Dynamic Reserves

Andres Flores
Ashley Ferrer
Energy Market Products

ICAP/MIWG

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Contents

Background

Background

- **NYISO has worked with stakeholders since 2019 to develop Dynamic Reserves, culminating in a presentation to BIC[1] in December 2023**
- **During the 2023 BIC presentation, the NYISO noted that that interaction between Dynamic Reserves and TCCs would be discussed in 2024**
  - At the 11/17/23 MIWG[2] (starting at slide 19) and 3/20/24 MIWG[3] (starting at slide 20), NYISO discussed the interaction of TCCs and Dynamic Reserves
  - Today's presentation will include NYISO's proposal for calculating and allocating Day-Ahead Market (DAM) congestion shortfalls attributable to Dynamic Reserves

1: https://www.nyiso.com/documents/20142/41671891/UPDATED%20-%2020231213%20BIC%20-%20Dynamic%20Reserves%20REPOSTED.pdf/0bc8d5df-6773-8db1-9f99-d91fd1fd0676

2: https://www.nyiso.com/documents/20142/41273741/20231117%20MIWG%20-%20Dynamic%20Reserves_final.pdf/d18195bc-c940-1a1f-51c1-3220a02c23bd

3: https://www.nyiso.com/documents/20142/43621521/2%2020240320%20Dynamic%20Reserves%20MIWG.pdf/9c1bc48a-4d42-13fb-f21d-7d7693ea32d9

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TCC Implications

Review

Dynamic Reserves and TCCs: Review

- **Dynamic Reserves will allow the optimization to more precisely calculate the tradeoffs between energy savings and reserve costs, as well as to more accurately calculate the amount of MW needed to relieve post-contingency flows**
  - The formulations allow energy to flow above long-term 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.
  - Further, the optimization may schedule fewer/no reserves if the cost of reserves exceeds the production cost savings of increasing energy flows
  - Owing to this optimization, energy flows on binding constraints may decrease, relative to today, to reduce post-contingency transmission flows associated with Dynamic Reserves constraints
- **In circumstances where a transmission element is fully utilized in the TCC auctions but not fully utilized in the DAM because Operating Reserve costs would exceed the energy savings from fully utilizing the transmission system, congestion rent shortfalls could occur**
  - These shortfalls would be realized due to the quantity of TCCs sold exceeding DAM energy flows, resulting in a mismatch between TCC payment obligations and the collection of energy congestion charges

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Dynamic Reserves and TCCs: Review (continued)

- **The NYISO has existing mechanisms for identifying if shortfalls or surpluses can be attributed to specific Transmission Owners due to DAM transmission facility outages, returns-to-service, uprates, and derates of transmission facilities that differ from facility status assumptions in the TCC auctions**
  - If a shortfall or surplus (or portion thereof) can be attributed to a specific Transmission Owner that is subject to Attachment N of the OATT (TO), then the costs relating thereto are assigned to that TO
  - Shortfalls or surpluses that aren't attributed to a specific TO are allocated across all TOs subject to Attachment N of the OATT
- **The NYISO is proposing a new DAM congestion shortfall settlement to identify shortfalls attributable to Dynamic Reserves constraints**

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Proposal

Dynamic Reserves DAM Congestion Shortfall Settlements

- This new calculation will utilize a similar process to the existing mechanisms for identifying the financial impact of transmission facility outages, returns-to-service, uprates, and/or derates
- For each hour of the DAM, the NYISO will identify all binding Dynamic Reserves constraints
  - Dynamic Reserves will have separate constraints than energy scheduling constraints
- For each binding Dynamic Reserves constraint, the NYISO will determine if that constraint led to an associated DAM congestion shortfall. To do this, NYISO will:
  - Simulate the Dynamic Reserve constraint in the TCC auction model of the most recently held TCC auction that includes the relevant period in which the Dynamic Reserves constraint is binding (e.g., Centralized Auction, Balance-of-Period Auction) and evaluate the flows
    - This is the same process that is used to evaluate existing shortfalls for existing Attachment N shortfall calculations
- The proposed formula for determining the proposed shortfall settlement is shown on the next slide

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Dynamic Reserves DA Congestion Shortfall Settlements (continued)

- **Dynamic Reserves Binding Constraint Charge (DRBCC):**
  - DRBCC = Abs($ShadowPrice_{r,h,DAM}$)*max((abs($FLOW_{r,h,TCCAuction}$ + $ReserveFlow_{r,h,DAM}$)-$LIMIT_{r,h}$),0); where:
    - r = Dynamic Reserves binding constraint
    - h = hour in DAM
    - $ShadowPrice_{r,h,DAM}$ – The Shadow Price, in dollars/MWh, of Dynamic Reserve binding constraint (*r*) in hour (*h*) of the Day-Ahead Market.
    - $FLOW_{r,h,TCCAuction}$ – The Energy flow, in MWh, on Dynamic Reserve binding constraint (*r*) for hour (*h*), determined by the simulation of the Dynamic Reserve constraint in the TCC auction model of the last auction held for TCCs valid for hour (*h*).

Dynamic Reserves DA Congestion Shortfall Settlements (continued)

- **Dynamic Reserves Binding Constraint Charge (DRBCC):**
  - DRBCC = Abs(ShadowPrice$_{r,h,DAM}$)*max((abs(FLOW$_{r,h,TCCAuction}$ + ReserveFlow$_{r,h,DAM}$)-LIMIT$_{r,h}$),0); where:
    - ReserveFlow$_{r,h,DAM}$ – Reserve flows scheduled in MWh, on Dynamic Reserve binding constraint (*r*) for hour (*h*) in the DAM.
      - This value accounts for the reserve flows following the contingency, which reduces the net flow on the element post-contingency
      - This value represents the total available relief considering the generator shift factors (see slide 40 from the 9/14/23 MIWG presentation)
      - This value will have the opposite sign than FLOW$_{r,h,TCCAuction}$ which is why this value is added to FLOW$_{r,h,TCCAuction}$
    - LIMIT$_{r,h}$ - The flow limit of the monitored transmission facility of the binding Dynamic Reserve constraint (*r*) applicable for hour (*h*) of the DAM absent any applicable facility status change events, in MWh

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Dynamic Reserves DA Congestion Shortfall Settlements (continued)

- **Dynamic Reserves Binding Constraint Charge (DRBCC):**
  - DRBCC = Abs($ShadowPrice_{r,h,DAM}$)*max((abs($FLOW_{r,h,TCCAuction}$ + $ReserveFlow_{r,h,DAM}$)-$LIMIT_{r,h}$),0); where:
    - When abs($FLOW_{r,h,TCCAuction}$ + $ReserveFlow_{r,h,DAM}$)-$LIMIT_{r,h}$ > 0, this indicates the presence of a shortfall attributable to a binding Dynamic Reserves constraint because it was more economic to reduce the flow on the element rather than buying reserves to back down flows post-contingency.

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Dynamic Reserves DA Congestion Shortfall Settlements (continued)

- **DAM congestion shortfalls due to Dynamic Reserves constraints are not attributable to a TO**
  - Dynamic Reserves constraints are reserve scheduling constraints based on reliability requirements and criteria to ensure sufficient Operating Reserves are scheduled to restore post-contingency transmission flows to applicable limits following a transmission or generation contingency
- **Charges for Operating Reserves are assigned to LSEs based on load-ratio share**
  - DAM congestion shortfalls due to Dynamic Reserves constraints are a reserve cost, since the optimization determined that the change in the energy flow that resulted in the shortfall was the most cost-effective solution to meet the reliability criteria represented in the reserve constraint
  - The NYISO proposes to allocate DAM congestion shortfalls attributable to Dynamic Reserves to LSEs consistent with Operating Reserves procurement costs through OATT Rate Schedule 5
  - Dynamic reserves shortfall collections would be accounted for in determining the net DAM congestion settlements pursuant to Attachment N of the OATT

Examples

Examples: Background

- **The NYISO developed 4 examples to demonstrate:**
  - Calculation of DAM congestion shortfalls due to Dynamic Reserve constraints
  - Interaction of Dynamic Reserves and other facility status changes
    - As noted above, the DAM congestion settlement process has existing mechanisms for calculating shortfalls or surpluses due to DAM transmission facility outages, returns-to-service, uprates, and derates of transmission facilities
    - These examples demonstrate how shortfalls due to both dynamic reserves and other facility status change events would be calculated
- **These calculations are based on the system topology and other inputs used in NYISO's 9/14/23 MIWG presentation on the "Proof of Concept" model for Dynamic Reserves**
  - Using those parameters, NYISO developed a set of feasible TCCs based on two sets of TCC auction limits

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Examples: Setup

- **This presentation will cover 4 different examples:**
  - *Example A:* Based on Example 1 from the 9/14/23 MIWG. In this example, no reserves were procured because reserves are more expensive than the energy market savings from higher post-contingency flows. There are no line deratings in the DAM (i.e., DAM line ratings = TCC auction line ratings).
  - *Example B:* Based on Example 2 from the 9/14/23 MIWG. In this example, 300 MW of system-wide reserves were procured because reserves were cheaper than the cost of reducing post-contingency flows below LTE. There are no line deratings in the DAM (i.e., DAM line ratings = TCC auction line ratings).
  - *Example C:* Based on Example 1 from the 9/14/23 MIWG. In this example, no reserves were procured because reserves are more expensive than the energy market savings from higher post-contingency flows. There are line deratings in the DAM (i.e., DAM line ratings < TCC auction line ratings).
  - *Example D:* Based on Example 2 from the 9/14/23 MIWG. In this example, 300 MW of system-wide reserves were procured because reserves were cheaper than the cost of reducing post-contingency flows below LTE. There are line deratings in the DAM (i.e., DAM line ratings < TCC auction line ratings).
- **To demonstrate how the scheduling outcomes from Examples 1 and 2 could lead to DAM congestion shortfalls, a set of feasible TCC awards was calculated for the system topology**
  - Examples A and B use the same set of TCCs
  - Examples C and D have a 200 MW increase on the TCC auction limits to simulate a derate
  - See Appendix for the set of TCC awards that was used in these examples

Examples: Calculate DRBCC

- **Each example does the following:**
  - Identifies binding dynamic reserve constraints
    - Determine the corresponding shadow price: $ShadowPrice_{r,h,DAM}$
    - Identify reserve flow: $ReserveFlow_{r,h,DAM}$
    - Identify the limit used in the DAM absent any other qualifying facility status change impacts on the monitored element of the binding reserve constraint: $LIMIT_{r,h}$
  - Simulate the Dynamic Reserve constraint in the TCC auction model
    - Determine $FLOW_{r,h,TCCAuction}$

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Example A

Example A Results: Identify DRBCC Inputs

- **Example A presents two binding Dynamic Reserves constraints: Loss of L1 on R1 and Loss of gen A on L2.**
- **Identify constraint formula inputs:**
  - Identify the binding dynamic reserve constraint(s): Loss of L1 on R1
    - Determine the corresponding shadow price: $ShadowPrice_{r,h,DAM}$ = $5.18/MW
    - Identify reserve flow: $ReserveFlow_{r,h,DAM}$ = 0 MW
    - Identify the limit on the monitored element of the binding reserve constraint absent any other applicable facility status change impacts: $LIMIT_{r,h}$ = 956 MW
    - Note: All these values came from Example 1 of the 9/14/23 MIWG
  - Simulate the Dynamic Reserve constraint in the TCC auction model
    - Determine $FLOW_{r,h,TCCAuction}$ = 1,072 MW
      - Note: This is an offline process that is completed following the results of the DAM

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Example A Results: Calculate DRBCC – Loss of L1 on R1

- DRBCC = $abs(ShadowPrice_{r,h,DAM}) * max((abs(FLOW_{r,h,TCCAuction} + ReserveFlow_{r,h,DAM}) - LIMIT_{r,h}),0)$; where:
  - $5.18/MW*max((abs(1,072+0)-956),0) = $5.18/MW*116 MW = $601

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Example A Results: Identify DRBCC Inputs

- **Identify formula inputs:**
  - Identify the binding dynamic reserve constraint(s): Loss of gen A on L2
    - Determine the corresponding shadow price: $ShadowPrice_{r,h,DAM}$ = $1.46/MW
    - Identify reserve flow: $ReserveFlow_{r,h,DAM}$ = 0 MW
    - Identify the limit on the monitored element of the binding reserve constraint absent any other applicable facility status change impacts: $LIMIT_{r,h}$ = 858 MW
    - Note: All these values came from Example 1 of the 9/14/23 MIWG
  - Simulate the Dynamic Reserve constraint in the TCC auction model
    - Determine $FLOW_{r,h,TCCAuction}$ = 738 MW
      - Note: This is an offline process that is completed following the results of the DAM

Example A Results: Calculate DRBCC – Loss of gen A on L2

- DRBCC = $abs(ShadowPrice_{r,h,DAM})*max((abs(FLOW_{r,h,TCCAuction} + ReserveFlow_{r,h,DAM})-LIMIT_{r,h}),0)$; where:
  - $4.16/MW*max((abs(738+0)-858),0) = $5.18/MW*max(-120,0) MW = $0

Example A Results: Settlement Calculations

- **The scheduling results of Example 1 would produce the following settlements (detailed calculations in Appendix)**
  - Total Generation Payments: $128,702
  - Total Load Payments: $134,907
  - DAM Congestion Rents = $134,907 - $128,702 = $6,205
- **The set of TCCs developed for this example generated the following payments owed to TCC holders: $6,631**
  - This leads to a DAM congestion shortfall = $6,205 - $6,631 = - $426
  - DRBCC for Loss of L1 on R1 = $601, which covers the shortfall due to Dynamic Reserves
  - DRBCC for Loss of Gen A on L2 = $0
  - Surplus credit allocated to TOs for another constraint unrelated to the binding Dynamic Reserves constraint: = $175
  - Net DAM Congestion Rent = $175 (i.e., ($6,205 + $601) - $6,631)
    - Shortfalls (i.e., due to transmission outages and derates) allocated to TOs (allocated pursuant to OATT Attachment N): $0
    - Surplus credit (unrelated to the binding Dynamic Reserves constraint) allocated to TOs (allocated pursuant to OATT Attachment N) = $175
- **Total Reserve Charges to Loads = $601**
  - DAM Reserve Payments = $0 (allocated to LSEs on a load-ratio share basis pursuant to OATT Rate Schedule 5)
  - DRBCC = $601 (allocated to LSEs on a load-ratio share basis pursuant to OATT Rate Schedule 5)

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Example B

*The following examples demonstrate the DRBCC calculation only for binding Dynamic Reserves constraints that generate a non-zero DRBCC value.

Example B Results: Identify DRBCC Inputs

- **Identify formula inputs:**
  - Identify the binding dynamic reserve constraint(s): Loss of L2 on R1
    - Determine the corresponding shadow price: $ShadowPrice_{r,h,DAM}$ = $5.00/MW
    - Identify reserve flow: $ReserveFlow_{r,h,DAM}$ = 92.50 MW
    - Identify the limit on the monitored element of the binding reserve constraint absent any other applicable facility status change impacts: $LIMIT_{r,h}$ = 956 MW
    - Note: All these values came from Example 1 of the 9/14/23 MIWG
  - Simulate the Dynamic Reserve constraint in the TCC auction model
    - Determine $FLOW_{r,h,TCCAuction}$ = 1,072 MW
      - Note: This is an offline process that is completed following the results of the DAM

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Example B Results: Calculate DRBCC

- DRBCC = abs($ShadowPrice_{r,h,DAM}$)*max((abs($FLOW_{r,h,TCCAuction}$ + $ReserveFlow_{r,h,DAM}$)-$LIMIT_{r,h}$),0); where:
  - $5.00/MW*max((abs(1,072+(-92.50)-956),0) = $5/MW*23.50 MW = $117.50

Example B Results: Settlement Calculations

- **The scheduling results of Example 2 would produce the following settlements (detailed calculations in Appendix)**
  - Total Generation Payments: $128,204
  - Total Load Payments: $133,447
  - DAM Congestion Rents = $133,447 - $128,204 = $5,243
- **The set of TCCs developed for this example generated the following payments owed to TCC holders: $5,360**
  - This leads to a DAM congestion shortfall = $5,243 - $5,360 = -$117
  - DRBCC = $117, which covers the shortfall due to Dynamic Reserves
  - Net DAM Congestion Rent = $0 (i.e., ($5,243 + $117) - $5,360)
    - Shortfalls (i.e., due to transmission outages and derates) and surplus credits allocated to TOs (allocated pursuant to OATT Attachment N): $0
    - Surplus credit (unrelated to the binding Dynamic Reserves constraint) allocated to TOs (allocated pursuant to OATT Attachment N) = $0
- **Total Reserve Charges to Loads = $580**
  - DAM Reserve Payments = $463 (allocated to LSEs on a load-ratio share basis pursuant to OATT Rate Schedule 5)
  - DRBCC = $117 (allocated to LSEs on a load-ratio share basis pursuant to OATT Rate Schedule 5)

Example C

Example C Results: Identify DRBCC Inputs

- **Identify formula inputs:**
  - Identify the binding dynamic reserve constraint(s): Loss of L1 on R1
    - Determine the corresponding shadow price: $ShadowPrice_{r,h,DAM}$ = $5.18/MW
      - This value came from Example 1 of the 9/14/23 MIWG
    - Identify reserve flow: $ReserveFlow_{r,h,DAM}$ = 0 MW
      - This value came from Example 1 of the 9/14/23 MIWG
    - Identify the limit on the monitored element of the binding reserve constraint absent any other applicable facility status change impacts: $LIMIT_{r,h}$ = 1,156 MW
  - Simulate the Dynamic Reserve constraint in the TCC auction model
    - Determine $FLOW_{r,h,TCCAuction}$ = 1,338 MW
      - Note: This is an offline process that is completed following the results of the DAM

Example C Results: Calculate DRBCC

- DRBCC = $abs(ShadowPrice_{r,h,DAM})*max((abs(FLOW_{r,h,TCCAuction} + ReserveFlow_{r,h,DAM})-LIMIT_{r,h}),0)$; where:
  - \$5.18/MW*max((abs(1,338+0)-1,156),0) = \$5.18/MW*182 MW = \$943

Example C Results: Settlement Calculations

- **The scheduling results of Example 1 would produce the following settlements (detailed calculations in Appendix)**
  - Total Generation Payments: $128,702
  - Total Load Payments: $134,907
  - DAM Congestion Rents = $134,907 - $128,702 = $6,205
- **The set of TCCs developed for this example generated the following payments owed to TCC holders: $8,297**
  - This leads to a DAM congestion shortfall = $6,205 - $8,297 = -$2,092
  - DRBCC = $943, which covers the shortfall due to Dynamic Reserves
  - Shortfall charge allocated to TOs for derate unrelated to the binding Dynamic Reserves constraint: = $1,149
  - Net DAM Congestion Rent = $0 (i.e., ($6,205 + $1,149 + $943) - $8,297)
    - Shortfalls (i.e., due to transmission outages and derates) allocated to TOs (allocated pursuant to OATT Attachment N): $1,149
    - Surplus credit (unrelated to the binding Dynamic Reserves constraint) allocated to TOs (allocated pursuant to OATT Attachment N) = $0
- **Total Reserve Charges to Loads = $943**
  - DAM Reserve Payments = $0 (allocated to LSEs on a load-ratio share basis pursuant to OATT Rate Schedule 5)
  - DRBCC = $943 (allocated to LSEs on a load-ratio share basis pursuant to OATT Rate Schedule 5)

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Example D

Example D Results: Identify DRBCC Inputs

- **Identify formula inputs:**
  - Identify the binding dynamic reserve constraint(s): Loss of L2 on R1
    - Determine the corresponding shadow price: $ShadowPrice_{r,h,DAM}$ = \$5.00/MW
      - This value came from Example 2 of the 9/14/23 MIWG
    - Identify reserve flow: $ReserveFlow_{r,h,DAM}$ = 92.50 MW
      - This value came from Example 2 of the 9/14/23 MIWG
    - Identify the limit on the monitored element of the binding reserve constraint absent any other applicable facility status impacts: $LIMIT_{r,h}$ = 1,156 MW
  - Simulate the Dynamic Reserve constraint in the TCC auction model
    - Determine $FLOW_{r,h,TCCAuction}$ = 1,338 MW
      - Note: This is an offline process that is completed following the results of the DAM

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Example D Results: Calculate DRBCC

- DRBCC = $abs(ShadowPrice_{r,h,DAM})*max((abs(FLOW_{r,h,TCCAuction} + ReserveFlow_{r,h,DAM})-LIMIT_{r,h}),0)$; where:
  - $5.00/MW*max((abs(1,338+(-92.50))-1,156),0) = $5/MW*90 MW = $448

Example D Results: Settlement Calculations

- **The scheduling results of Example 2 would produce the following settlements (detailed calculations in Appendix)**
  - Total Generation Payments: $128,204
  - Total Load Payments: $133,447
  - DAM Congestion Rents = $133,447 - $128,204 = $5,243
- **The set of TCCs developed for this example generated the following payments owed to TCC holders: $6,690**
  - This leads to a net DCR shortfall = $5,243 - $6,690 = -$1,447
  - DRBCC = $448, which covers the shortfall due to Dynamic Reserves
  - Shortfall charge allocated to TOs for derate unrelated to the binding Dynamic Reserves constraint: = $999
  - Net DAM Congestion Rent = $0 (i.e., ($5,243 + $448 + $999) - $6,690)
    - Shortfalls (i.e., due to transmission outages and derates) allocated to TOs (allocated pursuant to OATT Attachment N): $999
    - Surplus credit (unrelated to the binding Dynamic Reserves constraint) allocated to TOs (allocated pursuant to OATT Attachment N) = $0
- **Total Reserve Charges to Loads = $911**
  - DAM Reserve Payments = $463 (allocated to LSEs on a load-ratio share basis pursuant to OATT Rate Schedule 5)
  - DRBCC = $448 (allocated to LSEs on a load-ratio share basis pursuant to OATT Rate Schedule 5)

Next Steps

Next Steps

- The NYISO will return to upcoming MIWGs with the following:
  - Draft tariff revisions to support the proposal for TCCs
  - Review of 2023 MDC and tariff
  - Review of prototyping results
- NYISO will seek a BIC and MC vote on the complete design and tariff in Q4
- The 2024 deliverable for this project is Functional Requirements

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

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

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
December 6, 2023 MIWG	https://www.nyiso.com/documents/20142/41611225/20231206%20MIWG%20-%20Dynamic%20Reserves.pdf/65df622a-9fd6-7772-287e-b56575fc23e4
December 13, 2023 BIC	https://www.nyiso.com/documents/20142/41671891/UPDATED%20-%2020231213%20BIC%20-%20Dynamic%20Reserves%20REPOSTED.pdf/0bc8d5df-6773-8db1-9f99-d91fd1fd0676
January 25, 2024 MIWG	https://www.nyiso.com/documents/20142/42590322/20240125%20Dynamic%20Reserves%20MIWG%20v2.pdf/305719ad-74a3-c57b-30c2-e3ccd229fc54
February 20, 2024 MIWG	https://www.nyiso.com/documents/20142/43038997/5%2020240220%20Dynamic%20Reserves%20MIWG.pdf/5be7321e-c694-e5ad-f029-d648ea6cc806
March 20, 2024 MIWG	https://www.nyiso.com/documents/20142/43621521/2%2020240320%20Dynamic%20Reserves%20MIWG.pdf/9c1bc48a-4d42-13fb-f21d-7d7693ea32d9

Appendix: Set of TCC Awards Used

TCC Awards Used in Calculations

- **Examples A and B use the same set of TCCs**
  - 2432 MW: Generator E1 to load pocket zone
  - 1143 MW: Generator E2 to load pocket zone
  - 500 MW: Generator A to upstate load zone
- **Examples C and D have a 200 MW increase on the TCC auction limits to simulate a derate**
  - 2800 MW: Generator E1 to load pocket zone
  - 1569 MW: Generator E2 to load pocket zone
  - 500 MW: Generator A to upstate load zone

Appendix: Supporting Calculations for Examples A-D

*the next 3 slides are based on the outputs from in the 9/14/23 MIWG

Calculation of DAM Congestion Rents: Examples A and C

	System Lambda ($/MW)	Shadow Price Loss of L1 on R1 ($/MW)	Shift Factor on R1 for Loss of L1	Shadow Price Loss of Generator A on L1 ($/MW)	Pre-Contingency Shift Factor on L1	LBMP ($/MW)	Energy Schedule (MW)	Energy Revenues ($)
Generator A	21.09	5.18	-0.175	1.46	0	22.00	931.4	= $22/MW*931.4 MW = $20,487.54
Generator B	21.09	5.18	-0.3	1.46	-0.24	23.00	650.2	= $23/MW*650.2 MW= $14,950.96
Generator C	21.09	5.18	-0.45	1.46	-0.075	23.53	10	= $23.53/MW*10 MW= $235.31
Generator E1	21.09	5.18	-0.025	1.46	0.025	21.18	2,500	= $21.18/MW*2,500 MW= $52,957.50
Generator E2	21.09	5.18	-0.025	1.46	-0.025	21.26	1908.4	= $21.26/MW*1,908.4 MW= $40,070.67
							Total Generator Payments:	$128,701.98

	System Lambda ($/MW)	Shadow Price Loss of L1 on R1 ($/MW)	Shift Factor on R1 for Loss of L1	Shadow Price Loss of Generator A on L1 ($/MW)	Pre-Contingency Shift Factor on L1	LBMP ($/MW)	Load (MW)	Energy Revenues ($)
Zone X Load	21.09	5.18	-0.3	1.46	-.25	23.18	4,000	= $23.18/MW*4,000 MW = $92,726.67
Zone Y Load	21.09	5.18	0	1.46	0	21.09	2,000	= $21.09/MW*2,000 MW= $42,180
							Total Load Payments:	$134,906.67

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Calculation of DAM Congestion Rents: Examples B and D

	System Lambda ($/MW)	Shadow Price Loss of L2 on R1 ($/MW)	Shift Factor on R1 for Loss of L2	LBMP ($/MW)	Energy Schedule (MW)	Energy Revenues ($)
Generator A	21.13	5.00	-0.175	22.00	713	= $22/MW*713 MW = $15,689.57
Generator B	21.13	5.00	-0.3	22.63	500	= $22.63/MW*500 MW= $11,315.00
Generator C	21.13	5.00	-0.45	23.38	10	= $23.38/MW*10 MW= $233.80
Generator E1	21.13	5.00	-0.025	21.25	2,500	= $21.25/MW*2,500 MW= $53,137.50
Generator E2	21.13	5.00	0.025	21.00	2,277	= $21.00/MW*2,277 MW= $47,828.39
					Total Generator Payments:	$128,204.25

	System Lambda ($/MW)	Shadow Price Loss of L2 on R1 ($/MW)	Shift Factor on R1 for Loss of L2	LBMP ($/MW)	Load (MW)	Energy Revenues ($)
Zone X Load	21.09	5.00	-0.3	22.80	4,000	= $22.80/MW*4,000 MW = $91,186.67
Zone Y Load	21.09	5.00	0	21.13	2,000	= $21.09/MW*2,000 MW= $42,260.00
					Total Load Payments:	$133,446.67

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Calculation of DAM Reserve Payments: Examples B and D

	Shadow Price Loss of L2 on R1 ($/MW)	Shift Factor on R1 for Loss of L2	Reserve Price ($/MW)	Reserve Schedule	Reserve Revenues
Generator A	5.00	-0.175	0.88	100	= $0.88/MW*100 MW = $88.00
Generator B	5.00	-0.3	1.50	100	= $1.50/MW*100 MW= $150.00
Generator C	5.00	-0.45	2.25	100	= $2.25/MW*100 MW= $225.00
Generator E1	5.00	-0.025	0.13	0	= $0
Generator E2	5.00	0.025	0.13	0	= $0
Total Generator Reserve Payments to be collected from Loads:					$463.00

Calculation of Reserve Flow: Examples B and D

- In Example 2, the binding constraint was the Loss of L2 on R1
  - This was the most limiting constraint
- This example also showed post-contingency flows on L1, L2, and R2 exceeding LTE
  - The amount of reserves procured to solve the binding constraint will also ensure that flows on L1, L2, and R2 can be brought below LTE following a contingency
- Calculating the available relief by each generator based on their reserve schedule and shift factor can be used to illustrate adequate reserve capacity procurement for contingency event

Transmission Contingency Flow - Binding Flow on R1 for Loss of L2			
	Reserve Schedule (MW)	Shift Factor on R1 for Loss of L2	Available Relief (MW) [Reserve Schedule*Shift Factor]
Generator A	100	-0.175	17.5
Generator B	100	-0.3	30
Generator C	100	-0.45	45
Post-Contingency Flow			1049 MW
Total Available Relief			93 MW
Line Flow Post Reserve Activation [Post-Contingency Flow – Total Available Relief]			956 MW
LTE			956 MW

No changes to this slide from 9/14/23 MIWG presentation

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Appendix: TCC Example from 3/20/24 MIWG

*the next 4 slides are unrelated to the examples presented today and included to provide additional information

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Dynamic Reserve and TCCs: Example

- **At the November 17, 2023 MIWG, the NYISO presented a series of examples to demonstrate congestion rent allocation and settlements**
  - Please refer to the Appendix for a review of the example inputs
- **Example 3 of that presentation demonstrated how the optimal outcome (i.e., minimized production cost) may be able to respect transmission constraints through energy scheduling and not schedule reserves**
  - In this scheduling paradigm, energy would be scheduled such that post-contingency energy flows would not exceed LTE limits
  - This would occur in circumstances where scheduling reserves would be a more expensive solution

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Dynamic Reserves and TCCs: Example (continued)

- **Example 1 is the "Base Case Example" with no dynamic reserves constraints**
  - Post-Contingency Energy flows on each line are 1049 MW
- **Example 2 is a "Cheap Operating Reserves Example" with dynamic reserves constraints and a low offer for operating reserves**
  - Post-Contingency Energy flows on each line are 1049 MW
- **Example 3 is an "Expensive Operating Reserves Example" with dynamic reserves constraints and a high offer for operating reserves**
  - Post-Contingency Energy flows on each line are 999 MW
- **In this example, we will evaluate 1) difference in energy flows using Dynamic Reserves constraints with low and high reserves offers and 2) potential congestion rent shortfalls in Example 3**
  - This example assumes that the TCC market clearing price from the TCC auction is equal to the DAM congestion value of the TCC
  - This example also assumes that TCCs are sold up to the MTE limit of the line, similar to energy scheduling constraints in NYC

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Dynamic Reserves Scheduling: Difference in Energy Flows with Cheap and Expensive Operating Reserves

Congestion Rent Allocation and Settlements

		Example 2 - Cheap OR	Example 3 - Expensive OR
ROS Energy Offer	($/MWh)	5	5
Locality Energy Offer	($/MWh)	50	50
ROS Reserves Offer	($/MWh)	1	1
Locality Reserves Offer	($/MWh)	2	47
ROS LMP	($/MWh)	$ 5	$ 5
Locality LMP	($/MWh)	$ 50	$ 50
ROS OR Price	($/MWh)	$ -	$ -
Locality OR Price	($/MWh)	$ 2	$ 45
ROS Energy Sched	(MW)	3147	2997
Locality Energy Sched	(MW)	353	503
ROS OR Sched	(MW)	0	0
Locality OR Sched	(MW)	150	0

The clearing price of reserves increases from $2 to $45. At $45, no reserves are scheduled because the reserve offer is $47.

In Example 3, the reserve offer in the locality is increased from $2 to $47.

Due to the high reserve offers, energy flows are decreased by 150 MW, and internal generation scheduled is increased by 150 MW. The reserve requirement is reduced to 0 MW from 150 MW.

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Dynamic Reserves and TCCs: Calculation of Shortfalls

		Example 1 TODAY	Example 2 DR- Cheap OR	Example 3 DR - Expensive OR
Transmission DAM Congestion R	[A] = [E] * [F]	$ 141,615	$ 141,615	$ 134,865
Assumed TCC Sale Quantity	[B], assumed	1049	1049	1049
Assumed TCC Price	[C], assumed	$ (135)	$ (135)	$ (135)
TCC Auction Revenue	[D] = [B] * -[C]	$ 141,615	$ 141,615	$ 141,615
Post Contingency DAM Flow	[E], optimization output	1049	1049	999
Actual DAM Congestion Price	[F], optimization output	$ (135)	$ (135)	$ (135)
DAM Congestion Residual (DCR)	[G] = ([E] - [B]) * -[F]	$ -	$ (0)	$ (6,750)
TO Net of TCC Revenue and DCR	[H] = [D] + [G]	$ 141,615	$ 141,615	$ 134,865

- **Congestion rent shortfalls would be realized under Example 3 due to the decrease in energy flows across the transmission lines**

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