Dynamic Reserves

Matthew Musto

Market Solutions Engineering

Ashley Ferrer

Energy Market Design

Kanchan Upadhyay

Ting Dai

Market Solutions Engineering

ICAPWG/MIWG

September 26, 2023

Agenda

- Background
- Correlated Loss of Multiple Generators
- Treatment of Reserve Constraints in DAM and RTM
- Thunderstorm Alerts (TSAs)
- NYCA 30-Minute Operating Reserve Demand Curve
- Posting of Reserve Requirements
- Reserve Constraint Demand Curves
- Draft Tariff Revisions
- 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	https://www.nyiso.com/documents/20142/40004830/20230914%20MIWG%20-%20Dynamic%20Reserves.pdf/a1c6d806-5b67-a8fc-9d04-a1669a926f54
September 18, 2023	https://www.nyiso.com/documents/20142/40044890/5%2020230918%20MIWG%20-%20Dynamic%20Reserves.pdf/0b1b7e63-737d-5bee-4abc-be65c234aa3b

New York ISO

Current Progress

- Today's presentation will discuss several market design components to support the Generator Shift Factor Approach
- The Appendix of today's presentation contains several follow-up items from recent MIWGs

Foundation for Market Design Concepts

- **Energy scheduling constraints are formulated as follows:**
  - $\sum Shift\ Factors\ * (Gen\ and\ Load\ Schedules) \leq \text{Line Limit}$
    - 'Line Limit' is based on the normal limit for a base case constraints and LTE or MTE limits for a post contingency constraints.
    - The associated shift factors for Generation and Load come from the Network Security Analysis (NSA) power flow tool.
- **This formulation would be extended for Operating Reserves subject to successful integration into NYISO BMS software**
  - NYISO has identified approximately 20 lines which make up key interfaces across NYCA and factor into reserve area definitions, for which NYISO would monitor for post-contingency limits
  - New reserve constraints need to be modeled similarly to the transmission constraint and validated within the market software: $\sum Shift\ Factors\ (Gen, Load, and\ Reserves) \leq Line\ Limit$
  - Reserve shift factors are negative in the above equation so that only resources which would provide relief for the constraint would be evaluated
  - The 'Line Limit' and reserve product would be based on the projected overload and timing requirements to restore the flows on the facility, after the contingency
  - The shift factors used to calculate the reserve constraints are based on the appropriate constraints operating requirements

Generator Shift Factor Approach: Defining Locational Reserve Constraints

- **The locational reserve requirements (except for NYCA) would need to reflect the post-contingency system conditions as defined by reliability criteria:**
  - Loss of Transmission: The constraint would be evaluated for each monitored transmission element or interface[1] (*e.g.*, Central-East)
    - 10-Minute Total Reserves: Transmission elements must be below applicable limits[2] within 15 minutes following a single transmission contingency
      - [Post-Contingency Energy Flow – 10-Minute Reserves] <= Applicable Limits
    - 30-Minute Total Reserves: Transmission elements must be below Normal Transfer Criteria within 30 minutes following two transmission contingencies
      - [Post-Contingency Energy Flow – 30-Minute Reserves] <= Normal Transfer Criteria

1: The only interface that would be evaluated would be Central-East. All other transmission elements would be monitored individually.
2: An applicable limit for different constraints based on reliability criteria or system topology. For example, 1) reserve constraints for voltage conditions across the East interface would be based on Central East – Voltage Collapse maximum transfer capability and 2) reserve constraints for thermal conditions in NYC may be based on actual flows over LTE limits and 3) reserve constraints for thermal conditions in Long Island may be based on post contingency flows for the next contingency over LTE limits.

Generator Shift Factor Approach: Defining Locational Reserve Constraints (continued)

- **The locational reserve requirements (except for NYCA) would need to reflect the post-contingency system conditions as defined by reliability criteria:**
  - Loss of Generation: The constraint would be evaluated for each monitored transmission element or interface against the loss of each generator
    - 10-Minute Total Reserves: Transmission elements must be below applicable limits within 15 minutes following the loss of a generator
      - [Post- Generator Contingency Energy Flow – 10-Minute Reserves*] <= Applicable Limits
    - 30-Minute Total Reserves: Transmission elements must be below Normal Transfer Criteria within 30 minutes following the loss of two generators
      - [Post- Generator Contingency Energy Flow – 30-Minute Reserves*] <= Normal Transfer Criteria
  - Loss of Generation and Transmission: This constraint would be evaluated for each monitored transmission against the loss of a generation and transmission element
    - 30-Minute Total Reserves: [Post-Contingency Energy Flow – 30-Minute Reserves*] <= Normal Transfer Criteria
    - N-1 Transmission flow and loss of largest effective unit (Gen_MW * N-1_SF) for 30T requirement

* Not counting Reserves on the lost unit

New York ISO

*This slide contains a slight modification from previous versions, highlighted below

Generator Shift Factor Approach: Defining NYCA Reserve Constraints

- **Transmission flows and limits are only used in determining the reserve distribution within the NYCA**
  - NPCC and NYSRC rules require the NYISO to procure reserves in NYCA to cover the largest capability loss; therefore, the determination of the reserve requirement for NYCA does not consider transmission from external control areas
- **Nodal transmission security will determine distribution of the requirement**
  - All Reserve providers will have a shift factor of "unity" towards NYCA requirement
- **The proposed reserve constraints for NYCA 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 – Bid))
    - Basing the requirement on the combined output of the largest and second largest generators meets the NYSRC requirement for 30-Minute reserves. The NYSRC requirements state that: 1) NYISO must have enough 30-Minute Reserves equal to one-half of the 10-Minute Reserve requirement (i.e., one-half of the capability of the largest generator; and 2) NYISO must restore 10-Minute reserves within 30 minutes of a contingency[1]
    - NYISO's use of a multiplier of 2*largest generator is an approximation of this requirement. Calculating the reserve requirement based on the capability of the largest and second largest contingency would allow NYISO to have enough reserves to restore flows and 10-Minute reserves within 30 minutes
    - The Forecast-Bid Load component is a Day-Ahead Market construct only

1: https://www.nysrc.org/wp-content/uploads/2023/07/RRC-Manual-V46-final.pdf

New York ISO

Correlated Loss of Multiple Generators

Correlated Loss of Multiple Generators

- **During the 2022 MDCP, the NYISO proposed the concept of accounting for the potential loss of multiple resources that share a single point of failure**
  - This would capture the potential risk of losing multiple resources whose combined output may be the largest source of generation in a reserve area
  - The definition of correlated loss of multiple generators includes a single tower or line contingency leaving a generation complex that would result in the loss of multiple generating resources simultaneously
  - Applicable groups of generators are currently identified by NYISO

New York ISO

Correlated Loss of Multiple Generators: Definition

- **NYISO's proposal would develop logic for each group of resources that would evaluate each monitored transmission element or interface against that group of generators**
  - 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:
    - $Gen_A * Shift_A + Gen_B * Shift_B$

Treatment of Reserve Constraints In DAM and RTM

New York ISO

Treatment of Reserve Constraints in DAM and RTM

- **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

New York ISO

Thunderstorm Alerts (TSAs)

Thunderstorm Alert (TSA) Activations

- **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

New York ISO

Thunderstorm Alerts: 2022 MDCP Proposal

- **In the 2022 MDCP, NYISO identified two options for handling a TSA with Dynamic Reserves:**
  - Disable reserve constraints
    - This would be the same process as it done currently
  - Allow Dynamic Reserves to solve for a reserve requirement. 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
    - The reserve constraints would be solving to the same system conditions as energy constraints, and therefore would not be more restrictive
- **Additionally in 2022, the NYISO proposed to prototype the second approach and review the outcomes to determine if the Dynamic Reserve solution would solve as anticipated and set a near-zero reserve requirement during TSAs**
  - This approach was driven, in part, by some of the challenges that NYISO had identified in calculating interface limits under the MDCP approach

New York ISO

Thunderstorm Alerts: 2023 MDC Proposal

- **The NYISO is modifying its proposal for the treatment of TSAs based on the modeling improvements of the Nodal Reserve Design**
- **The NYISO is proposing that no modifications or changes be made to the reserve constraints during a TSA**
  - As discussed on the previous slide, 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

NYCA 30-Minute Operating Reserve Demand Curve

New York ISO

NYCA 30-Minute Operating Reserve Demand Curve

- **The existing NYCA 30-Minute ORDC is based on a static procurement of 2620 MW and needs to be modified to price reserve shortages correctly based on a dynamic reserve procurement**
- **NYISO is proposing to 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
  - NYISO is not proposing any changes to the shortage prices as part of Dynamic Reserves. A zonal average shift factor will be applied to the ORDC to represent what 1 MW of relief from the ORDC would cost.

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 what percent of the 655 MW "tail" is 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
- 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 "tail" is maintained

New York ISO

NYCA 30-Minute Operating Reserve Demand Curve: Proposal

- The proposed reserve constraint for NYCA 30-Minute Reserves is:
  - Equal to the output of the Largest Generator + Second Largest Generator + max(0,(Forecast –Bid))
- The NYISO proposes that the first step of the ORDC (corresponding to 1.5 times the largest contingency today) would be calculated as the total output of largest generator + one-half the output of the second largest generator
- The NYISO proposes that the Forecast-Bid component of the NYCA reserves would be added to the total reserve procurement (i.e., these MW are not priced differently than any other MW of the reserve procurement)
  - This component would only be evaluated in the Day-Ahead Market

New York ISO

NYCA 30-Minute Operating Reserve Demand Curve: Formulaic Example

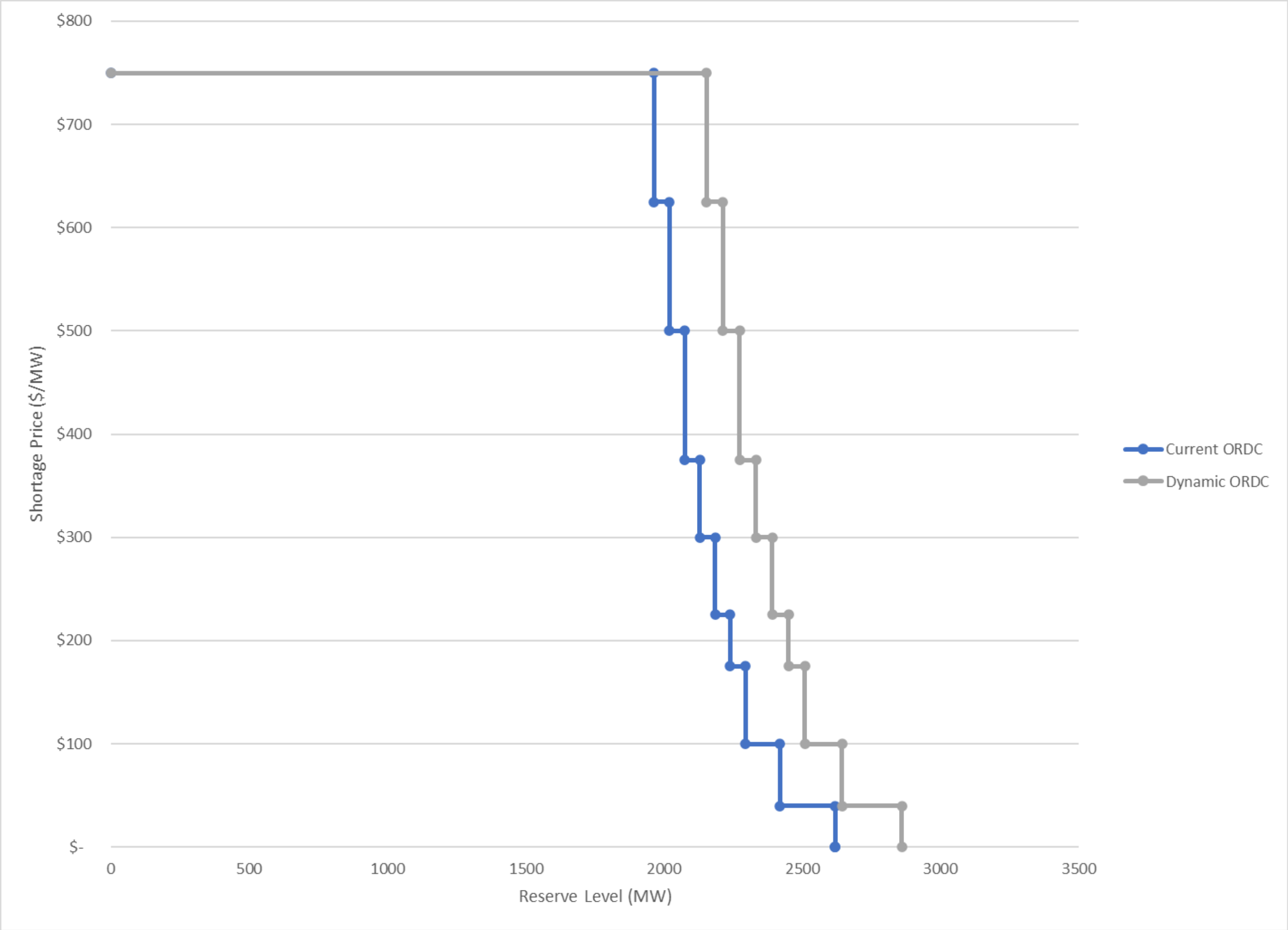
- The following example will illustrate how the NYCA 30-Minute ORDC will be formulaically updated in the Day-Ahead Market. This example uses the following assumptions:
  - Output of Largest Generator = 1500 MW; Second Largest = 1310 MW
  - Forecast Load exceeds Bid Load by 50 MW
  - Total NYCA 30-Minute requirement = 1500 +1310 + 50 = 2860 MW
- The first step of the demand curve would be the sum of 100% of largest contingency and 50% of second largest contingency = 1500 + 655 = 2155 MW
  - For the 705 MW between 2155 MW and 2860 MW, the demand curve steps would be graduated based on the existing structure

New York ISO

NYCA 30-Minute Operating Reserve Demand Curve: Formulaic Example Results

Shortage Price ($/MW)	Demand Curve Step (MW)	Percent of Existing ORDC "Tail"	Calculation	Percent of Total Procurement of ORDC "Tail"	Reserve Levels (MW)	Reserve Shortage Relative to Requirement (MW)
750	2155	N/A	=1500+0.5*1310	N/A	0 to 2155	705
625	59	8.40%	=8.40%*705	8.40%	2155 to 2214	646
500	59	8.40%	=8.40%*705	16.79%	2214 to 2273	587
375	59	8.40%	=8.40%*705	25.19%	2273 to 2333	527
300	59	8.40%	=8.40%*705	33.59%	2333 to 2392	468
225	59	8.40%	=8.40%*705	41.98%	2392 to 2451	409
175	59	8.40%	=8.40%*705	50.38%	2451 to 2510	350
100	135	19.08%	=19.08%*705	69.47%	2510 to 2645	215
40	215	30.53%	=30.53%*705	100.00%	2645 to 2860	0

NYCA 30-Minute Operating Reserve Demand Curve: Formulaic Example Results – Graphical



Posting of Dynamic Reserve Requirements

Posting of Dynamic Reserve Requirements

- **Postings will be analogous to energy pricing and scheduling**
  - 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 inferred 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

New York ISO

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 ($/MWhr)
- **NYCA Reserve Procurement will be posted with the following fields:**
  - Time Stamp, Time Zone, NYCA 10 Min Spinning Reserve (MW), NYCA 10 Min Non-Synchronous Reserve (MW), NYCA 30 Min Operating Reserve (MW)
- **Limiting Reserve Constraints will be posted with the following fields:**
  - Time Stamp, Time Zone, Limiting Facility, Facility PTID, Contingency, Constraint Cost ($)

New York ISO

Operating Reserve Demand Curves

Operating Reserve Demand Curves Under Nodal Design

- NYISO currently has ORDCs defined for each for 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 remain
- For each of the locational reserve constraints (discussed on slide 8), an ORDC will be applied to each transmission element
- These ORDCs will be modelled similarly to NYISO's existing Transmission Constraint Pricing logic. Transmission constraint prices are assigned to specific facilities to represent the marginal cost of resolving a specific constraint
- NYISO's proposal is to utilize the structure developed for transmission facilities and to apply the corresponding shortage values in place today
- The NYISO is developing examples to demonstrate how shortage pricing would work under this nodal construct

New York ISO

Draft Tariff Revisions

Draft Tariff Revisions: Summary of Substantive Draft Tariff Revisions

- NYISO has drafted proposed tariff revisions to certain, but not all, sections of MST 15.4
- These tariff changes were posted with this meeting material. However, to give sufficient time to review these changes, the updates will be reviewed in detail at the next MIWG.
- MST 15.4.1
  - Revised description of NYCA 10-Minute Spinning, 10-Minute Non-Synchronized, and 30-Minute Reserve Requirements
  - Revised description of Operating Reserves to describe Locational Operating Reserve Constraints, including definition of reserve constraints and definition of secured interfaces
- MST 15.4.4
  - Revised description of methods for determining location reserve and scarcity reserve requirement prices
  - Removed Section 15.4.4.2 to reflect changes to settlements for Suppliers of Operating Reserves Located on Long Island
- MST 15.4.5 and MST 15.4.6
  - Revised description of Day-Ahead Market and Real-Time Market Clearing Prices
- MST 15.4.7
  - Revised description of Operating Reserve demand curves
  - Further revisions to this section will be discussed in early October

New York ISO

Next Steps

Next Steps

- **The deliverable for 2023 is Market Design Complete**
- **Timeline to completion of MDC**
  - Review market design elements at 10/3/23 MIWG
  - Present additional examples to support nodal design at 10/3/23 MIWG
  - Discuss remaining outstanding market design elements and tariff at October MIWGs
  - Present MDC and tariff at November BIC

New York ISO

Questions?

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

New York ISO

Appendix: Links to Previous Material on Long Island Reserves

New York ISO

Previous Material on Long Island Reserve Scheduling Constraints

- At the 9/18/2023 MIWG meeting, NYISO discussed scheduling constraints for reserves on Long Island
- Stakeholders asked for materials which discussed the initial rational for these scheduling constraints
- These constraints have been part of scheduling of reserves on Long Island since it was created as part of the Comprehensive Shortage Pricing project
- The following materials discuss Long Island reserve contribution:
  - 10/7/2014:https://www.nyiso.com/documents/20142/1411342/Comprehensive%20Shortage%20Pricing%20October%20MIWG%20FINAL.pdf/40b3ea47-2f9f-39ee-a78b-ece60e1bcfb6
  - 10/30/2014:https://www.nyiso.com/documents/20142/1402295/Comprehensive%20Shortage%20Pricing%20October%2030%20MIWG%20FINAL.pdf/4650b53b-2c8f-8a30-ad34-e3d662358158
  - 11/27/17: https://www.nyiso.com/documents/20142/1403425/LI%20Reserve%20Modeling%20-%20Nov%20MIWG%20FINAL.pdf/439eb65b-879-fa77-6337-b36eb5435bbf

New York ISO

Appendix: Calculations of Generator Profits

New York ISO

Generator Profit Calculations

- At the 9/14/23 and 9/18/23 MIWG meetings, NYISO presented the results of its model demonstrating the feasibility of a nodal design for Dynamic Reserves
- The NYISO received feedback to demonstrate how the results of each example would be the profit-maximizing solution for each generator
  - In response, NYISO developed a table for each example and each generator
  - The following slide will walk through one of the tables, with the remaining tables following on subsequent slides

New York ISO

Generator Profit Calculations: Example

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	10	10.00	0.50	10	0	$ 12.00	$ 0.38	$ 120	$ -	$ 120
Segment 2	10	600	20.00	0.50	590	0	$ 2.00	$ 0.38	$ 1,180	$ -	$ 1,180
Segment 3	600	1000	22.00	0.50	113	100	$ -	$ 0.38	$ -	$ 38	$ 38
Total for Generator A					**713**	**100**			**$ 1,300**	**$ 38**	**$ 1,338**

LBMP ($/MW)	$ 22.00
Energy Schedule (MW)	713
Reserve Shadow Price ($/MW)	$ 0.88
Reserve Schedule (MW)	100

- **The table provides a calculation of the profits a generator would receive based on its Energy and Operating Reserve schedule**
- **In the above example, the Generator's profit would break down as follows:**
  - Energy Profit ($/MWh) = LBMP - Energy Offer Price; Energy Profit ($) = Energy Profit*Energy Schedule
  - Reserves Profit ($/MWh) = Reserve Shadow Price – Reserves Offer Price; Reserves Profit ($) = Reserves Profit*Reserves Schedule
  - In Segment 1, Energy Profit ($12) > Operating Reserves Profit ($0.38). Generator A is fully scheduled for Energy at this segment.
  - In Segment 2, Energy Profit ($2) > Operating Reserves Profit ($0.38). Generator A is fully scheduled for Energy at this segment.
  - In Segment 3, Energy Profit ($0) < Operating Reserves Profit ($0.38). Generator A is fully scheduled for Operating Reserves based on its ramp rate in this segment. Generator A also has an energy schedule since that does not reduce profits.

New York ISO

Generator Profits: Example 1 from 9/14

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	10	10.00	8.00	10	0	$ 12.00	$ (7.09)	$ 120	$ -	$ 120
Segment 2	10	600	20.00	8.00	590	0	$ 2.00	$ (7.09)	$ 1,180	$ -	$ 1,180
Segment 3	600	1000	22.00	8.00	332	0	$ -	$ (7.09)	$ -	$ -	$ -
Total for Generator A					**932**	**0**			**$ 1,300**	**$ -**	**$ 1,300**

LBMP ($/MW)	$ 22.00
Energy Schedule (MW)	932
Reserve Shadow Price ($/MW)	$ 0.91
Reserve Schedule (MW)	0

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	5	15.00	9.00	5	0	$ 8.00	$ (7.10)	$ 40	$ -	$ 40
Segment 2	5	500	20.00	9.00	495	0	$ 3.00	$ (7.10)	$ 1,485	$ -	$ 1,485
Segment 3	500	700	23.00	9.00	150	0	$ -	$ (7.10)	$ -	$ -	$ -
Total for Generator B					**650**	**0**			**$ 1,525**	**$ -**	**$ 1,525**

LBMP ($/MW)	$ 23.00
Energy Schedule (MW)	650
Reserve Shadow Price ($/MW)	$ 1.90
Reserve Schedule (MW)	0

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	10	20.00	3.00	10	0	$ 3.00	$ (1.10)	$ 30	$ -	$ 30
Segment 2	10	200	24.00	3.00	0	0	$ (1.00)	$ (1.10)	$ -	$ -	$ -
Segment 3	200	300	25.00	3.00	0	0	$ (2.00)	$ (1.10)	$ -	$ -	$ -
Total for Generator C					**10**	**0**			**$ 30**	**$ -**	**$ 30**

LBMP ($/MW)	$ 23.53
Energy Schedule (MW)	10
Reserve Shadow Price ($/MW)	$ 2.44
Reserve Schedule (MW)	0

Generator Profits: Example 1 from 9/14 (continued)

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	10	5.00	2.00	10	0	$ 16.18	$ (2.00)	$ 162	$ -	$ 162
Segment 2	10	800	8.00	2.00	790	0	$ 13.18	$ (2.00)	$ 10,412	$ -	$ 10,412
Segment 3	800	2500	9.00	2.00	1700	0	$ 12.18	$ (2.00)	$ 20,706	$ -	$ 20,706
Total for Generator E1					**2500**	**0**			**$ 31,280**	**$ -**	**$ 31,280**

LBMP ($/MW)	$ 21.18
Energy Schedule (MW)	2500
Reserve Shadow Price ($/MW)	$ 0.09
Reserve Schedule (MW)	0

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	10	10.00	3.00	10	0	$ 11.00	$ (3.00)	$ 110	$ -	$ 110
Segment 2	10	750	15.00	3.00	740	0	$ 6.00	$ (3.00)	$ 4,440	$ -	$ 4,440
Segment 3	750	2500	21.00	3.00	1158	0	$ -	$ (3.00)	$ -	$ -	$ -
Total for Generator E2					**1908**	**0**			**$ 4,550**	**$ -**	**$ 4,550**

LBMP ($/MW)	$ 21.00
Energy Schedule (MW)	1908
Reserve Shadow Price ($/MW)	$ (0.09)
Reserve Schedule (MW)	0

New York ISO

Generator Profits: Example 2 from 9/14

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	10	10.00	0.50	10	0	$ 12.00	$ 0.38	$ 120	$ -	$ 120
Segment 2	10	600	20.00	0.50	590	0	$ 2.00	$ 0.38	$ 1,180	$ -	$ 1,180
Segment 3	600	1000	22.00	0.50	113	100	$ -	$ 0.38	$ -	$ 38	$ 38
Total for Generator A					**713**	**100**			**$ 1,300**	**$ 38**	**$ 1,338**

LBMP ($/MW)	$ 22.00
Energy Schedule (MW)	713
Reserve Shadow Price ($/MW)	$ 0.88
Reserve Schedule (MW)	100

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	5	15.00	0.60	5	0	$ 7.63	$ 0.90	$ 38	$ -	$ 38
Segment 2	5	500	20.00	0.60	495	0	$ 2.63	$ 0.90	$ 1,302	$ -	$ 1,302
Segment 3	500	700	23.00	0.60	0	100	$ (0.37)	$ 0.90	$ -	$ 90	$ 90
Total for Generator B					**500**	**100**			**$ 1,340**	**$ 90**	**$ 1,430**

LBMP ($/MW)	$ 22.63
Energy Schedule (MW)	500
Reserve Shadow Price ($/MW)	$ 1.50
Reserve Schedule (MW)	100

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	10	20.00	0.70	10	0	$ 3.38	$ 1.55	$ 34	$ -	$ 34
Segment 2	10	200	24.00	0.70	0	100	$ (0.62)	$ 1.55	$ -	$ 155	$ 155
Segment 3	200	300	25.00	0.70	0	0	$ (1.62)	$ 1.55	$ -	$ -	$ -
Total for Generator C					**10**	**100**			**$ 34**	**$ 155**	**$ 189**

LBMP ($/MW)	$ 23.38
Energy Schedule (MW)	10
Reserve Shadow Price ($/MW)	$ 2.25
Reserve Schedule (MW)	100

New York ISO

Generator Profits: Example 2 from 9/14 (continued)

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	10	5.00	0.01	10	0	$ 16.25	$ 0.12	$ 163	$ -	$ 163
Segment 2	10	800	8.00	0.01	790	0	$ 13.25	$ 0.12	$ 10,468	$ -	$ 10,468
Segment 3	800	2500	9.00	0.01	1700	0	$ 12.25	$ 0.12	$ 20,825	$ -	$ 20,825
Total for Generator E1					**2500**	**0**			**$ 31,455**	**$ -**	**$ 31,455**

LBMP ($/MW)	$ 21.25
Energy Schedule (MW)	2500
Reserve Shadow Price ($/MW)	$ 0.13
Reserve Schedule (MW)	0

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	10	10.00	0.02	10	0	$ 11.00	$ (0.11)	$ 110	$ -	$ 110
Segment 2	10	750	15.00	0.02	740	0	$ 6.00	$ (0.11)	$ 4,440	$ -	$ 4,440
Segment 3	750	2500	21.00	0.02	1527	0	$ -	$ (0.11)	$ -	$ -	$ -
Total for Generator E2					**2277**	**0**			**$ 4,550**	**$ -**	**$ 4,550**

LBMP ($/MW)	$ 21.00
Energy Schedule (MW)	2277
Reserve Shadow Price ($/MW)	$ (0.09)
Reserve Schedule (MW)	0

New York ISO

Generator Profits: Example 1 from 9/18

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	10	10.00	8.00	10	0	$ 14.00	$ 2.00	$ 140	$ -	$ 140
Segment 2	10	600	20.00	8.00	590	0	$ 4.00	$ 2.00	$ 2,360	$ -	$ 2,360
Segment 3	600	1000	22.00	8.00	300	100	$ 2.00	$ 2.00	$ 600	$ 200	$ 800
Total for Generator A					**900**	**100**			**$ 3,100**	**$ 200**	**$ 3,300**

LBMP ($/MW)	$ 24.00
Energy Schedule (MW)	900
Reserve Shadow Price ($/MW)	$ 10.00
Reserve Schedule	100

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	5	15.00	9.00	5	0	$ 9.00	$ 1.00	$ 45	$ -	$ 45
Segment 2	5	500	20.00	9.00	495	0	$ 4.00	$ 1.00	$ 1,980	$ -	$ 1,980
Segment 3	500	1000	23.00	9.00	400	100	$ 1.00	$ 1.00	$ 400	$ 100	$ 500
Total for Generator B					**900**	**100**			**$ 2,425**	**$ 100**	**$ 2,525**

LBMP ($/MW)	$ 24.00
Energy Schedule (MW)	900
Reserve Shadow Price ($/MW)	$ 10.00
Reserve Schedule (MW)	100

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	10	20.00	3.00	10	0	$ 4.00	$ 7.00	$ 40	$ -	$ 40
Segment 2	10	200	24.00	3.00	90	100	$ -	$ 7.00	$ -	$ 700	$ 700
Segment 3	200	300	25.00	3.00	0	0	$ (1.00)	$ 7.00	$ -	$ -	$ -
Total for Generator C					**100**	**100**			**$ 40**	**$ 700**	**$ 740**

LBMP ($/MW)	$ 24.00
Energy Schedule (MW)	100
Reserve Shadow Price ($/MW)	$ 10.00
Reserve Schedule	100

New York ISO

Generator Profits: Example 1 from 9/18 (continued)

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	10	10.00	8.00	10	0	$ 14.00	$ 2.00	$ 140	$ -	$ 140
Segment 2	10	300	20.00	8.00	290	0	$ 4.00	$ 2.00	$ 1,160	$ -	$ 1,160
Segment 3	300	400	22.00	8.00	0	100	$ 2.00	$ 2.00	$ -	$ 200	$ 200
Total for Generator IL1					**300**	**100**			**$ 1,300**	**$ 200**	**$ 1,500**

LBMP ($/MW)	$ 24.00
Energy Schedule (MW)	300
Reserve Shadow Price ($/MW)	$ 10.00
Reserve Schedule	100

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	5	15.00	9.00	5	0	$ 9.00	$ 1.00	$ 45	$ -	$ 45
Segment 2	5	300	20.00	9.00	295	0	$ 4.00	$ 1.00	$ 1,180	$ -	$ 1,180
Segment 3	300	400	23.00	9.00	0	100	$ 1.00	$ 1.00	$ -	$ 100	$ 100
Total for Generator IL2					**300**	**100**			**$ 1,225**	**$ 100**	**$ 1,325**

LBMP ($/MW)	$ 24.00
Energy Schedule (MW)	300
Reserve Shadow Price ($/MW)	$ 10.00
Reserve Schedule	100

New York ISO

Generator Profits: Example 1 from 9/18 (continued)

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	10	5.00	2.00	10	0	$ 19.00	$ 8.00	$ 190	$ -	$ 190
Segment 2	10	800	8.00	2.00	790	0	$ 16.00	$ 8.00	$ 12,640	$ -	$ 12,640
Segment 3	800	2500	9.00	2.00	1700	0	$ 15.00	$ 8.00	$ 25,500	$ -	$ 25,500
Total for Generator E1					**2500**	**0**			**$ 38,330**	**$ -**	**$ 38,330**

LBMP ($/MW)	$ 24.00
Energy Schedule (MW)	2500
Reserve Shadow Price ($/MW)	$ 10.00
Reserve Schedule	0

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	10	10.00	3.00	10	0	$ 14.00	$ 7.00	$ 140	$ -	$ 140
Segment 2	10	750	15.00	3.00	740	0	$ 9.00	$ 7.00	$ 6,660	$ -	$ 6,660
Segment 3	750	2500	21.00	3.00	1250	500	$ 3.00	$ 7.00	$ 3,750	$ 3,500	$ 7,250
Total for Generator E2					**2000**	**500**			**$ 10,550**	**$ 3,500**	**$ 14,050**

LBMP ($/MW)	$ 24.00
Energy Schedule (MW)	2000
Reserve Shadow Price ($/MW)	$ 10.00
Reserve Schedule	500

New York ISO

Generator Profits: Example 2 from 9/18

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	10	10.00	8.00	10	0	$ 13.00	$ 5.00	$ 130	$ -	$ 130
Segment 2	10	600	20.00	8.00	590	0	$ 3.00	$ 5.00	$ 1,770	$ -	$ 1,770
Segment 3	600	1000	22.00	8.00	300	100	$ 1.00	$ 5.00	$ 300	$ 500	$ 800
Total for Generator A					**900**	**100**			**$ 2,200**	**$ 500**	**$ 2,700**

LBMP ($/MW)	$ 23.00
Energy Schedule (MW)	900
Reserve Shadow Price ($/MW)	$ 13.00
Reserve Schedule	100

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	5	15.00	9.00	5	0	$ 8.00	$ 4.00	$ 40	$ -	$ 40
Segment 2	5	500	20.00	9.00	495	0	$ 3.00	$ 4.00	$ 1,485	$ -	$ 1,485
Segment 3	500	1000	23.00	9.00	290	100	$ -	$ 4.00	$ -	$ 400	$ 400
Total for Generator B					**790**	**100**			**$ 1,525**	**$ 400**	**$ 1,925**

LBMP ($/MW)	$ 23.00
Energy Schedule (MW)	790
Reserve Shadow Price ($/MW)	$ 13.00
Reserve Schedule (MW)	100

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	10	20.00	3.00	10	0	$ 3.00	$ 10.00	$ 30	$ -	$ 30
Segment 2	10	200	24.00	3.00	0	100	$ (1.00)	$ 10.00	$ -	$ 1,000	$ 1,000
Segment 3	200	300	25.00	3.00	0	0	$ (2.00)	$ 10.00	$ -	$ -	$ -
Total for Generator C					**10**	**100**			**$ 30**	**$ 1,000**	**$ 1,030**

LBMP ($/MW)	$ 23.00
Energy Schedule (MW)	10
Reserve Shadow Price ($/MW)	$ 13.00
Reserve Schedule	100

Generator Profits: Example 2 from 9/18 (continued)

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	10	10.00	8.00	10	0	$ 8.00	$ -	$ 80	$ -	$ 80
Segment 2	10	300	15.00	8.00	290	0	$ 3.00	$ -	$ 870	$ -	$ 870
Segment 3	300	1000	18.00	8.00	100	200	$ -	$ -	$ -	$ -	$ -
Total for Generator IL1					**400**	**200**			**$ 950**	**$ -**	**$ 950**

LBMP ($/MW)	$ 18.00
Energy Schedule (MW)	400
Reserve Shadow Price ($/MW)	$ 8.00
Reserve Schedule	200

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	5	15.00	9.00	5	0	$ 4.00	$ -	$ 20	$ -	$ 20
Segment 2	5	300	16.00	9.00	295	0	$ 3.00	$ -	$ 885	$ -	$ 885
Segment 3	300	1000	19.00	9.00	100	200	$ -	$ -	$ -	$ -	$ -
Total for Generator IL2					**400**	**200**			**$ 905**	**$ -**	**$ 905**

LBMP ($/MW)	$ 19.00
Energy Schedule (MW)	400
Reserve Shadow Price ($/MW)	$ 9.00
Reserve Schedule	200

Generator Profits: Example 2 from 9/18 (continued)

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	10	5.00	2.00	10	0	$ 18.00	$ 11.00	$ 180	$ -	$ 180
Segment 2	10	800	8.00	2.00	790	0	$ 15.00	$ 11.00	$ 11,850	$ -	$ 11,850
Segment 3	800	2500	9.00	2.00	1700	0	$ 14.00	$ 11.00	$ 23,800	$ -	$ 23,800
Total for Generator E1					**2500**	**0**			**$ 35,830**	**$ -**	**$ 35,830**

LBMP ($/MW)	$ 23.00
Energy Schedule (MW)	2500
Reserve Shadow Price ($/MW)	$ 13.00
Reserve Schedule	0

	Minimum Output (MW)	Maximum Output (MW)	Energy Offer Price ($/MWh)	Reserves Offer Price ($/MWh)	Energy Schedule (MW)	Reserves Schedule (MW)	Energy Profit ($/MWh)	Reserves Profit ($/MWh)	Energy Profit ($)	Reserves Profit ($)	Total Profit ($)
Segment 1	0	10	10.00	3.00	10	0	$ 13.00	$ 10.00	$ 130	$ -	$ 130
Segment 2	10	750	15.00	3.00	740	0	$ 8.00	$ 10.00	$ 5,920	$ -	$ 5,920
Segment 3	750	2500	21.00	3.00	1250	500	$ 2.00	$ 10.00	$ 2,500	$ 5,000	$ 7,500
Total for Generator E2					**2000**	**500**			**$ 8,550**	**$ 5,000**	**$ 13,550**

LBMP ($/MW)	$ 23.00
Energy Schedule (MW)	2000
Reserve Shadow Price ($/MW)	$ 13.00
Reserve Schedule	500

New York ISO