Additional Pricing Rules

Mathangi Srinivasan Kumar
Program Lead, Market Training, NYISO

Gina Elizabeth Craan
Manager, Market Training, NYISO

LBMP In Depth Course

April 29 – May 1, 2025
Rensselaer, NY

Session Topics

- Proxy Generator Bus Pricing
- Market Based Ancillary Services Pricing
  - Regulation Capacity
  - Regulation Movement
  - Operating Reserves
  - Shortage Pricing
- Scarcity Pricing

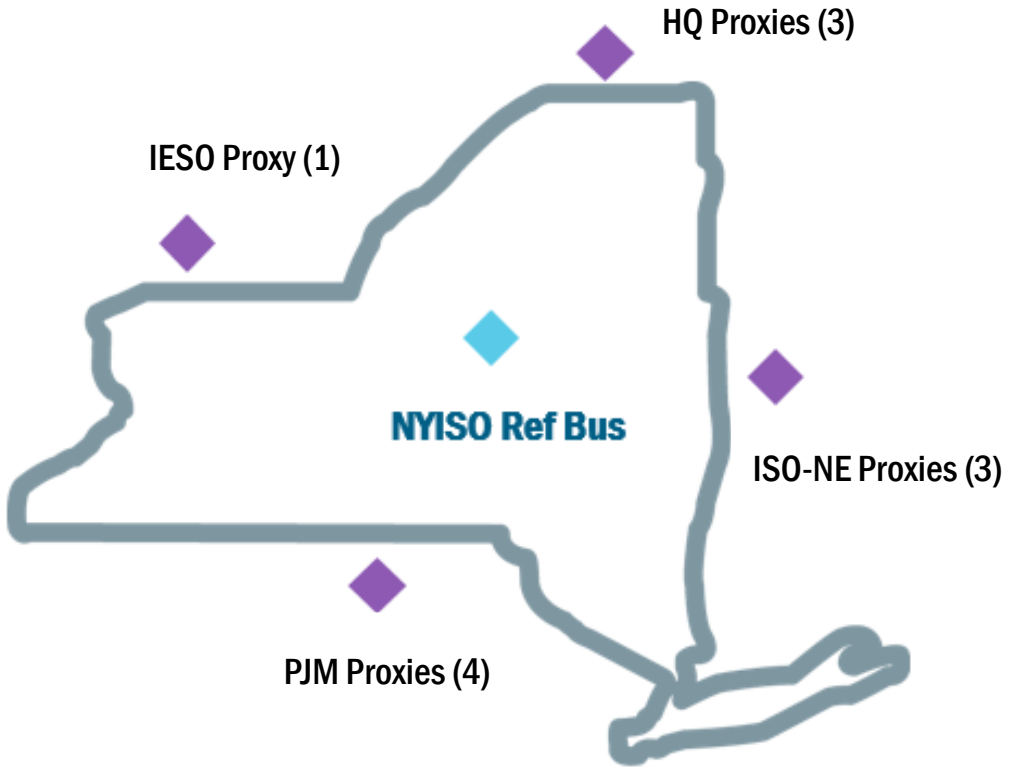
Session Objectives

- Upon completion of this module, trainees will be able to:
  - Understand the types of proxy generator bus pricing rules
  - Distinguish the differences between pricing rules for the following Ancillary Services
    - Regulation and Frequency Response Service
    - Operating Reserve Service
    - Shortage Pricing
  - Identify conditions in which scarcity pricing mechanism is employed by the NYISO

Proxy Generator Bus Pricing

Proxy Generator Bus Pricing

- External Proxy Generator Bus
  - Located outside of the NYCA
  - Selected by the ISO to represent a generator in an adjacent Control Area
  - LBMP prices for external proxy generator buses are calculated with reference to the NY reference bus
  - NYISO designated for PJM, HQ, IESO, and ISO-NE



Proxy Generator Bus Pricing

- Imports and Exports

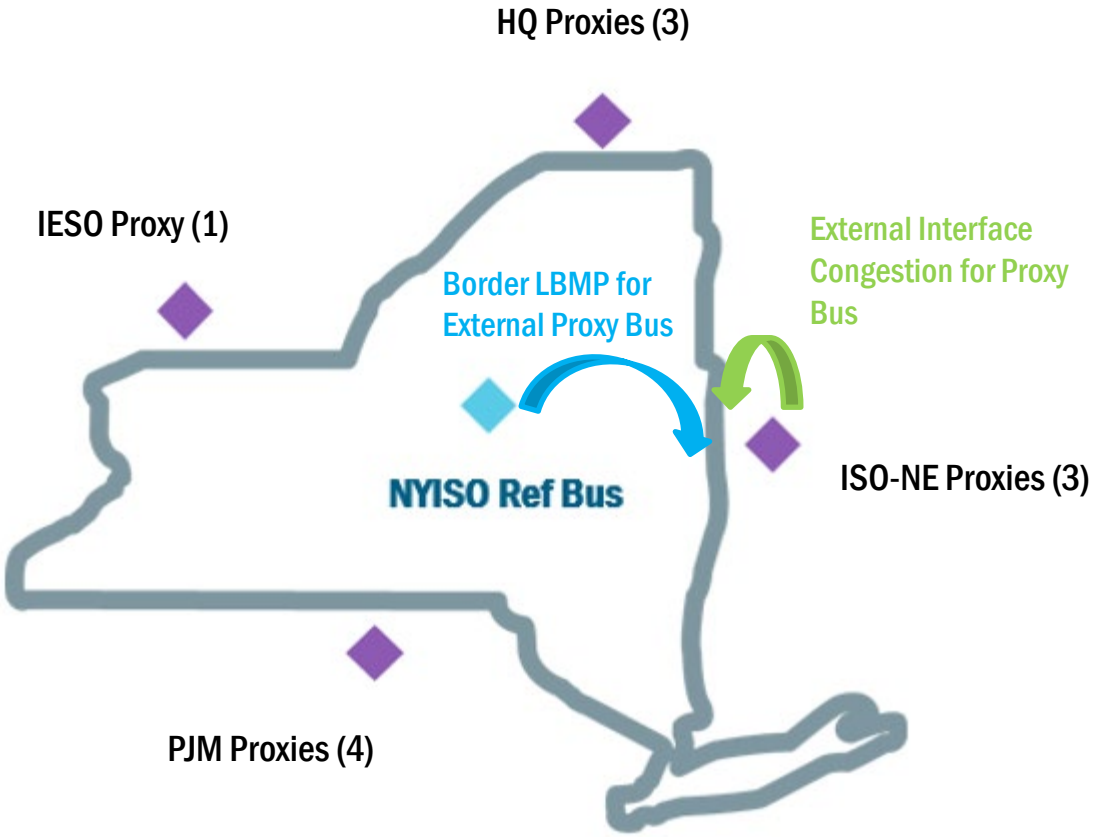
Control Area - Interface	Source Proxy Bus	Sink Proxy Bus
Hydro Quebec – Chateauguay Import/Export	HQ_GEN_IMPORT	HQ_LOAD_EXPORT
Hydro Quebec – Chateauguay Wheels-Through	HQ_GEN_WHEEL	HQ_LOAD_WHEEL
HQ – Dennison	HQ_GEN_CEDARS_PROXY	HQ_LOAD_CEDARS_PROXY
ISO New England – Sandy Pond	N.E._GEN_SANDY POND	N.E._LOAD_SANDY POND
ISO New England Northport- Norwalk Scheduled Line	NPX_GEN_1385_PROXY	NPX_LOAD_1385_PROXY
ISO New England Cross-Sound Scheduled Line	NPX_GEN_CSC	NPX_LOAD_CSC
Ontario Independent Market Operator	OH_GEN_PROXY	OH_LOAD_PROXY
PJM Interconnection	PJM_GEN_KEYSTONE	PJM_LOAD_KEYSTONE
PJM Neptune Scheduled Line	PJM_GEN_NEPTUNE_PROXY	PJM_LOAD_NEPTUNE_PROXY
PJM Linden VFT Scheduled Line	PJM_GEN_VFT_PROXY	PJM_LOAD_VFT_PROXY
PJM HTP Scheduled Line	PJM_HTP_GEN	HUDSONTP_345KV_HTP_LOAD

From MST Section 4.4.4

External Proxy Generator Bus Pricing

LBMP
=
Energy
+
Loss
-
Congestion

- Internal Congestion
- External Interface Congestion



Border LBMP = Energy +Loss - Internal Congestion

Proxy Generator Bus Pricing

- **Factors associated with External Interface Congestion:**
  - Interface ATC Constraints: Exists when proposed economic transactions over an Interface between the NYCA and the Control Area with which one or more Proxy Generator Bus(es) are associated would exceed the transfer capability for the Interface or for an associated Proxy Generator Bus
  - Interface Ramp Constraint: Exists when proposed interchange schedule changes pertaining to an Interface between the NYCA and the Control Area with which one or more Proxy Generator Bus(es) are associated would exceed any Ramp Capacity limit imposed by the ISO for the Interface or an associated Proxy Generator Bus
  - NYCA Ramp Constraint: Exists when proposed interchange schedule changes pertaining to the NYCA would exceed any Ramp Capacity limits in place for the NYCA

MST Section 17.1.6.1

Types of Proxy Generator Bus Pricing Rules

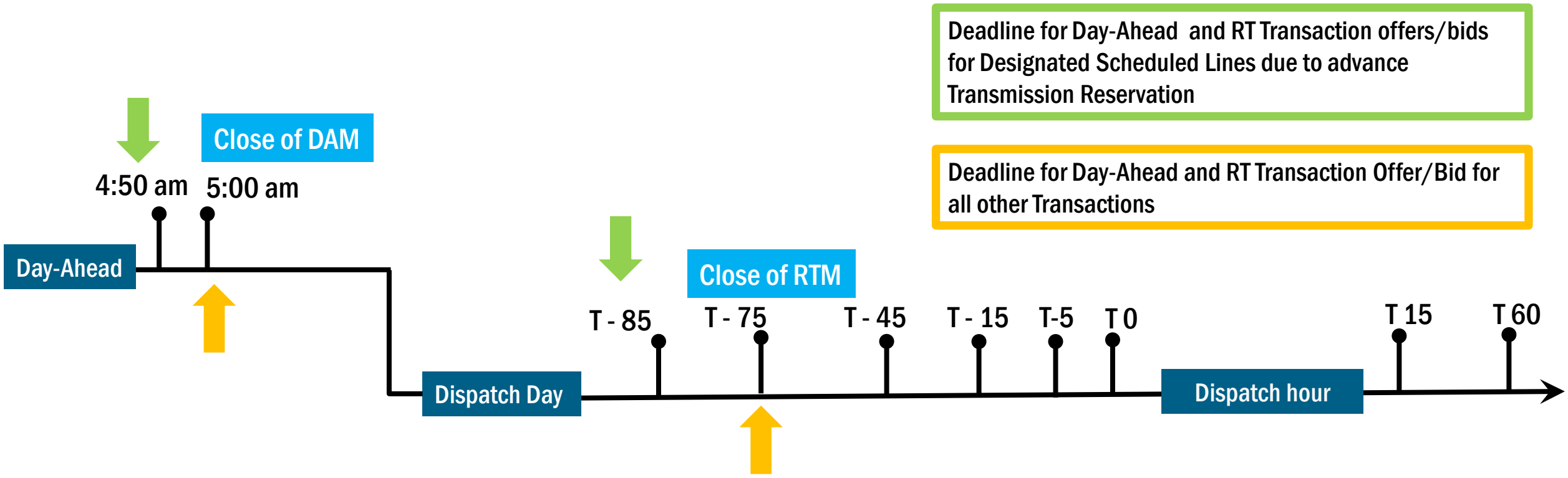
External Transactions					
Competitive		Non- Competitive		Designated Scheduled Lines	
Variably Scheduled	Non-Variably Scheduled	Variably Scheduled	Non-Variably Scheduled	Variably Scheduled	Non-Variably Scheduled
(Every 15 minutes)	(Hourly)	(Every 15 minutes)	(Hourly)	(Every 15 minutes)	(Hourly)

Non-Competitive and Designated Scheduled Lines have similar pricing rules

Types of Proxy Generator Bus Pricing Rules

Control Area - Interface	Competitive/Non-competitive/Designated Scheduled Lines	Variably /Hourly Scheduled
Hydro Quebec – Chateauguay Import/Export	Non-Competitive	Variably Scheduled (hourly and 15 min)
Hydro Quebec – Chateauguay Wheels-Through	Non-Competitive	Hourly Scheduled
HQ – Dennison	Designated Scheduled Line	Hourly Scheduled
ISO New England – Sandy Pond	Competitive	Variable Scheduled (only Wheels can be scheduled hourly)
ISO New England Northport- Norwalk Scheduled Line	Competitive	Hourly Scheduled
ISO New England Cross-Sound Scheduled Line	Designated Scheduled Line	Hourly Scheduled
Ontario Independent Market Operator	Competitive	Hourly Scheduled
PJM Interconnection - Keystone	Competitive	Variably Scheduled (Only Wheels scheduled hourly)
PJM Neptune Scheduled Line	Designated Scheduled Line	Variably Scheduled (Only Wheels scheduled hourly)
PJM Linden VFT Scheduled Line	Designated Scheduled Line	Variably Scheduled (Only Wheels scheduled hourly)
PJM HTP Scheduled Line	Designated Scheduled Line	Variably Scheduled (Only Wheels scheduled hourly)

DAM and RTM Timelines for Transactions Associated with Designated Scheduled lines



Real-Time Proxy Generator Bus Pricing Rules

- Competitive Proxy Buses:
  - RTC calculates the External Interface Congestion component of Real-Time LBMP for all External Transactions if constraints at the interface associated with that External Transaction are binding
  - In addition, RTC will calculate the External Interface Congestion component of the Real Time LBMPs at Proxy Generator Buses for any hour in which one of the three exists:
    1. Interface ATC Constraints
    2. Interface Ramp Constraints
    3. NYCA Ramp Constraints

Real-Time Proxy Generator Bus Pricing Rules

- Non-Competitive Proxy Buses and Proxies with Designated Scheduled Lines:
  - RTC will also calculate the External Interface Congestion component of the Real-Time LBMPs at certain times at these buses
  - Any External Interface Congestion calculated by RTC will be added to the Marginal Cost of Internal Congestion calculated by RTD to determine the total Marginal Cost of Congestion that will be reflected in the RTD LBMP at these Proxy Generator Buses

Please refer to Appendix for additional detail

Proxy Generator Bus Pricing Rules

Competitive, Variably Scheduled

Proxy Generator Bus Constraint affecting External Schedules at location a	Direction of Proxy Generator Bus Constraint	Real-Time Pricing Rule (for location *a*)
Unconstrained in RTC_{15}, Rolling RTC and RTD	N/A	Real-Time LBMP = RTD LBMP
The Rolling RTC used to schedule External Transactions in a given 15-minute interval is subject to a Proxy Generator Bus Constraint	Into NYCA or out of NYCA (Import or Export)	Real-Time LBMP = RTD LBMP + Rolling RTC External Interface Congestion

Competitive, Hourly Scheduled

Proxy Generator Bus Constraint affecting External Schedules at location a	Direction of Proxy Generator Bus Constraint	Real-Time Pricing Rule (for location *a*)
Unconstrained in RTC_{15}, Rolling RTC and RTD	N/A	Real-Time LBMP = RTD LBMP
RTC_{15} is subject to a Proxy Generator Bus Constraint	Into NYCA or out of NYCA (Import or Export)	Real-Time LBMP = RTD LBMP+ RTC_{15} External Interface Congestion

Example: Proxy Bus Pricing Rules, Competitive Bus

Proxy Bus: ISO NE Sandy Pond Interface (Competitive Proxy Gen Bus)
ATC constraint for the Proxy bus is binding for Rolling RTC 16:15 to 16:30

Rolling RTC 16:15 to 16:30 LBMP = $45.45		
RTD 16:15-16:20 LBMP = $35.57	RTD 16:20 -16:25 LBMP = $37.11	RTD 16:25-16:30 LBMP = $35.05

External Interface Congestion associated with Interface ATC constraint for RTC = $8.39

Example: Proxy Bus Pricing Rules, Competitive Bus

Proxy Bus: ISO NE Sandy Pond Interface (Competitive Proxy Gen Bus)
ATC constraint for the Proxy bus is binding for Rolling RTC 18:15 to 18:30

Rolling RTC 16:15 to 16:30 LBMP = $45.45		
RTD 16:15-16:20 LBMP = $35.57	RTD 16:20 -16:25 LBMP = $37.11	RTD 16:25-16:30 LBMP = $35.05

External Interface Congestion associated with Interface ATC constraint for RTC = $8.39

RTD Proxy Bus LBMP	
16:15 to 16:20	$35.57 + $8.39 = $43.96
16:20 to 16:25	$37.11 + $8.39 = $45.50
16:25 to 16:30	$35.04 + $8.39 = $43.43

Proxy Generator Bus Pricing Rules

Non-Competitive Proxy Buses and Designated Scheduled Lines, Scheduled every 15-minutes

Rule No.	Proxy Generator Bus Constraint affecting External Schedules at location *a*	Direction of Proxy Generator Bus Constraint	Real-Time Pricing Rule (for location *a*)
1	Unconstrained in RTC_{15}, Rolling RTC and RTD	N/A	Real-Time $LBMP_a$ = RTD $LBMP_a$
4	The Rolling RTC used to schedule External Transactions for a given 15-minute interval is subject to an Interface ATC or Interface Ramp Constraint	Into NYCA (Import)	If Rolling RTC Proxy Generator Bus $LBMP_a > 0$, then Real-Time $LBMP_a$ = RTD $LBMP_a$ + Rolling RTC External Interface $Congestion_a$ Otherwise, Real-Time $LBMP_a$ = Minimum of (i)RTD $LBMP_a$ and (ii) zero
5	The Rolling RTC used to schedule External Transaction for a given 15-minute interval is subject to an Interface ATC or Interface Ramp Constraint	Out of NYCA (Export)	If Rolling RTC Proxy Generator Bus $LBMP_a < 0$, then Real-Time $LBMP_a$ = RTD $LBMP_a$ + Rolling RTC External Interface $Congestion_a$ Otherwise, Real-Time $LBMP_a$ = RTD $LBMP_a$

Appendix: Proxy Generator Bus Pricing Rules

MST Section 17.1.6.2

Proxy Generator Bus Pricing Rules

Competitive, Variably Scheduled

Rule No.	Proxy Generator Bus Constraint affecting External Schedules at location *a*	Direction of Proxy Generator Bus Constraint	Real-Time Pricing Rule (for location *a*)
1	Unconstrained in RTC_{15}, Rolling RTC and RTD	N/A	Real-Time $LBMP_a$ = RTD $LBMP_a$
2	The Rolling RTC used to schedule External Transactions in a given 15-minute interval is subject to a Proxy Generator Bus Constraint	Into NYCA or out of NYCA (Import or Export)	Real-Time $LBMP_a$ = RTD $LBMP_a$ + Rolling RTC External Interface $Congestion_a$

Competitive, Hourly Scheduled

Rule No.	Proxy Generator Bus Constraint affecting External Schedules at location *a*	Direction of Proxy Generator Bus Constraint	Real-Time Pricing Rule (for location *a*)
1	Unconstrained in RTC_{15}, Rolling RTC and RTD	N/A	Real-Time $LBMP_a$ = RTD $LBMP_a$
3	RTC_{15} is subject to a Proxy Generator Bus Constraint	Into NYCA or out of NYCA (Import or Export)	Real-Time $LBMP_a$ = RTD $LBMP_a$ + RTC_{15} External Interface $Congestion_a$

Proxy Generator Bus Pricing Rules

Non-Competitive Proxy Buses and Designated Scheduled Lines, Scheduled every 15-minutes

Rule No.	Proxy Generator Bus Constraint affecting External Schedules at location *a*	Direction of Proxy Generator Bus Constraint	Real-Time Pricing Rule (for location *a*)
1	Unconstrained in RTC_{15}, Rolling RTC and RTD	N/A	Real-Time $LBMP_a$ = RTD $LBMP_a$
4	The Rolling RTC used to schedule External Transactions for a given 15-minute interval is subject to an Interface ATC or Interface Ramp Constraint	Into NYCA (Import)	If Rolling RTC Proxy Generator Bus $LBMP_a > 0$, then Real-Time $LBMP_a$ = RTD $LBMP_a$ + Rolling RTC External Interface $Congestion_a$ Otherwise, Real-Time $LBMP_a$ = Minimum of (i)RTD $LBMP_a$ and (ii) zero
5	The Rolling RTC used to schedule External Transaction for a given 15-minute interval is subject to an Interface ATC or Interface Ramp Constraint	Out of NYCA (Export)	If Rolling RTC Proxy Generator Bus $LBMP_a < 0$, then Real-Time $LBMP_a$ = RTD $LBMP_a$ + Rolling RTC External Interface $Congestion_a$ Otherwise, Real-Time $LBMP_a$ = RTD $LBMP_a$

Proxy Generator Bus Pricing Rules

Non-Competitive and Designated Scheduled Lines, Scheduled hourly

Rule No.	Proxy Generator Bus Constraint affecting External Schedules at location *a*	Direction of Proxy Generator Bus Constraint	Real-Time Pricing Rule (for location *a*)
1	Unconstrained in RTC_{15}, Rolling RTC and RTD	N/A	Real-Time $LBMP_a$ = RTD $LBMP_a$
6	RTC_{15} is subject to an Interface ATC or Interface Ramp Constraint	Into NYCA (Import)	If RTC_{15} Proxy Generator Bus $LBMP_a > 0$, then Real-Time $LBMP_a$ = RTD $LBMP_a$ + RTC_{15} External Interface $Congestion_a$ Otherwise, Real-Time $LBMP_a$ = Minimum of (i)RTD $LBMP_a$ and (ii) zero
7	RTC_{15} is subject to an Interface ATC or Interface Ramp Constraint	Out of NYCA (Export)	If RTC_{15} Proxy Generator Bus $LBMP_a < 0$, then Real-Time $LBMP_a$ = RTD $LBMP_a$ + RTC_{15} External Interface $Congestion_a$ Otherwise, Real-Time $LBMP_a$ = RTD $LBMP_a$

Market Based Ancillary Services Pricing

Market Based Ancillary Services Pricing

- Pricing rules for the following Ancillary Services:
  - Regulation Service
    - Regulation Capacity
    - Regulation Movement
  - Operating Reserve Service
  - Shortage Pricing
    - Regulation and Frequency Response Service
    - Operating Reserve Service

Regulation Service

Regulation Service Pricing

- Three Regulation Clearing Prices are determined
  - The cost to provide the next available MW of regulation capacity
    - DAM Regulation Capacity Price
    - RT Regulation Capacity Price
  - The cost to provide regulation movement
    - RT Regulation Movement Price

Regulation Service Pricing

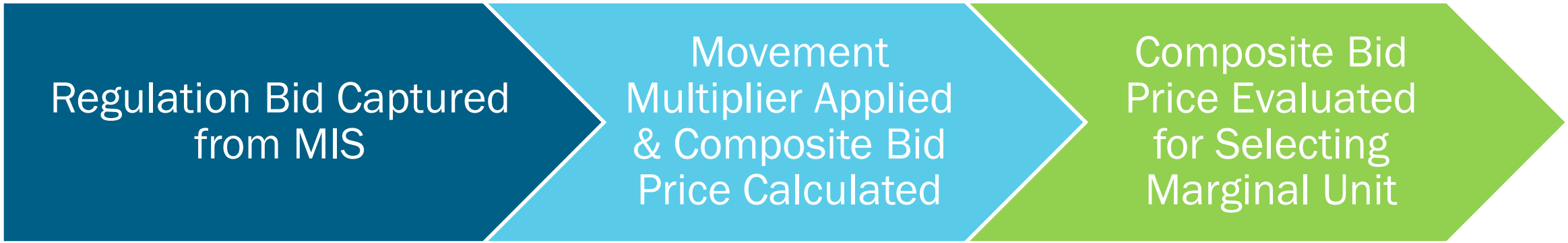
- Primary Steps in Process:
  - Establishing Composite Bid
  - Determining Marginal Regulation Unit
  - Calculating Regulation Capacity Clearing Price
  - Calculating Regulation Movement Clearing Price

Establishing Composite Bid

- Bids for Regulation Capacity and Regulation Movement are evaluated collectively
  - Known as Composite Bid Price
- Composite Bid Price
  - Represents cost associated with scheduling regulation availability *AND* represents cost associated with regulation units providing movement
  - Used in Solving to meet NYISO's Regulation Capacity Requirement
    - Determining Regulation schedules and subsequently Regulation Clearing Prices

Establishing Composite Bid

- Data used in calculation includes:
  - Regulation Capacity Bid
  - Regulation Movement Bid
  - Regulation Movement Multiplier (RMM)



Establishing Composite Bid

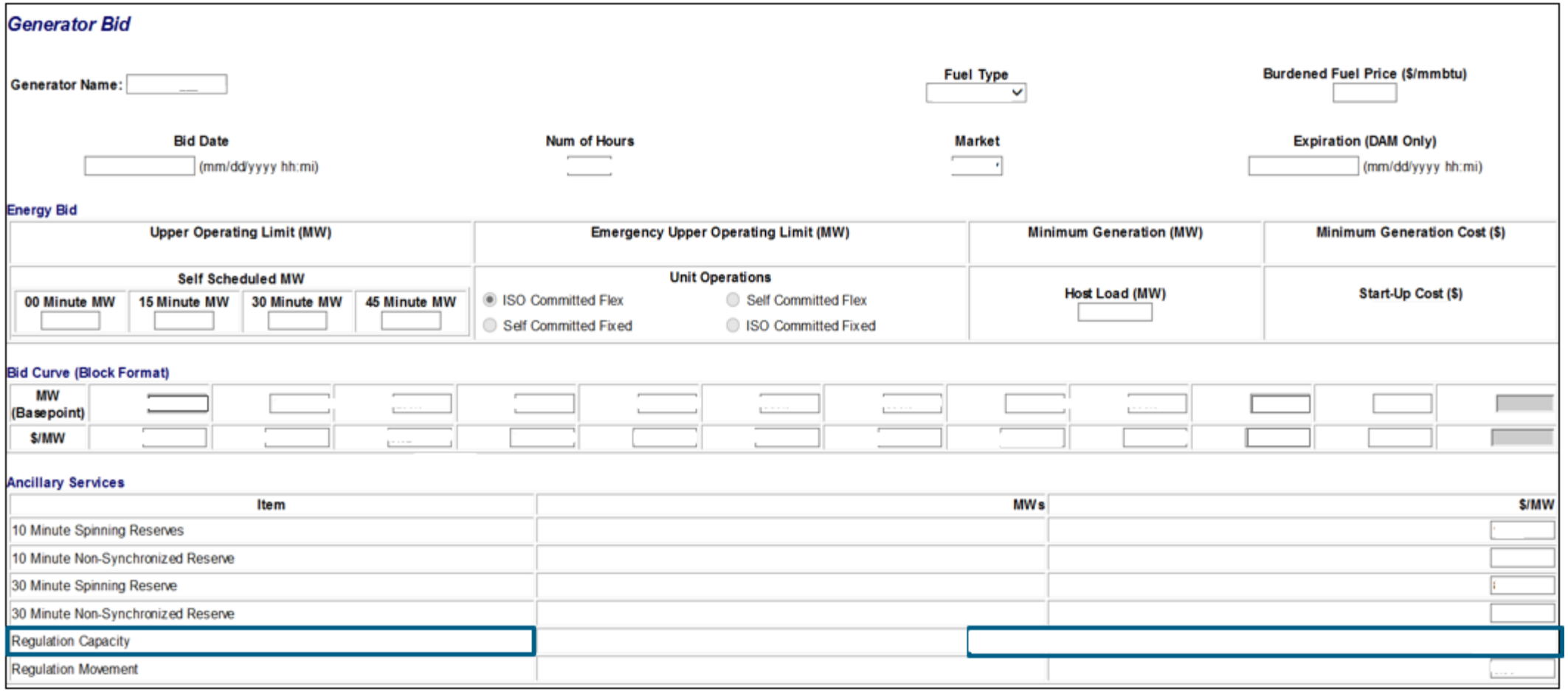
- Calculation of Composite Bid Price

Composite Bid Price = Regulation Capacity Bid Price + Weighted Movement Bid

(Regulation Movement Bid Price) x (RMM)

Establishing Composite Bid

- Regulation Capacity Bid



Generator Bid

Generator Name:

Fuel Type

Burdened Fuel Price ($/mmbtu)

Bid Date (mm/dd/yyyy hh:mi)

Num of Hours

Market

Expiration (DAM Only) (mm/dd/yyyy hh:mi)

Energy Bid

Upper Operating Limit (MW)				Emergency Upper Operating Limit (MW)	Minimum Generation (MW)	Minimum Generation Cost ($)
Self Scheduled MW				Unit Operations		
00 Minute MW	15 Minute MW	30 Minute MW	45 Minute MW	ISO Committed Flex / Self Committed Flex / Self Committed Fixed / ISO Committed Fixed	Host Load (MW)	Start-Up Cost ($)

Bid Curve (Block Format)

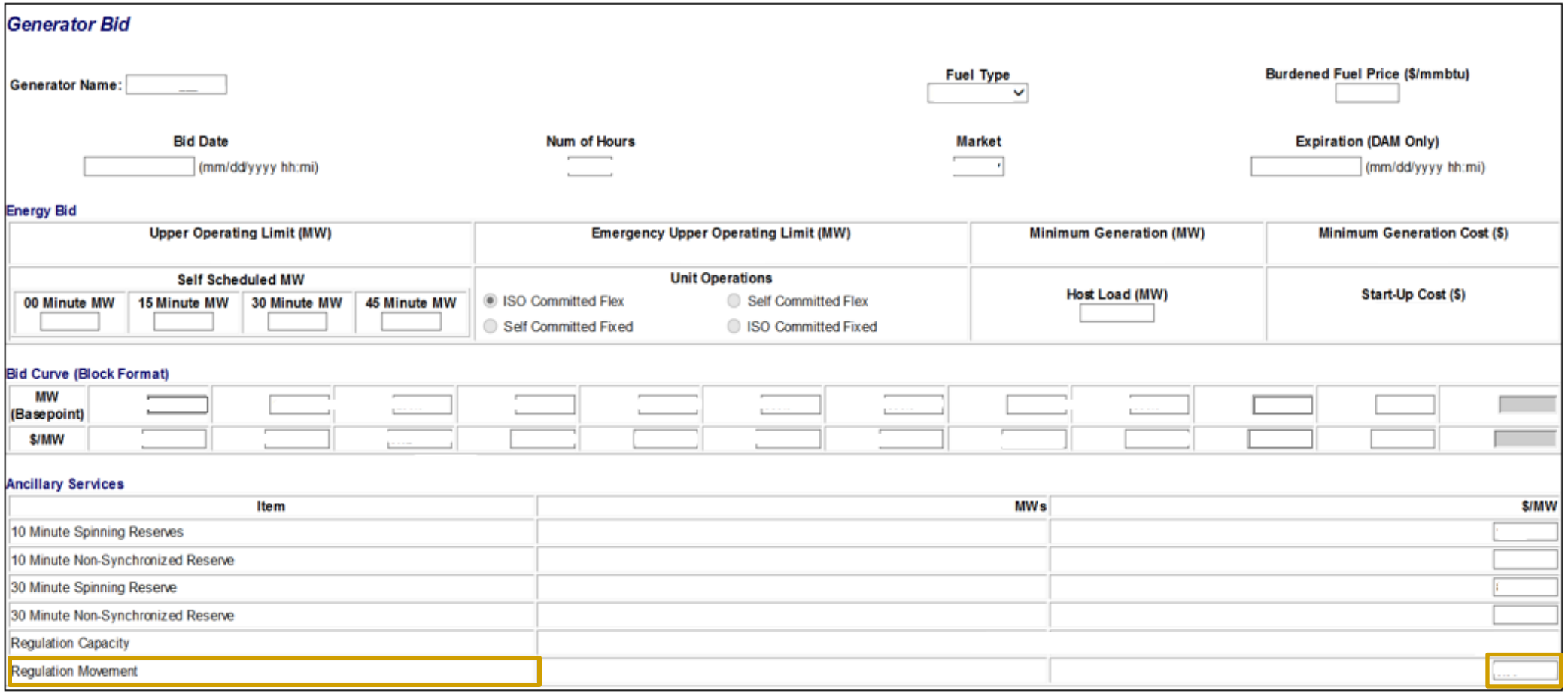
MW (Basepoint)													
$/MW													

Ancillary Services

Item	MWs	$/MW
10 Minute Spinning Reserves		
10 Minute Non-Synchronized Reserve		
30 Minute Spinning Reserve		
30 Minute Non-Synchronized Reserve		
Regulation Capacity		
Regulation Movement		

Establishing Composite Bid

- Regulation Movement Bid



Generator Bid

Generator Name:

Fuel Type

Burdened Fuel Price ($/mmbtu)

Bid Date (mm/dd/yyyy hh:mi)

Num of Hours

Market

Expiration (DAM Only) (mm/dd/yyyy hh:mi)

Energy Bid

Upper Operating Limit (MW)				Emergency Upper Operating Limit (MW)	Minimum Generation (MW)	Minimum Generation Cost ($)
Self Scheduled MW				Unit Operations		
00 Minute MW	15 Minute MW	30 Minute MW	45 Minute MW	ISO Committed Flex / Self Committed Flex / Self Committed Fixed / ISO Committed Fixed	Host Load (MW)	Start-Up Cost ($)

Bid Curve (Block Format)

MW (Basepoint)													
$/MW													

Ancillary Services

Item	MWs	$/MW
10 Minute Spinning Reserves		
10 Minute Non-Synchronized Reserve		
30 Minute Spinning Reserve		
30 Minute Non-Synchronized Reserve		
Regulation Capacity		
Regulation Movement		

Establishing Composite Bid

Regulation Movement Multiplier (RMM):

- Represents historical relationship between Regulation Capacity MW that NYISO sought to maintain in each hour & Regulation Movement MW instructed by AGC in each hour
- **Important step in regulation scheduling process**
- **Identified a Movement to Regulation Requirement Ratio**
  - **Found for every 1 MWh of Capacity Scheduled there are on average 8* MWs of Movement to Pay for**
  - **Based on Comprehensive Analysis of Historic Data**
  - **Considering Data Across…**
    - » Year
    - » Season
    - » Year & Month
    - » Peak vs. Off-Peak
    - » Day of Week
    - » Weekdays vs. Weekends
    - » Day & Hour
    - » Hour of Day

*RMM proposed to update to 13 as of May 1, 2025

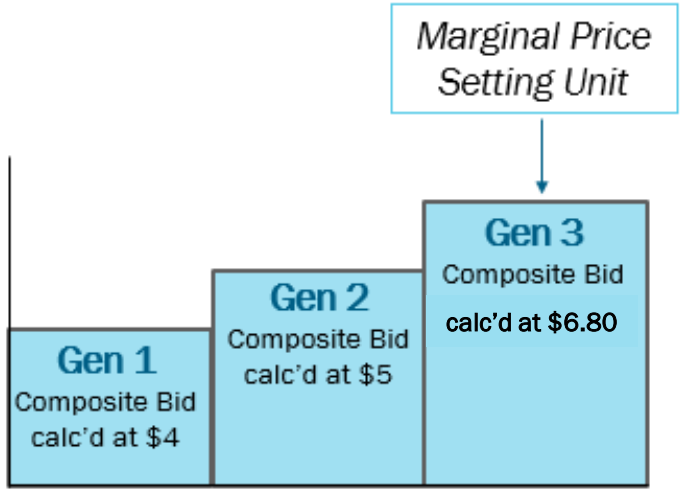
Establishing Composite Bid

- **Regulation Movement Multiplier (RMM):**
  - Set to a Static value
  - Re-evaluated periodically
    - NYISO will monitor to evaluate if adjustment warranted
  - Applied to Regulation Movement Bid for Scheduling purposes only

Weighted Movement Bid = (Regulation Movement Bid $) x (RMM)

Determining Marginal Regulation Unit

- **Composite Bid Example:**
  - Movement Bid $/MW = $0.10
  - Regulation Movement Multiplier (RMM) = 8
    - **$0.10 x 8 = $0.80 [Weighted Movement Bid]**
  - Regulation Capacity Bid $/MW = $6
  - Weighted Movement Bid = $0.80
  - Composite Bid Price is calculated as $6 + $0.80 = $6.80



- **Pool of resources offering Regulation Capacity are stacked**
  - Using Composite Bid
- **Last unit selected to meet next MW of Regulation Capacity becomes 'Marginal' unit**

6

Calculating Regulation Capacity Clearing Price

- Regulation Capacity Clearing Price
  - Once Marginal unit is established using Composite Bid the Regulation Capacity Clearing Price can be determined
  - Becomes Statewide Regulation Capacity Clearing Price
    - For applicable market

    And

    - For applicable period-of-time

Regulation Capacity Clearing Price = Reg. Clearing Price – Weighted Movement Bid of Marginal Unit

(Marginal Unit Composite Bid) + (LOC)

Calculating Regulation Capacity Clearing Price

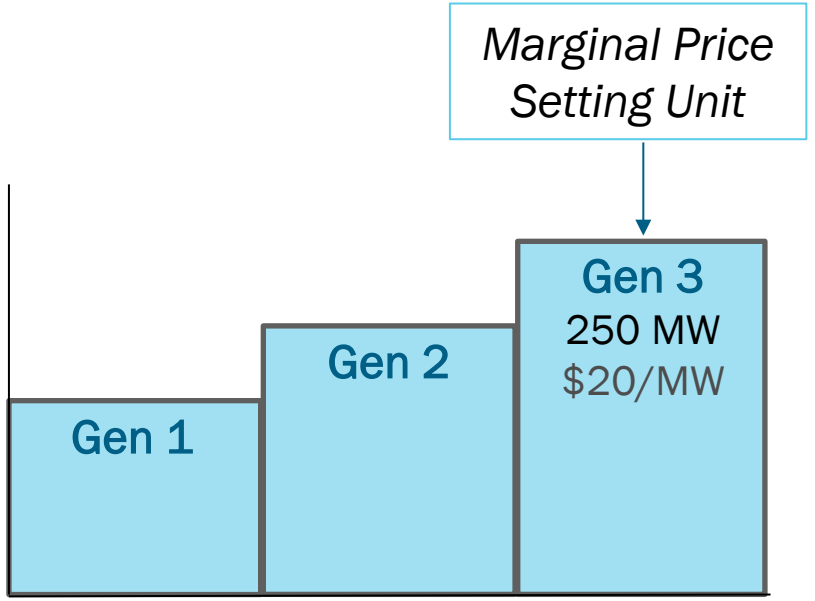
- **Lost Opportunity Cost (LOC)**
  - The margin on the sale of energy that the marginal unit foregoes to provide regulation
  - Secondary value in establishing Regulation Capacity Clearing Price

LOC = Energy LBMP – Regulation Marginal Unit Energy Offer

Calculating Regulation Capacity Clearing Price

- **Lost Opportunity Cost Example:**
  - Marginal Regulation Unit is Gen 3
    - Energy offer for unit is $20/MW
  - LBMP is $28/MW
  - Calculate LOC:
    - LOC = LBMP – Marginal Unit Energy Offer

      $28 - $20
    - LOC = $8



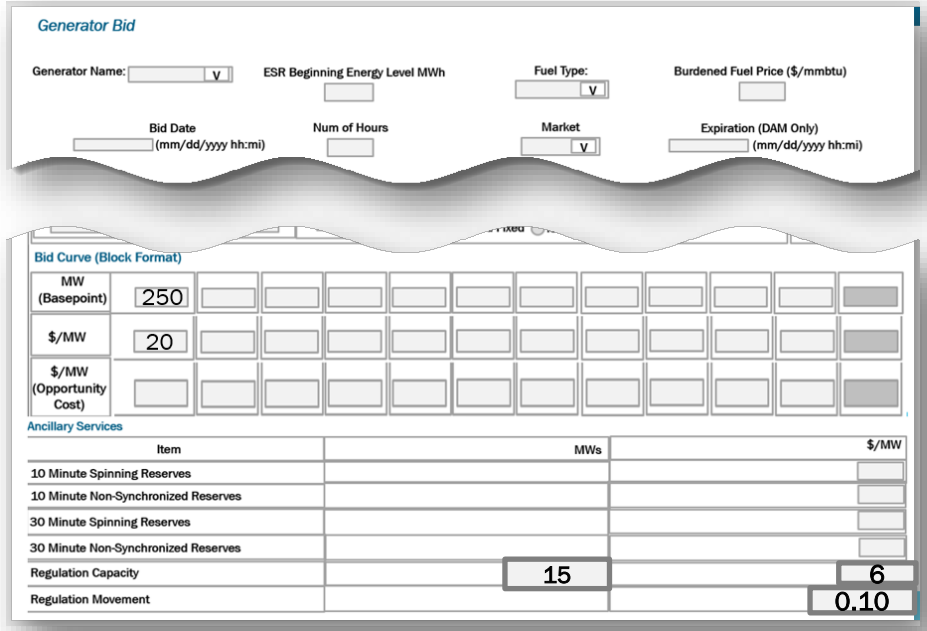
Calculating Regulation Capacity Clearing Price

- Regulation Capacity Clearing Price Example

Regulation Capacity Clearing Price = Reg. Clearing Price – Weighted Movement Bid of Marginal Unit

(Marginal Unit Composite Bid) + (LOC)

$14 = ($6.80 + $8) – $0.80



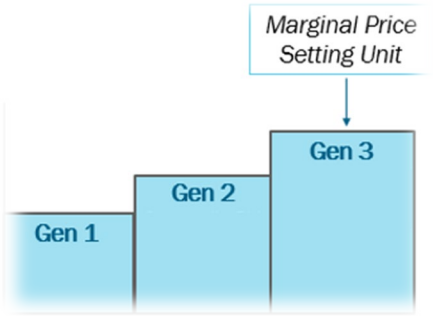
Legend:

Slide 25 - Marginal Unit Composite Bid = $6.80/MW Regulation Capacity
Slide 28 - Marginal Unit Energy Offer = $20/MW Energy
Slide 28 - LBMP Calculated = $28/MW
Slide 25 - Marginal Unit Weighted Movement Bid = $0.80

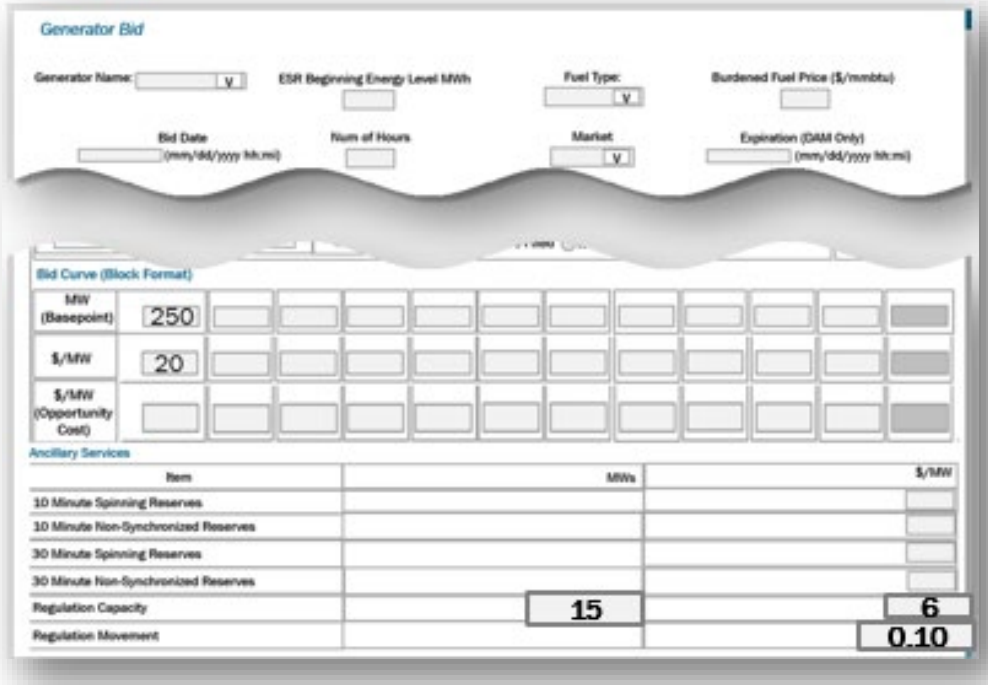
Calculating Regulation Movement Clearing Price

- Regulation Movement Clearing Price Example

Regulation Movement Clearing Price = Reg. Movement Bid of Marginal Regulation Unit



Regulation Movement Clearing Price = $0.10/MW



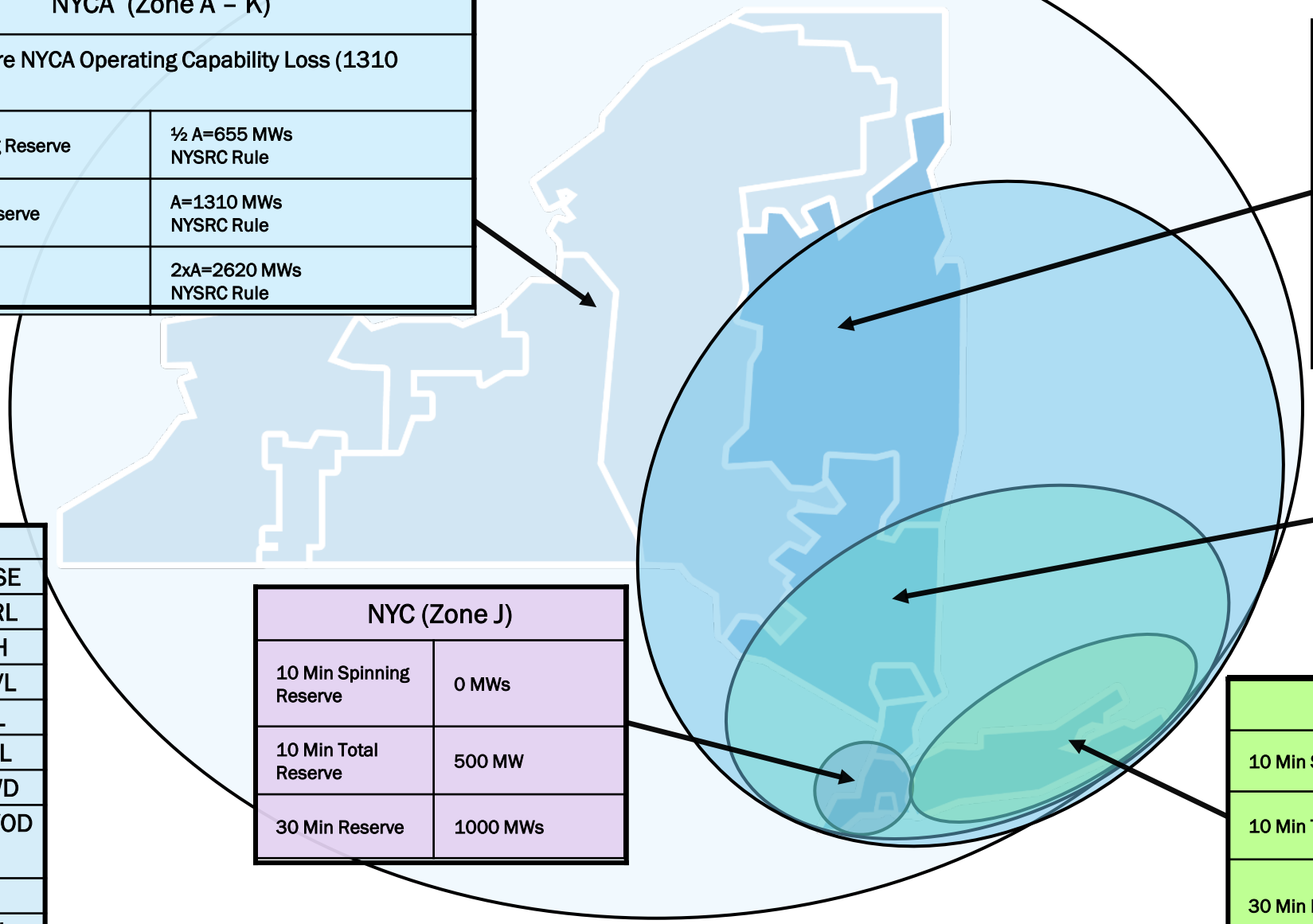
Legend:

Slide 25 - Marginal Unit Regulation Movement Bid = $0.10/MW Regulation Movement

Operating Reserve Service

NYCA Operating Reserves

NYCA (Zone A – K)	
A=most severe NYCA Operating Capability Loss (1310 MWs)	
10 Min Spinning Reserve	½ A=655 MWs NYSRC Rule
10 Min Total Reserve	A=1310 MWs NYSRC Rule
30 Min Reserve	2xA=2620 MWs NYSRC Rule



East (Zone F – K)	
A=most severe NYCA Operating Capability Loss (1310 MWs)	
10 Min Spinning Reserve	¼ A=330 MWs NERC, NPCC Rule
10 Min Total Reserve	1200 MWs NYSRC Rule
30 Min Reserve	1200 MWs NERC, NPCC Rule

SENY (Zone G – K)	
10 Min Spinning Reserve	0 MWs
10 Min Total Reserve	0 MWs
30 Min Reserve	1300 MWs NYSRC Rule

A	WEST
B	GENESE
C	CENTRL
D	NORTH
E	MHK VL
F	CAPITL
G	HUD VL
H	MILLWD
I	DUNWOD
J	N.Y.C.
K	LONGIL

NYC (Zone J)	
10 Min Spinning Reserve	0 MWs
10 Min Total Reserve	500 MW
30 Min Reserve	1000 MWs

Long Island (Zone K)	
10 Min Spinning Reserve	0 MWs
10 Min Total Reserve	120 MW NERC, NPCC Rule
30 Min Reserve	270 – 540 MWs Max limits NYSRC Rule

Operating Reserve Service Pricing

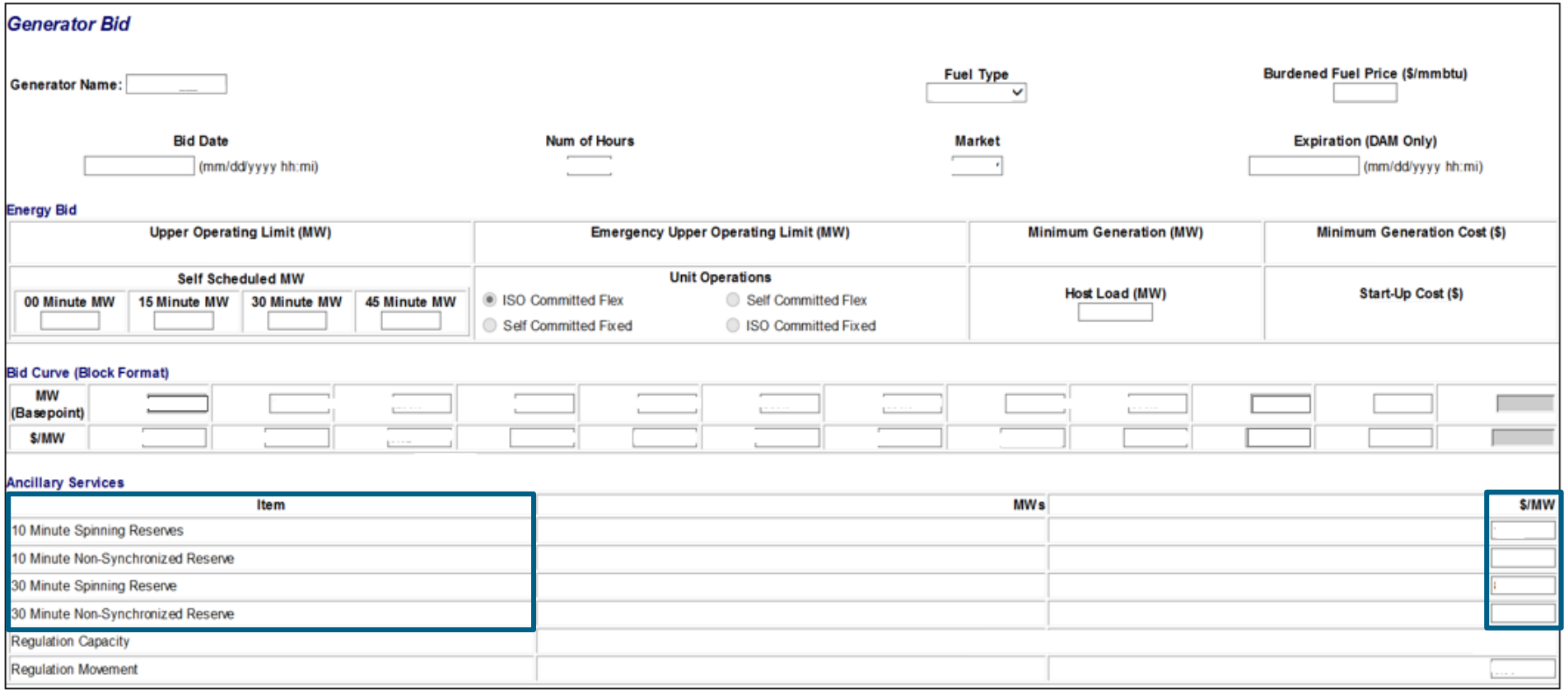
- Fifteen Operating Reserve Service Clearing Prices are determined
  - The actual cost to provide the next available MW of operating reserves
    - DAM Operating Reserves Market Price
    - RT Operating Reserves Market Price
  - Prices are determined for each product type and location

Operating Reserve Service Pricing

- Operating Reserve Market Clearing Price accounts for:
  - Operating Reserve Availability Bid $/MW
  - Operating Reserve Shadow Pricing
  - Lost Opportunity Cost (LOC)
  - Cascading Shadow Prices

Operating Reserve Service Pricing

- ## Operating Reserve Availability Bid
  - Bid that is provided by a unit offering operating reserves



Generator Bid

Generator Name: ___ Fuel Type Burdened Fuel Price ($/mmbtu)

Bid Date (mm/dd/yyyy hh:mi) Num of Hours Market Expiration (DAM Only) (mm/dd/yyyy hh:mi)

Energy Bid

Upper Operating Limit (MW)				Emergency Upper Operating Limit (MW)	Minimum Generation (MW)	Minimum Generation Cost ($)
Self Scheduled MW				Unit Operations		
00 Minute MW	15 Minute MW	30 Minute MW	45 Minute MW	ISO Committed Flex / Self Committed Flex / Self Committed Fixed / ISO Committed Fixed	Host Load (MW)	Start-Up Cost ($)

Bid Curve (Block Format)

MW (Basepoint)												
$/MW												

Ancillary Services

Item	MWs	$/MW
10 Minute Spinning Reserves		
10 Minute Non-Synchronized Reserve		
30 Minute Spinning Reserve		
30 Minute Non-Synchronized Reserve		
Regulation Capacity		
Regulation Movement		

Operating Reserve Service Pricing

- **Operating Reserve Shadow Pricing**
  - The actual cost to provide the next MW of operating reserves

Reserve Shadow Price = Availability Bid + LOC

NOTE

This is performed for each product type and each location

Operating Reserve Service Pricing

- **Lost Opportunity Cost (LOC)**
  - The margin on the sale of energy that the marginal unit foregoes to provide operating reserves

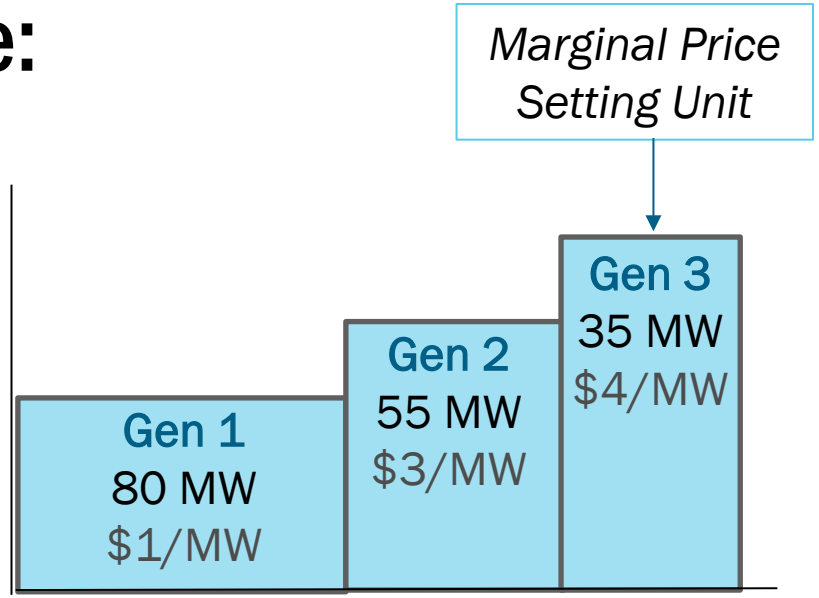
LOC = (Energy LBMP – Reserve Unit Energy Offer)

NOTE

This is performed for each product type and each location

Operating Reserve Service Pricing

- **Operating Reserve Shadow Price Example:**
  - West 30-Minute Reserves/*Shadow Price 1* (SP1)
    (a.k.a. ***NYCA 30-Minute Reserves***)
    - Operating Reserve MWs required for given hour = 165 MWs
    - Availability Bid for Reserve Price Setting Unit = $4
    - Assume Energy LBMP is $31/MW
    - Energy Offer of Reserve Unit is $25/MW
      - Reserve LOC is calculated as (31 – 25)
        - » LOC for Price Setting Unit = $6
    - Operating Reserve Shadow Price is calculated as (4+6) = $10
      - Now becomes West (a.k.a. ***NYCA***) 30-Minute Reserve Shadow Price
        - » For that given Period of Time



NOTE

This is performed for each product type and each location

Operating Reserve Service Pricing

Cascading Shadow Prices

Reserve Product	Cascading Shadow Prices used for Market Clearing Price (MCP)
MCP for WEST 30-Minute Reserves	= SP1
MCP for WEST 10-Minute Non-Synchronized Reserves	= SP1 + SP2
MCP for WEST Spinning Reserves	= SP1 + SP2 + SP3
MCP for EAST 30-Minute Reserves	= SP1 + SP4
MCP for EAST 10-Minute Non-Synchronized Reserves	= SP1 + SP2 + SP4 + SP5
MCP for EAST Spinning Reserves	= SP1 + SP2 + SP3 + SP4 + SP5 + SP6
MCP for SENY 30-Minute Reserves	= SP1 + SP4 + SP7
MCP for SENY 10-Minute Non-Synchronized Reserves	= SP1 + SP2 + SP4 + SP5 + SP7 + SP8
MCP for SENY Spinning Reserves	= SP1 + SP2 + SP3 + SP4 + SP5 + SP6 + SP7 + SP8 + SP9
MCP for N.Y.C. 30-Minute Reserves	= SP1 + SP4 + SP7 + SP10
MCP for N.Y.C. 10-Minute Non-Synchronized Reserves	= SP1 + SP2 + SP4 + SP5 + SP7 + SP8 + SP10 + SP11
MCP for N.Y.C. Spinning Reserves	= SP1 + SP2 + SP3 + SP4 + SP5 + SP6 + SP7 + SP8 + SP9 + SP10 + SP11 + SP12
MCP for L.I. 30-Minute Reserves	= SP1 + SP4 + SP7 + SP13
MCP for L.I. 10-Minute Non-Synchronized Reserves	= SP1 + SP2 + SP4 + SP5 + SP7 + SP8 + SP13 + SP14
MCP for L.I. Spinning Reserves	= SP1 + SP2 + SP3 + SP4 + SP5 + SP6 + SP7 + SP8 + SP9 + SP13 + SP14 + SP15

Ancillary Services Shortage Pricing

Ancillary Services Shortage Pricing

- Shortage pricing is a mechanism employed by the NYISO that ensures that Regulation or Reserves are not scheduled at a cost greater than the market demand curves indicate
- This shortage pricing mechanism
  - Provides incentives to ensure needed resources remain available for providing ancillary services and maintaining bulk power system reliability
  - Crucial to reflect system conditions and operational needs
- Shortage pricing rules applies to the following Ancillary Services:
  - Regulation Service
  - Reserves Service

Regulation Service Shortage Pricing

- Regulation Service Shortage Pricing is applied when
  - Desired amount of Regulation is unavailable
  - Cost to Procure Regulation exceeds Regulation Shortage Pricing Demand Curve

Regulation Service Shortage Pricing

- **Regulation Demand Curve**

Regulation MW Shortage	Regulation Demand Curve Price
Shortage MW < 25 MWs	**$25**
25 MWs ≤ Shortage MW < 80 MWs	**$525**
Shortage MWs ≥ 80 MWs	**$775**

Reserve Service Shortage Pricing

- Reserve Service Shortage prices are applied when
  - Desired amounts of Operating Reserves is unavailable
  - Cost to Procure Reserves exceeds Reserve Shortage Pricing Demand Curve
- Reserve Service Shortage Price accounts for:
  - Operating Reserves Demand Curve (ORDC)
- Operating Reserves Demand Curve (ORDC)
  - NYISO uses stepwise shortage pricing curves that are differentiated by
    - Reserve product
    - Location (reserve region)
    - Magnitude of shortages

Reserve Service Shortage Pricing

Operating Reserves Demand Curve

Reserve Product	Reserves MW Shortage	NYCA Reserves Demand Curve Price	EAST Reserves Demand Curve Price	SENY Reserves Demand Curve Price	NYC Reserves Demand Curve Price	LI Reserves Demand Curve Price
30-Min. Total Reserves	Any MW	----------	$40/MWh	$500/MWh **Up to the applicable incremental SENY 30-minute reserve quantity (if applicable, a quantity not exceeding 500 MW) **	$25/MWh	$25/MWh
	Up to 200 MW	$40/MWh	----------	----------	----------	----------
	At least 200 MW, up to 325 MW	$100/MWh				
	At least 325 MW, up to 380 MW	$175/MWh				
	At least 380 MW, up to 435 MW	$225/MWh				
	At least 435 MW, up to 490 MW	$300/MWh				
	At least 490 MW, up to 545 MW	$375/MWh				
	At least 545 MW, up to 600 MW	$500/MWh	----------	----------	----------	----------
	At least 600 MW, up to 655 MW	$625/MWh	----------	----------	----------	----------
	655 MW or more	$750/MWh	----------	----------	----------	----------
10-Min. Total Reserves	Any MW	$750/MWh	$775/MWh	$40/MWh	$25/MWh	$25/MWh
10-Min. Spinning Reserves	Any MW	$775/MWh	$40/MWh	$40/MWh	$25/MWh	$25/MWh

NOTE

Prices in effect all the time, with exception of periods when the Emergency Demand Response Program (EDRP) and/or Special Case Resources (SCRs) are activated in real-time

Reserve Service Shortage Pricing

- ## Operating Reserves Shadow Price

Reserve Product	Operating Reserves Shadow Pricing				
	NYCA	EAST	SENY	NYC	LI
30-Min. Total Reserves	SP1 $750/MWh	SP4 $40/MWh	SP7 $500/MWh	SP10 $25/MWh	SP13 $25/MWh
10-Min. Total Reserves	SP2 $750/MWh	SP5 $775/MWh	SP8 $40/MWh	SP11 $25/MWh	SP14 $25/MWh
10-Min. Spinning Reserves	SP3 $775/MWh	SP6 $40/MWh	SP9 $40/MWh	SP12 $25/MWh	SP15 $25/MWh

Operating Reserve Service Pricing

Reserve Product	Cascading of Operating Reserve Shadow Prices
MCP for WEST 30-Min Total Res.	SP1
MCP for WEST 10-Min Total Res.	SP1 + SP2
MCP for WEST 10-Min Spinning Res.	SP1 + SP2 + SP3
MCP for EAST 30-Min Total Res.	SP1 + SP4
MCP for EAST 10-Min Total Res.	SP1 + SP2 + SP4 + SP5
MCP for EAST 10-Min Spinning Res.	SP1 + SP2 + SP3 + SP4 + SP5 + SP6
MCP for SENY 30-Min Total Res.	SP1 + SP4 + SP7
MCP for SENY 10-Min Total Res.	SP1 + SP2 + SP4 + SP5 + SP7 + SP8
MCP for SENY 10-Min Spinning Res.	SP1 +SP2 + SP3 + SP4 + SP5 +SP6 + SP7 + SP8 + SP9
MCP for N.Y.C. 30-Min Total Res.	SP1 + SP4 + SP7 + SP10
MCP for N.Y.C. 10-Min Total Res.	SP1 +SP2 + SP4 + SP5 +SP7 + SP8 + SP10 + SP11
MCP for N.Y.C. 10-Min Spinning Res.	SP1 +SP2 + SP3 + SP4 + SP5 +SP6 + SP7+ SP8 + SP9 + SP10 + SP11 + SP12
MCP for L.I. 30-Min Total Res.	SP1 + SP4 + SP7 + SP13
MCP for L.I. 10-Min Total Res.	SP1 + SP2 + SP4 + SP5 + SP7 + SP8 + SP13 + SP14
MCP for L.I. 10-Min Spinning Res.	SP1 + SP2 + SP3 + SP4 + SP5 + SP6 + SP7 + SP8 + SP9 + SP13 + SP14 + SP15

Scarcity Pricing

Scarcity Pricing

- Scarcity pricing is a mechanism employed by the NYISO that establishes a price when reliability-based Demand Response events are deployed
  - Supplement generation when Operating Reserves are forecast to be short or when there is an actual Operating Reserve Deficiency
- Scarcity pricing rules apply to the following Demand Response events:
  - Special Case Resource (SCR) activation
  - Emergency Demand Response Program (EDRP) activation
- This scarcity pricing mechanism
  - Creates consistent prices and schedules during EDRP/SCR events and aligns pricing outcomes with operator actions
  - Ensures EDRP/SCR resource participation in a reliability-based event is factored into calculating the Real Time prices

Reliability Demand Response Programs

- Demand Response resources reduce their power use for discrete periods of time as directed by the NYISO
  - Load reduction through interruptible loads or loads with a qualified behind-the-meter Local Generator
    - EDRP – Voluntary reduction
    - SCR – Mandatory reduction

Scarcity Pricing Methodology

- **Expected load reduction from SCR/EDRP resources is used as an input in calculating the Scarcity Reserve Requirement within each Scarcity Reserve Region**

Scarcity Reserve Region

Collection of zones in which EDRP/SCR is activated

- **RTD and RTC procure additional 30-minute reserves during EDRP/SCR activations**
  - Amount of scarcity reserves procured will be set equal to the Expected EDRP/SCR MW less the Available Operating Capacity for the Load Zones included in a Scarcity Reserve Region

NOTE

For more information, refer to MST Section 15.4.6.2

Scarcity Reserve Requirement

- Applicable for all Real-Time intervals during which NYISO has activated EDRP/SCR resources to provide load reduction

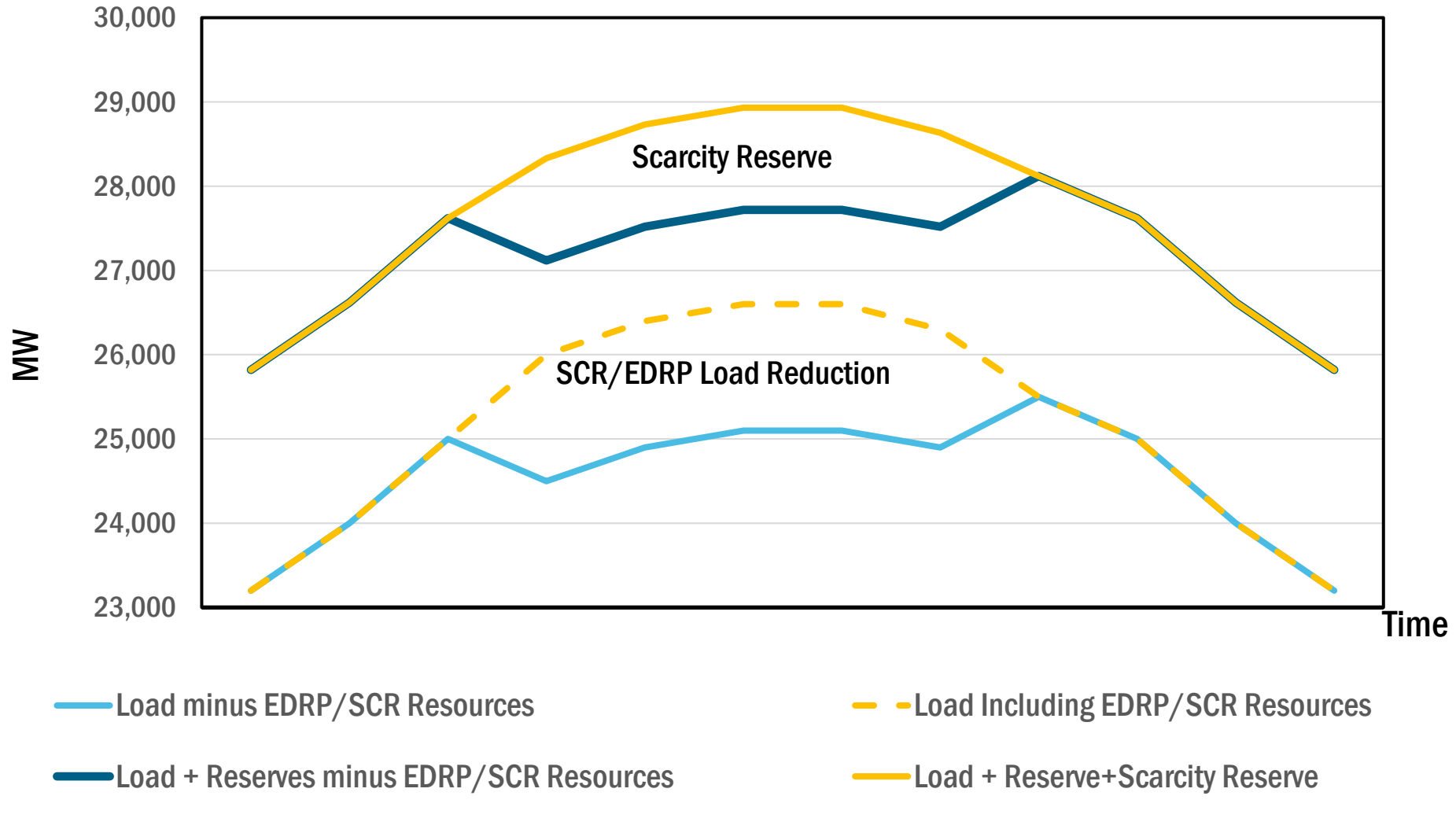
Scarcity Reserve Requirement = (Expected Load Reduction by SCR/EDRP Resources – Available 30-60 minute Reserves)

Revised 30-minute Reserve Requirement = 2620 MW + Scarcity Reserve Requirement

NOTE

This example is for a NYCA-wide activation.

Scarcity Pricing - Illustration



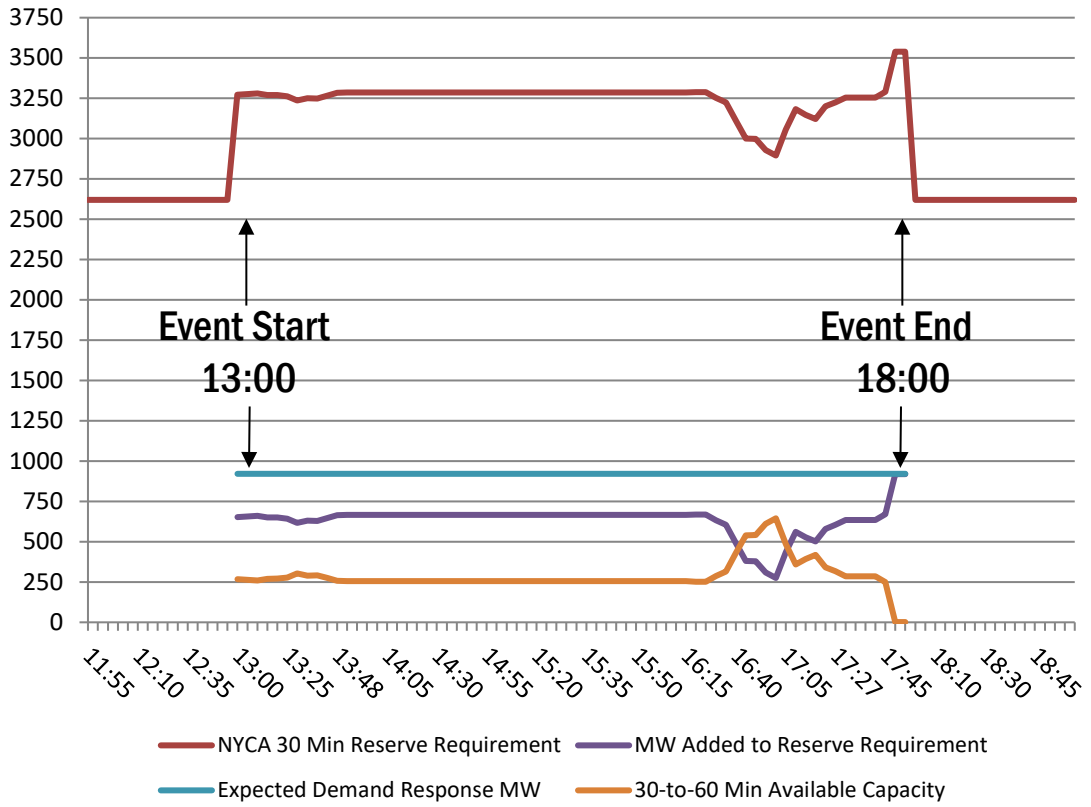
Scarcity Pricing Methodology

- Operating Reserves Market Clearing prices will be calculated using the revised 30-minute requirements, and the Operating Reserve demand curves, adjusted in Real Time to account for the Scarcity Reserve Requirement
  - According to the rules set forth in the MST, NYCA 30-minute reserve demand curve values priced at less than $500/MW will be set to $500/MW in real-time during EDRP/SCR activations
  - Market Clearing prices will be calculated for every 5-minute RTD time interval for the duration of the event

Scarcity Pricing

Scarcity Pricing Example:

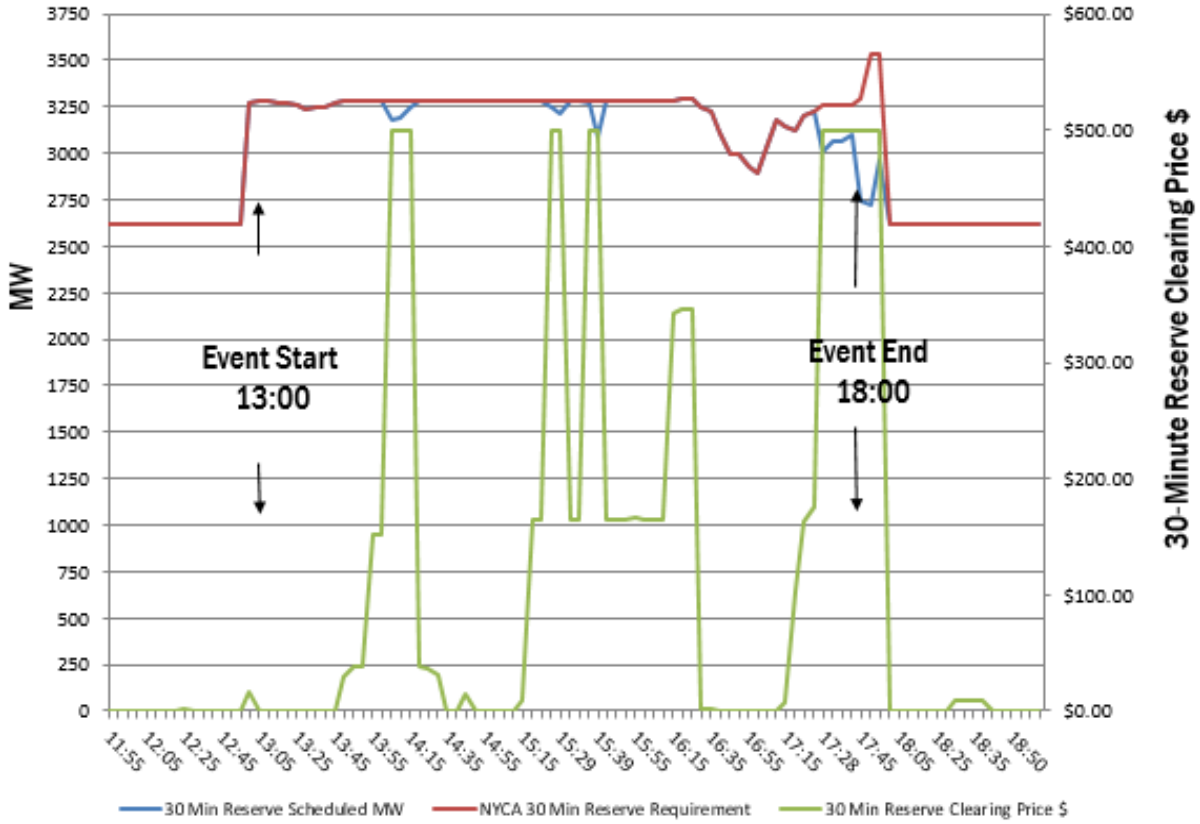
- EDRP/SCR Reliability Event deployed by NYISO on August 12, 2016
  - NYISO activated EDRP/SCR resources NYCA wide, from 13:00-18:00 due to projected Reserves shortage
  - Revised 30-minute Reserve requirement was calculated as discussed above



Scarcity Pricing

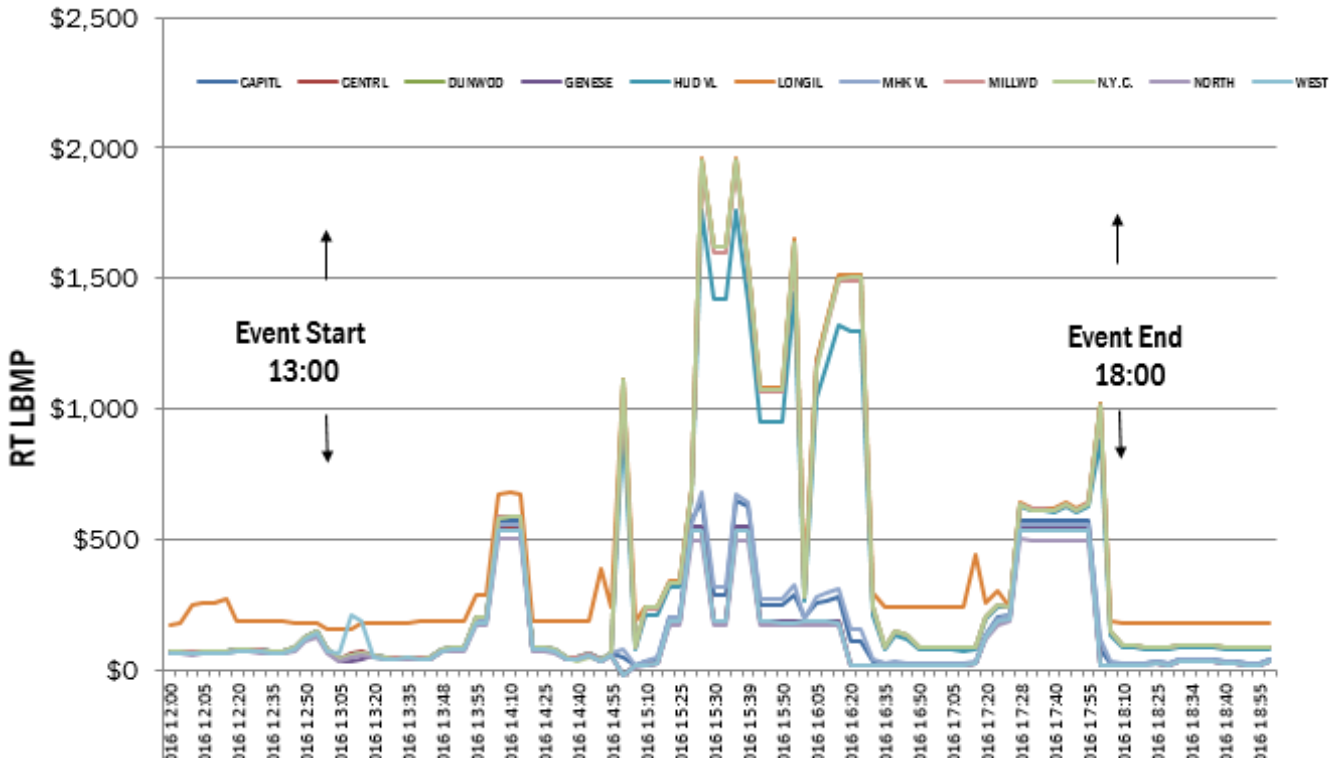
Scarcity Pricing Example:

- 30-minute Reserves procured at every 5-minute interval for event duration
  - 18 Real Time pricing intervals with $500 clearing price for NYCA 30- minute reserves
  - Scarcity pricing reflects the consistency between the price signals and actual system needs



Scarcity Pricing

- ## Scarcity Pricing Example:
  - Zonal RT-LBMP for the 18 Real Time pricing intervals with $500 clearing price for NYCA 30-minute reserves



Summary of Scarcity Pricing Mechanism

Normal Operating day – 2620 MW of Operating Reserves

Real Time Market Clearing price for all Operating Reserves products

Operating Reserves forecast to be short or actual shortage

NYISO deploys SCR/EDRP resources

Additional 30-minute Operating Reserves procured in Real Time in SCR/EDRP deployment zone(s)

Scarcity pricing rules used to calculate Market Clearing prices for revised 30-minute reserves

Additional Resources

- Tariffs – OATT & MST
- Day Ahead Scheduling Manual
- Transmission and Dispatching Operations Manual
- Market Participant User's Guide
- Technical Bulletins