or operating reserves will also affect energy prices, i.e., LBMPs
  - The LMORP is included in both the energy and reserve pricing as both the energy and reserve schedule from a generator can be used to satisfy the reserve constraints

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Utilizing Generation Shift Factors

- **The LMORP will be calculated using the following equation:**

$$\gamma_{i,p} = \lambda_p^R - \sum_{k \epsilon K} GF_{ik}\mu_k$$

- Where:
  - $\gamma_{i,p}$ = LMORP for Operating Reserve product *p* at bus *i* in $/MWh
  - λ_p^R = the system marginal Operating Reserve product *p* price for the NYCA
  - K = the set of locational Operating Reserve Constraints ("LORC") that Operating Reserve product *p* satisfies;
  - GF_{ik} = Shift Factor for bus *i* on LORC *k* in the Post-Contingency case which limits flows across LORC *k* (the Shift Factor measures the incremental change in flow on LORC *k* for an injection at bus *i* and a corresponding withdrawal at the Reference Bus); and
  - μ_k= the Shadow Price of LORC *k*, expressed in $/MWh; provided however, that this Shadow Price shall not exceed the price that corresponds to the quantity of Operating Reserve product *p* procured on the applicable Operating Reserve Demand Curve.

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Concept 4: Identify and Monitor Key Transmission Elements

Identify Key Transmission Elements

- **Dynamic Reserves will identify transmission elements that would need to be monitored for post-contingency conditions**
  - Dynamic Reserves will initially model elements that align with existing locational reserve requirements
    - These elements include approximately 20 lines which make up key interfaces across NYCA and factor into existing reserve area definitions
  - The identified transmission elements will ensure that the transmission elements that NYISO currently uses to define its reserve areas will continue to be monitored for, and manage, post-contingency power flow
  - Dynamic Reserves will create a structure that enables additional elements to be managed with reserve constraints, e.g., load pocket reserves
  - An update to date list of these facilities will be posted on the NYISO public website
- **The Dynamic Reserves formulations would model these transmission elements similarly to how power flow constraints are modeled today**
  - The reserve constraints would be based on the projected overload and timing requirements to restore the flows on the facility, after the contingency

Concept 5: Consider DAM Forecast Load

Establish Operating Reserve Requirements to Secure NYISO's DAM Forecast Load

- **Dynamic Reserves will include reserve constraints, in the DAM, to secure energy and operating reserves to the NYISO's DAM Forecast Load**
  - These forecast reserve constraints will be for 30-minute Operating Reserve products (i.e., 10-minute Operating Reserve products will only secure to Scheduled Load)
  - 30-minute Operating Reserve products will secure the higher of Scheduled Load versus Forecast Load
    - Reliable system operations requires the NYISO to consider both scheduled and forecast load
    - Scheduled load represents market participant positions and expectations for the upcoming operating day
  - The forecast reserve constraints will, at least cost, procure additional reserves or reserve transmission headroom to ensure sufficient energy exists in real time to serve NYISO DAM Forecast Load
- **Forecast reserve constraints provide multiple benefits to ensure that Dynamic Reserves best represents expected system conditions:**
  - Supports reliable operations by providing needed resources DAM schedules
  - Signals market need and values for flexibility and dispatchability
  - Mitigates the need for Forecast Pass commitments
- **The general formulation for the reserve constraints that solve to forecast load are:**
  - 30-Minute NYCA Reserves: Equal to the output of the Largest Generator + Second Largest Generator + max(0,(Forecast Load–Scheduled Load))
  - 30-Minute Locational Reserves: $\sum Sf_l * Gen + \sum Sf_l * (ForecastLoad_{ZN}) + \sum_{Sf_l<0} Sf_l * Res \leq Line\ Limit$

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Additional Discussion of Design Concepts

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Developing Dynamic Reserve Constraints (Concepts 1, 2, 5)

- Dynamic Reserves will allow the optimization to more precisely calculate the tradeoffs between energy and reserves compared to the static reserve area approach, as well as to more accurately calculate the amount of MW needed to relieve post-contingency flows
- Dynamic Reserves will introduce additional constraints into the optimization based on the previously identified foundational concepts to evaluate if post-contingency energy flows, less reserves, will respect post-contingency line limits and operating criteria
- Post-contingency energy flows will be calculated by considering the applicable shift factors for generation and load
- The following slides provide the constraint formulations which would be implemented to facilitate Dynamic Reserves for each reserve area

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Reserve Criteria (10 Spin)

	NYCA	East	SENY	NYC	LI
10-Minute Spinning Reserves Static Value Reliability Rule Dynamic Reserves Calculation	1/2*A = 655 MW 10-minute spinning reserve is equal to at least one-half of the 10-minute total reserve. [NYSRC Reliability Rules, Section E] DR: ½ Largest Schedule (The Largest Schedule is formulated as the capability of the largest generator, as the combined energy, regulation, 10-Minute Spin, 10-Minute Total, 30-Minute Total schedules)	1/4*A = 330 MW* 10-minute spinning reserve is based on the NERC requirement to plan to meet energy reserve requirements, including the deliverability/capability for any single Contingency and the NPCC requirement that reserves be distributed to ensure that they can be used without exceeding individual element ratings or transfer limitations. [NERC TOP-002-2.1b; NPCC Reliability Directory No. 5, Section 5.6] Hold a portion of 10-min Total requirements as Spin. Please refer to 10-min Total requirement criteria on next slide a. For one transmission contingency (Gen Energy + Gen 10S Reserves/0.5 + Load) * Shift Factor <= Central East Voltage Collapse(VC) limit – (N-1) Derate b. For one Generation contingency Gen Energy + Gen 10S Reserves/0.5 – Largest Gen Schedule + Load) * Shift Factor <= Central East Voltage Collapse(VC) limit	0	0	0

https://www.nyiso.com/documents/20142/3694424/Locational-Reserves-Requirements.pdf
https://www.nysrc.org/wp-content/uploads/2023/07/RRC-Manual-V46-final.pdf

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Reserve Criteria (10 Total)

	NYCA	East	SENY	NYC	LI
10-Minute Total Reserves Static Value Reliability Rule Dynamic Reserves Calculation	A = 1310 MW 10-minute total reserve is equal to the operating capability loss caused by the most severe contingency under normal transfer conditions. [NYSRC Reliability Rules, Section E] DR: Largest Schedule	1200 MW 10-minute total reserve is based on Reliability Rules that require immediate measures (activation of EAST 10-minute reserves) be applied to bring loadings on an internal NY transfer interface to within limits in 15 minutes. [NYSRC Reliability Rules, Section D] a. Hold enough 10-min Total reserves such that all modelled EAST Interface lines can be brought down to the lower Central East VC limit in 10-minutes following one transmission contingency that can derate the limit (Gen Energy + Gen 10T Reserves + Load) * Shift Factor <= Central East Voltage Collapse(VC) limit – (N-1) Derate b. Hold enough 10-min Total reserves such that all modelled EAST Interface lines can be brought down to the Central East VC limit following one generation contingency (Gen Energy + Gen 10T Reserves – Largest Gen Schedule + Load) * Shift Factor <= Central East Voltage Collapse(VC) limit	0	500 MW 10-minute total reserve is based on Reliability Rules that require a calculated percentage of the NYCA 10-minute total reserve requirement be procured within NYC. [NYSRC Reliability Rules, Section G] During Thunderstorm Alerts, will be reduced to zero. Hold enough 10-min Total reserves such that all modelled NYC Interface lines can be brought down to LTE in 10-minutes following the one transmission or generation contingency in NYC a. For one transmission contingency: (Gen Energy + Gen 10T Reserves + Load) * Shift Factor <= LTE limit b. For one generation contingency: (Gen Energy + Gen 10T Reserves – Largest Gen Schedule + Load) * Shift Factor <= LTE limit	1/10*East = 120* [NERC TOP-002-2.1b; NPCC Reliability Directory No. 5, Section 5.6]

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Reserve Criteria (30 Total)

	NYCA	East	SENY
30-Minute Total Reserves Static Value **Reliability Rule** **Dynamic Reserves Calculation**	2*A = 2620 MW 30-minute total reserve is equal to two times the 10-minute reserve necessary to replace the operating capability loss caused by the most severe contingency under normal transfer conditions. [NYSRC Reliability Rules, Section E] DAM : Largest Schedule + 2^{nd} Largest Schedule + max(0, Forecast Load – Scheduled Load) RTM : Largest Schedule + 2^{nd} Largest Schedule	1200 MW Hold 30-Minute total reserve to bring loadings on an internal NY transfer interface to within limits in 30 minutes. [NERC TOP-002-2.1b; NPCC Reliability Directory No. 5, Section 5.6] a. Hold enough 30-min Total reserves such that all modelled EAST Interface lines can be brought down to the lower Central East VC limit in 30-minutes following two transmission contingencies. In DA, the Load considered for the calculation would be higher of Scheduled and Forecast load: (Gen Energy + Gen 30T Reserves + Load) * Shift Factor <= Central East Voltage Collapse(VC) limit – (N-2) Derate b. Hold enough 30-min Total reserves such that all modelled EAST Interface lines can be brought down to the Central East VC limit in 30-minutes following two generation contingencies. In DA, the Load considered for the calculation would be higher of Scheduled and Forecast load: (Gen Energy + Gen 30T Reserves - Largest Schedule – Second Largest Schedule + Load) * Shift Factor <= Central East Voltage Collapse(VC) limit c. Hold enough 30-min Total reserves such that all modelled EAST Interface lines can be brought down to the Central East VC limit in 30-minutes following one transmission and one generation contingency. In DA, the Load considered for the calculation would be higher of Scheduled and Forecast load: (Gen Energy + Gen 30T Reserves - Largest Schedule + Load) * Shift Factor <= Central East Voltage Collapse(VC) limit – (N-1) Derate	1300-1800 30-minute total reserve is, depending on the hour, based on Reliability Rules that require the ability to restore a transmission circuit loading to Emergency or Normal Transfer Operating Criteria within 30 minutes of the contingency. Hold enough 30-min Total reserves such that all modelled SENY Interface lines can be operated to Normal Transfer criteria following one transmission or one generation contingency in SENY. In DA, the Load considered for the calculation would be higher of Scheduled and Forecast load: a. For one transmission contingency: (Gen Energy + Gen 30T Reserves + Load) * Shift Factor <= Normal Limit b. For one generation contingency: (Gen Energy + Gen 30T Reserves –Largest Schedule+ Load) * Shift Factor <= Normal Limit c. For two transmission contingencies: (Gen Energy + Gen 30T Reserves + Load) * Shift Factor <= LTE Limit d. For two generation contingencies: (Gen Energy + Gen 30T Reserves – Largest Schedule –Second Largest Schedule + Load) * Shift Factor <= LTE Limit e. For a combination of one transmission and one generation contingency: (Gen Energy + Gen 30T Reserves – Largest Schedule + Load) * Shift Factor <= LTE Limit

Reserve Criteria (30 Total) cont'd

	NYC	LI
30-Minute Total Reserves Static Value Reliability Rule Dynamic Reserves Calculation	1000 MW 30-minute total reserve is based on Reliability Rules that require the ability to bring transmission line loadings to Normal Operating Criteria within 30 minutes following a contingency. [NYSRC Reliability Rules, Section C] During Thunderstorm Alerts, will be reduced to zero. Hold enough 30-min Total reserves such that all modelled NYC Interface lines can be operated to Normal Transfer criteria following one transmission or one generation contingency in NYC. In DA, the Load considered for the calculation would be higher of Scheduled and Forecast load: a. For one transmission contingency: (Gen Energy + Gen 30T Reserves + Load) * Shift Factor <= Normal Limit b. For one generation contingency: (Gen Energy + Gen 30T Reserves –Largest Schedule+ Load) * Shift Factor <= Normal Limit c. For two transmission contingencies: (Gen Energy + Gen 30T Reserves + Load) * Shift Factor <= LTE Limit d. For two generation contingencies: (Gen Energy + Gen 30T Reserves – Largest Schedule –Second Largest Schedule + Load) * Shift Factor <= LTE Limit e. For a combination of one transmission and one generation contingency: (Gen Energy + Gen 30T Reserves – Largest Schedule + Load) * Shift Factor <= LTE Limit	270-540 MW [NYSRC Reliability Rules, Section D] Hold enough 30-min Total reserves such that all modelled LI Interface lines can be operated to Normal Transfer criteria following one transmission or one generation contingency in LI. In DA, the Load considered for the calculation would be higher of Scheduled and Forecast load: a. For one transmission contingency: (Gen Energy + Gen 30T Reserves + Load) * Shift Factor <= Normal Limit b. For one generation contingency: (Gen Energy + Gen 30T Reserves –Largest Schedule+ Load) * Shift Factor <= Normal Limit c. For two transmission contingencies: (Gen Energy + Gen 30T Reserves + Load) * Shift Factor <= LTE Limit d. For two generation contingencies: (Gen Energy + Gen 30T Reserves – Largest Schedule –Second Largest Schedule + Load) * Shift Factor <= LTE Limit e. For a combination of one transmission and one generation contingency: (Gen Energy + Gen 30T Reserves – Largest Schedule + Load) * Shift Factor <= LTE Limit

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Reserve Criteria Summary

- **Dynamic Reserve design aligns with the criteria used to procure Operating reserves today**
  - NYCA level requirement will ensure enough 10-min reserves to secure for loss of gen with largest schedule. 30-min reserve requirement will ensure enough reserves to replenish the 10-min reserve requirement following the largest contingency
  - Locational 10-min reserve requirement will ensure appropriate distribution of 10-min reserves such that loadings on transmission circuits/interfaces are brought down to appropriate limits in 15-minutes following a contingency
  - Locational 30-min reserve requirement will ensure appropriate distribution of 30-min reserves to ensure the ability to bring such that loadings on transmission circuits/interface to Normal Operating criteria within 30-minutes following a contingency

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Energy and Reserve Price Formation

Reserve Constraint Shadow Prices (Concepts 2, 3, 4, 5)

- **Each binding reserve constraint will produce a shadow price, which will be used to calculate the LMORP**
  - The shadow prices of these reserve constraints will be included in the congestion component of Nodal and Zonal LBMPs based on the shift factor of gen/load bus with respect to these constraints
  - The LMORP calculation will be based on the shadow prices of all binding locational Operating Reserve Constraints and shift factor of gen/load bus with respect to these constraints
  - The reserve constraints shadow prices will be included in both the energy and reserve pricing as both the energy and reserve schedules can be used to satisfy the reserve constraints
  - These constraints, and their associated shadow prices, will signal the locational value of reserves
    - There will no longer be defined reserve areas, as these will be replaced by reserve constraints and constraint shadow prices
- **Reserves scheduled when Forecast Load > Scheduled Load ("forecast reserves") to meet the 30-Minute requirements will produce a shadow price representing the cost to secure to Forecast Load in the DAM**
  - These shadow prices will be included in the nodal generator LBMP and zonal LBMP

Pricing for Reserve Providers on Long Island (Concepts 2, 4)

- **Currently, Long Island Operating Reserve prices are set by tariff at the SENY Operating Reserve price and total Operating Reserve schedules on Long Island are capped**
- **Dynamic Reserves will establish Operating Reserve requirements and nodal reserve prices on Long Island consistent with other locations throughout the NYCA**
- **Dynamic Reserves will model the ability for Long Island Operating Reserves to reduce inflow into Long Island and thereby support reliability in other locations (i.e., recognize the value of scheduling Operating Reserves above the Long Island requirement)**
  - Operating Reserves may be scheduled until post-deployment inflow onto Long Island reached zero across the relevant transmission lines
  - Long Island reserve constraint shadow prices will account for this flow constraint

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Settlements: Forecast Reserve Shadow Prices

Forecast Reserve Shadow Prices (Concept 5)

- **Forecast reserve shadow prices will be reflected in both DAM LBMPs and LMORPs**
  - There are no forecast reserves in the RTM
- **Dynamic reserves will:**
  - Create a Forecast Reserve Charge, which will be applicable to Virtual Supply, RT Load that did not schedule in the DAM, and imports that do not materialize in real-time
    - The Forecast Reserve Charge ($/MWh) will be the NYCA forecast reserve shadow price plus the sum-product of the applicable locational forecast reserve shadow prices and shift factors
  - Apply these revenues to offset the total reserve charges to LSEs (i.e., offset Rate Schedule 4)
- **The Forecast Reserve Charge ensures that:**
  - Only the suppliers that satisfy the forecast reserve constraints are paid the shadow prices of these constraints
    - Virtual Supply cannot solve any 30M constraints which utilize Forecast Load, consistent with its current treatment in the DAM Forecast Pass
  - All loads including the loads that do not have a DA schedule are charged the cost of procuring Forecast reserves in DAM
  - Scheduling “virtual” imports does not generate arbitrage profits

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Forecast Reserve Charge (Concept 5)

- **The Forecast Reserve Charge to Virtual Supply and LSEs will be derived as:**
  - $\text{ForecastReservePrice}_{\text{ZN}} = \text{NYCA 30F price} + \sum_{l \in L}\left(Sf_l^{ZN} * 30FShadowPrice_l\right)$
  - The Forecast Reserve Charge to Virtual Supply:
    - $ForecastReserveCharge_{VS} = ForecastReservePrice_{ZN} * DA \text{ Scheduled Virtual Supply}$
  - The Forecast Reserve Charge to LSEs:
    - $ForecastReserveCharge_{\text{LSE}} = \max(0, ForecastReservePrice_{ZN} * (Actual\ Withdrawal - DA\ Scheduled\ Withdrawals + 1))$
    - The 1 MW buffer is instituted to accommodate the existing 1 MW minimum bidding floor for LSEs
- **The Forecast Reserve Charge$_{\text{Proxy}}$ to imports will be derived as:**
  - $\text{ForecastReservePrice}_{Proxy} = \text{NYCA 30F price} + \sum_{l \in L}\left(Sf_l^{Proxy} * 30FShadowPrice_l\right)$
  - The Forecast Reserve Charge to Imports will be calculated as:
    - $ForecastReserveCharge_{\text{Imports}} = \max(0, ForecastReservePrice_{Proxy} * (\text{Actual Imports} - DA\ Scheduled\ \text{Imports}))$

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Correlated Loss of Multiple Generators

Correlated Loss of Multiple Generators (Concepts 2, 3, 4)

- **Dynamic Reserves will account for the correlated loss of multiple generators when evaluating generator contingencies**
  - 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
  - This would capture the potential risk of losing multiple resources that share a single point of failure and whose combined output may be the largest source of generation in an area as required by reliability standards.
  - Applicable groups of generators are currently identified by NYISO
  - An applicable group of generators would be treated just like a single-source generator
  - To monitor the correlated loss of multiple generators, the post-generator contingency energy flow would be modeled as: $Gen_A * Shift_A + Gen_B * Shift_B$

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Treatment of Reserve Constraints In DAM and RTM

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Treatment of Reserve Constraints in DAM and RTM (Concept 2)

- **Day-Ahead Market (DAM) treatment:**
  - NYISO proposes to evaluate reserve constraints in the BID, AMP I/II, FCT, LRR, and BRD passes
- **Real-Time Market (RTM) treatment:**
  - NYISO proposes to include reserve constraints in each RTC and RTD run
  - This would develop reserve constraints based on current system conditions and provide the appropriate market response and pricing outcomes

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Thunderstorm Alerts (TSAs)

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Thunderstorm Alert (TSA) Activations (Concepts 2, 4)

- **During TSA events today, the system is operated as if the first contingency has already occurred (NYSRC Reliability Rules, Section I)**
  - Power transfer into SENY and NYC is lowered by increasing generation in SENY and NYC
  - In the event of a contingency, line flows could be increased to deliver more power into SENY and NYC
  - TSAs are real-time event only
- **Given that sufficient headroom exists to import power during a TSA, NYISO currently reduces the 10-Minute Total requirement for NYC and 30-Minute Total Requirements for SENY and NYC to 0 MW**
- **The Dynamic Reserves formulation uses line flow to account for the ability to import reserves into a reserve area**
  - Under TSA conditions, the decreased line flow would decrease the calculated reserve requirements
- **The NYISO is proposing that no modifications or changes be made to the reserve constraints during a TSA**
  - Given the logic of Dynamic Reserves and the amount of available transmission headroom during a TSA, it is anticipated that the solution would set a reserve requirement close to or equal to 0

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NYCA 30-Minute Operating Reserve Demand Curve

NYCA 30-Minute Operating Reserve Demand Curve (Concepts 2, 3)

- **The existing NYCA 30-Minute ORDC is based on a static procurement of 2620 MW and needs to be modified to accommodate a dynamic reserve procurement**
- **Dynamic Reserves will introduce a dynamic demand curve that would be proportional to the steps of the existing demand curve**
  - The NYCA 30-Minute Operating Reserve Demand Curve would be formulaically updated such that the percent of the largest and second largest contingency that is procured at each step of the demand curve is maintained

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Operating Reserve Demand Curves: Formulaic Calculation

Shortage Price ($/MW)	Reserve Level (MW)	Demand Curve Step (MW)	Percent of Reserve Procurement Greater than 1.5x Largest Contingency Existing ORDC "Tail" = 655 MW	
750	≤ 1,965 to 0	1,965	N/A	N/A
625	1,965 to 2,020	55	=55/655	8.40%
500	2,020 to 2,075	55	=55/655	8.40%
375	2,075 to 2,130	55	=55/655	8.40%
300	2,130 to 2,185	55	=55/655	8.40%
225	2,185 to 2,240	55	=55/655	8.40%
175	2,240 to 2,295	55	=55/655	8.40%
100	2,295 to 2,420	125	=125/655	19.08%
40	2,420 to 2,620	200	=200/655	30.53%

- **The existing NYCA 30-Minute ORDC has 9 steps, as shown in the table above. Reserve procurement levels between 1965 and 2620 MW are broken down into 8 different steps for the remaining 655 MW of the demand curve after securing 1.5 times the largest contingency**
- **To develop a dynamic ORDC, NYISO calculated the percent of the 655 MW "tail" held on each step**
  - For example, the $625/MWh shortage price would occur if the reserve level was between 1,965 and 2,020 MW. Those 55 MW represent 8% of 655 MW
  - This ensures that the same proportion of reserves are being priced at the existing shortage prices
  - This calculation varies slightly from the approach discussed in the 2022 MDCP, which calculated steps as a percent of the largest contingency

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Operating Reserve Demand Curves (cont'd)

- **The Dynamic Reserves constraint for NYCA 30-Minute Operating Reserve product is equal to the output of the Largest Generator + Second Largest Generator + max(0,(Forecast Load – Scheduled Load))**
  - The first step of the ORDC would be the total output of largest generator + one-half the output of the second largest generator
    - This corresponds to 1965 MW, or 1.5 times the largest contingency, on the current ORDC
  - The remainder of the ORDC steps would be one-half the output of the second largest generator plus any Operating Reserves procured to satisfy forecast reserves constraints. These MWs would be assigned to the various ORDC price steps per the table and percentage values on the prior slide

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Other Operating Reserve Demand Curves

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Operating Reserve Demand Curves (Concepts 2, 3)

- **NYISO currently has ORDCs defined for each of its existing Operating Reserve products (e.g., NYCA, SENY, NYC)**
  - Changes to the NYCA 30-Minute ORDC were discussed previously in this presentation
  - For NYCA 10-Minute Spinning and 10-Minute Total Reserves, the existing ORDCs will apply
- **An ORDC will be applied to each of the locational reserve area constraints**
  - These ORDCs will be modelled similarly to NYISO's existing Transmission Constraint Pricing logic.
  - NYISO's proposal is to utilize the structure developed for Secured Facilities for Reserves and map the appropriate shortage values in place today (e.g., M51 into NYC would have the existing NYC shortage demand curve applied to relief on that element)
- **NYISO is not proposing any changes to the shortage prices as part of Dynamic Reserves. A load weighted average shift factor will be applied to the ORDC to represent what 1 MW of relief from the ORDC would cost.**

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Scarcity Pricing

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Scarcity Reserve Requirements (Concepts 2, 3)

- Scarcity Reserve Requirements will continue to interact similarly with the 30-Minute Dynamic Reserve Requirements as they have with static reserve regions
- As defined today, the Scarcity Reserve Requirement will be calculated as: Scarcity Reserve Requirement = Expected EDRP/SCR MW – average Available Operating Capacity MW
  - Available Operating Capacity is unscheduled energy production capability that could be provided by available resources in greater than 30 minutes and less than or equal to 60 minutes
- The Scarcity Reserve Requirement will be added to the NYCA 30-min constraint:

$$NYCA\ 30T \geq Largest\ Schedule + Second\ Largest\ Schedule + Scarcity\ Reserve\ Requirement$$

  - Same as today, all steps on NYCA ORDCs that are lower than $500/MW will be increased to this price level.
- The Scarcity Reserve Requirement will be added to any applicable 30-Minute locational reserves constraint by adding the Scarcity Reserve Requirement to the Load

$$\sum Generation\ * ShiftFactor + \sum (Loads + Scarcity\ Reserve\ Requirement)\ * ShiftFactor - \sum Reserves\ * ShiftFactor \leq LineLimit$$

  - The applicable 30-minute constraints are constraints that the Zonal load have a shift factor for
  - The 30-minute demand curve for each constraint will be adjusted in real-time to account for the Scarcity Reserve Requirement. The Scarcity Reserve Requirement MWs will be priced at $500/MW

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Scarcity Reserve Requirements (continued)

- **Under NYISO's existing nested reserve area construct, the Scarcity Reserve Requirement for the Scarcity Reserve Region is also added to the 30-Minute Reserve Requirement for any of the upstream reserve areas**
  - For example, if there is a 100 MW Scarcity Reserve Requirement in NYC, this 100 MW is also added to the SENY, East, and NYCA 30-Minute reserve requirements[1]
  - For NYCA, the ORDC is modified for any steps priced at less than $500 as follows:
    - $750/MWh "step" up to and including 1,965 MW
    - $625/MWh "step" beyond 1,965 MW through 2,020 MW
    - $500/MWh "step" beyond 2,020 MW through (2,620 + the applicable Scarcity Reserve Requirement)
- **NYISO proposes to maintain this logic under Dynamic Reserves as described in the next slide**

1: For more information, please see the Ancillary Services Manual at page 98: https://www.nyiso.com/documents/20142/16688820/11%20Ancillary%20Services%20Shortage%20Pricing%20-%2011112020%20BIC.pdf/29cc3bf3-d635-4e9c-4261-f07cab86c525

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Scarcity Pricing Formulation

- **Impute additional load equal to EDRP/SCR activation and secure flows to applicable limits**

$$\sum Gen_k * SF_{k,l} + \sum (\text{Loads} + \text{Scarcity Reserve Requirement})_{Zn} * SF_{Zn,l} - \sum_{SF<0} \left(Res_k * SF_{k,l}\right) \leq \text{LineLimit}$$

  - Calculates a reserve requirement as though the load were still there, resulting in higher locational reserve requirement. Consistent with today's logic.
  - k: Index for Gens; l: Index for constraints; Zn: Index for Zones
  - This constraint uses the existing single value locational demand curve
  - Constraint ensures sufficient reserves are available in the activated zone(s) or by electrically beneficial downstream resources (negative shift factor to the Secure Facility for Reserves Constraint) in a least cost method

- **Hold reserves at appropriate locations to cover the additional flow but/for the load reduction created by EDRP/SCR activation**

$$\sum_{SF<0} \left(Res_k * SF_{k,l}\right) \geq \sum_{Zn} \text{Scarcity Reserve Requirement}_{Zn} * SF_{Zn,l}$$

  - This constraint has a $500/MW demand curve
  - This constraint ensures that there are enough reserves to have met load but for the activation.

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Interaction with Transmission Congestion Contracts (TCCs)

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Interaction with TCCs (Concepts 2, 4)

- Dynamic Reserves may change the quantity of congestion rent accrued
  - For example, the optimization may reduce line flows to avoid scheduling expensive reserves, leaving additional transmission capacity available but uneconomic
- Congestion rent owed to TCC holders will not vary with the quantity of congestion rent accrued
- In combination DAM Congestion Rents may be insufficient to fund TCC awards, potentially producing Congestion Residuals (e.g., DAM Congestion Residuals)
- NYISO is continuing to review whether the interaction of Dynamic Reserves and today's TCC rules creates the need for further modifications and will discuss with stakeholders

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DAM Congestion Rents

DAM Congestion Rent (Concepts 3 and 5)

- The NYISO proposes to retain the existing congestion rent allocation and retain the existing Operating Reserve cost allocation (i.e., Rate Schedule 4)
- Potomac Economics proposes compensating locational Operating Reserve suppliers from the pool of congestion rent, removing the need to fund locational Operating Reserve suppliers through the existing Operating Reserve cost allocation
  - In practice, this will decrease the share of congestion rent payments to TCC holders and use reduced congestion rent payments to TCC holders to compensate Locality Operating Reserve Suppliers. These two exactly net out.
- NYISO will continue reviewing the DAM Congestion Rent allocation and Operating Reserve cost allocation and will discuss with stakeholders, in parallel with prototyping

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Additional Elements Discussed by Potomac Economics

Feedback Received from Potomac Economics

- **Potomac Economics provided comments at the 11/27 and 12/4 MIWGs on NYISO's proposal for Dynamic Reserves. The topics included:**
  - Calculation of DAM Congestion Rent (Concepts 3 and 5)
  - Allocation of the Forecast Reserve Charge (Concept 5)
  - Treatment of Bid Load (Concept 5)
  - Treatment of DAM Imports (Concept 5)
  - Settlements for First and Second Largest Generator (Concept 1)
- **NYISO will continue reviewing this feedback and will discuss with stakeholders, in parallel with prototyping**

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Posting of Dynamic Reserve Requirements

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Posting of Dynamic Reserve Requirements

- **Postings will be analogous to posting for energy prices and schedules**
  - NYCA, Zonal and Generator Bus reserve prices will be published
    - $NYC\ Zonal\ 30T\ Price = NYCA_{30TPrice} + \sum_K (NYCShift_k * ShadowPrice_K)$
    - Dunwoodie $Zonal\ 30T\ Price = NYCA_{30TPrice} + \sum_K (DunwoodShift_k * ShadowPrice_K)$
  - NYCA requirement for 10S, 10T and 30T will be published for every interval
  - Active constraints will be published for each interval
- **Shortage will be implied by the reserve prices being equal to the shortage demand curve, as is done today for transmission shortages**
- **There will no longer be defined reserve areas; only facilities secured for reserves and associated active constraint status and values**
- **NYISO will maintain a secured transmission facilities for reserves list similar to its secured transmission facilities list[1]**

1: https://www.nyiso.com/documents/20142/32280631/M-29-OSM-Att%20A-v2023-05-08-Final.pdf/3df1d8f2-abbb-8449-07b2-2b21413c53a5

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Posting of Dynamic Reserve Requirements: Descriptions

- **NYCA and Zonal Reserve Prices will be posted in the same format as posted today, with the following fields in one report:**
  - Time Stamp, Time Zone, Name, PTID, 10 Min Spinning Reserves ($/MWhr), 10 Min Non-Synchronous Reserve ($/MWhr), 30 Min Operating Reserve ($/MWhr), NYCA Regulation Capacity ($/MWHr)
- **Generator Bus Reserves Prices will be posted with the following fields:**
  - Time Stamp, Name, PTID, 10 Min Spinning Reserves ($/MWhr), 10 Min Non-Synchronous Reserve ($/MWhr), 30 Min Operating Reserve ($/MWhr)
- **NYCA Reserve Procurement will be posted with the following fields:**
  - Time Stamp, Time Zone, NYCA 10 Min Spinning Reserve (MW), NYCA 10 Min Non-Synchronous Reserve (MW), NYCA 30 Min Operating Reserve (MW)
- **Limiting Reserve Constraints will be posted with the following fields:**
  - Time Stamp, Time Zone, Limiting Facility, Facility PTID, Contingency, Constraint Cost ($)

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Draft Tariff Revisions

Draft Tariff Revisions

- Included in today's presentation materials are the following draft tariff sections:
  - MST 2.5
  - MST 2.12
  - MST 2.19
  - MST 4.2
  - MST 15.4
  - MST 17.1.1
  - OATT 6.5
- These changes are intended to represent the design as outlined in the presentation. Stakeholders will not be asked to vote on the tariff at the 12/13 BIC.

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Next Steps

Next Steps

- The deliverable for 2023 is Market Design Complete
- Timeline to completion of MDC
  - Present Dynamic Reserves market design at the December 13th BIC as discussed in more detail on slide 8
- NYISO will continue prototyping and testing the proposed functionality through early 2024 and will continue discussions with stakeholders
- Per the 2023 Market Vision, these concepts are expected to be deployed in 2026, assuming prototyping and testing are successful.

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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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