

Energy Storage Resources

Participation Model

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Presentation Outline

- **Project Background**
- **Energy Market and Ancillary Services Participation**
- **Installed Capacity Market Participation**
- **Mitigation Measures**
- **Additional Documentation Resources**

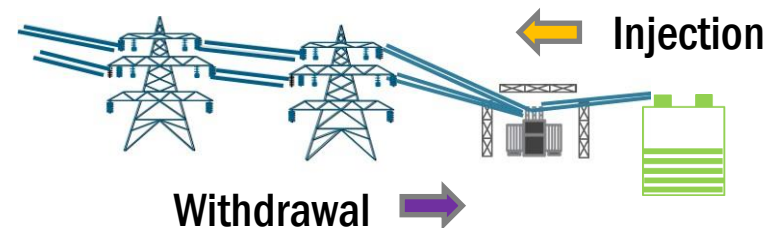
ESR – Project Background

Project Background Topics

- Energy Storage Resources (ESR) Defined
- Driver behind ESR Participation Model Development
- Purpose and Benefits of ESR Participation Model
- ESR Participation Model Timeline
- Impacted Markets and Services

Energy Storage Resources Defined

- Energy Storage Resources are Withdrawal-Eligible Generators (negative generation)
- Generators that receive Energy from the grid at a specified location and are capable of storing that Energy, for later injection back onto the grid, at the same location
 - Resources that cannot inject Energy onto the grid cannot be Energy Storage Resources



Driver Behind ESR Participation Model

- **FERC Order No. 841:**
 - Issued on February 15, 2018
 - Directed “each RTO/ISO to revise its tariffs to establish a participation model consisting of market rules that, recognizing the physical and operational characteristics of electric storage resources, facilitates their participation in the RTO/ISO markets” [1]

[1] Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators, Order No. 841, 162 FERC ¶ 61,127, at P3 (Feb. 15, 2018) (“Order No. 841”) as amended by the Feb. 28, 2018 Errata Notice (“Order No. 841 Errata”).

Purpose of ESR Participation Model

- NYISO's participation model is designed to:
 - Promote full integration of storage resources in NY's wholesale markets while accounting for their unique operating capabilities
 - Accommodate advanced energy storage technology
 - Allow ESRs to be dispatched and set market clearing prices, when both withdrawing and injecting, consistent with existing market rules for other Resource types
 - Account for physical and operational characteristics of ESRs through bidding parameters or other means

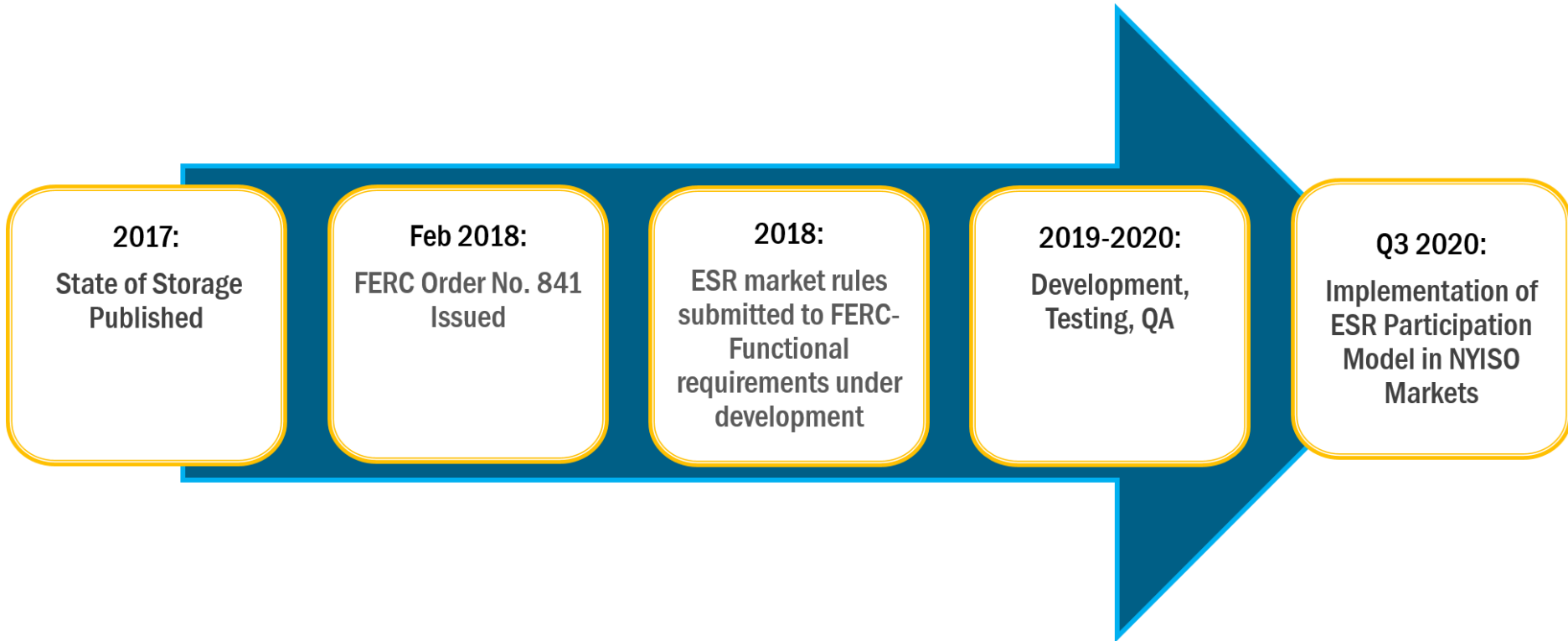


Benefits of ESR Participation Model

- **Integrating ESRs in Wholesale Markets has the potential to:**
 - Reduce system peak demand and lower overall power costs
 - Facilitate effective ramp management
 - Mitigate generator start up and shut down costs
 - Absorb over generation
 - Ease integration of intermittent resources
 - Provide ancillary services while taking greater advantage of clean energy



ESR Participation Model Timeline



Impacted Markets and Services

Energy Market

ESRs can participate in the Day-Ahead and Real-Time Energy Markets

Ancillary Services

ESRs can qualify to participate in Ancillary Services and provide:

Cost Based: Voltage Support Service

Market Based: Regulation & Frequency Control and/or Operating Reserves

Capacity Market

ESRs can qualify to provide capacity and participate in the Installed Capacity market

ESR – Energy Market and Ancillary Services

Participation in Energy & Ancillary Services

- Participation Requirements
- Registration Parameters
- Bid Parameters
- Scheduling
- Financial Settlements

ESR Participation Requirements

- Qualifying for wholesale market participation requires that ESRs:
 - Meet a minimum offer size requirement of 100 kW
 - Inject at a rate of at least 0.1 MW for a period of at least one hour
 - Comply with all metering requirements
 - Account for energy consumed as Station Power

ESR Participation Requirements (cont'd)

- **Metering Requirements**
 - Provide direct metering regardless of physical location
 - Meters must:
 - Be approved by Metering Authority
 - Provide revenue-quality metering information
 - Provide six-second telemetry
 - Comply with minimum acceptable accuracy standards
 - Submit dual channel hourly meter data
 - Separate fields for Injection MW and Withdrawal MW vs. single net MW value
 - Results in less distortion of values
 - Provide Energy Level (MWh) telemetry in RT

Metering Requirements

- Example:

Dual Channel Metering

Single Net Meter

	RTD Avg Actual Injection MW	RTD Avg Actual Withdrawal MW	RTD Adjusted Injection MW	RTD Adjusted Withdrawal MW	Final Adjusted MW
:00	10	0	10.4854	0.0000	10.4854
:05	10	0	10.4854	0.0000	10.4854
:10	10	0	10.4854	0.0000	10.4854
:15	10	0	10.4854	0.0000	10.4854
:20	10	0	10.4854	0.0000	10.4854
:25	1.5	-2	1.5728	-1.9024	-0.3296
:30	0	-5	0	-4.7561	-4.7561
:35	0	-6	0	-5.7073	-5.7073
:40	0	-7	0	-6.6585	-6.6585
:45	0	-7	0	-6.6585	-6.6585
:50	0	-7	0	-6.6585	-6.6585
:55	0	-7	0	-6.6585	-6.6585
	4.2917	-3.4167	4.5000	-3.2500	1.2500
Revenue Meter MWH	4.5000	-3.2500			
Adjustment Ratio	1.0485	0.9512			

VS.

	RTD Avg Actual MW	RTD Adjusted MW
:00	10	14.2857
:05	10	14.2857
:10	10	14.2857
:15	10	14.2857
:20	10	14.2857
:25	-0.5	-0.7143
:30	-5	-7.1429
:35	-6	-8.5714
:40	-7	-10.0000
:45	-7	-10.0000
:50	-7	-10.0000
:55	-7	-10.0000
	0.8750	1.2500
Revenue Meter MWH	1.2500	
Adjustment Ratio	1.4286	



ESR Participation Requirements (cont'd)

■ Station Power

- ESRs subject to existing Station Power registration requirements
- Station Power withdrawals reported to NYISO as load on a load bus
 - ESR withdrawals stored for later injection onto grid is *not* Station Power
- ESRs required to identify metering configuration used to measure station service
- Meter Authority must agree to configuration to account for and report station service load to NYISO

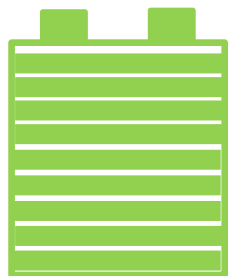
Registration and Bid Parameters

ESR Registration Parameters

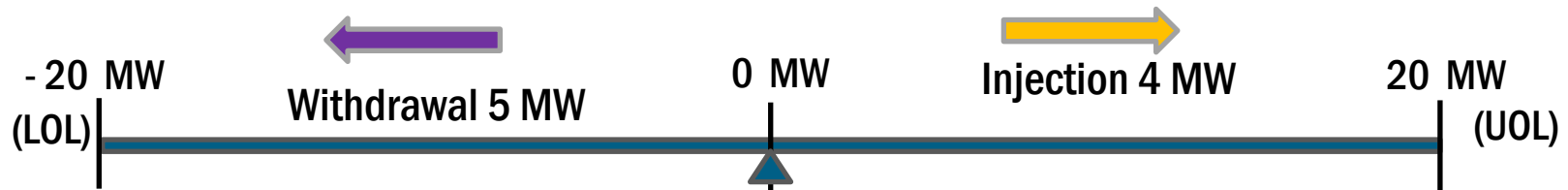
- MP Administrators will be required to provide the following parameters:

Parameter	Definition	Unit of Measure
Physical Upper Operating Limit (UOL)	Physical maximum MW level rating of the ESR	MW
Physical Lower Operating Limit (LOL)	Physical minimum MW level rating of the ESR	MW
Response Rate	Represents how quickly ESR can respond to dispatch instructions from the NYISO to inject onto or withdraw from the grid	MW/min.
Physical Upper Storage Limit	Maximum amount of Energy an ESR is physically capable of storing	MWh
Physical Lower Storage Limit	Minimum amount of Energy an ESR is physically capable of storing	MWh
Roundtrip Efficiency	Ratio of the Energy (in MWh) that can be injected to the grid to the Energy that must be withdrawn	%

ESR – Registration Parameters



Roundtrip efficiency:
Ratio of energy injections to energy withdrawals for an ESR



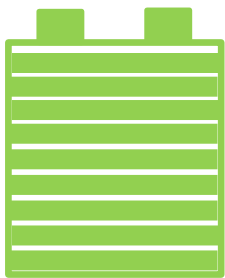
$$\text{Roundtrip Efficiency} = 4 \text{ MW} / 5 \text{ MW} = 80\%$$

ESR Bid Parameters

- ESRs will submit the following bid parameters with economic offers:

Parameter	Definition	Unit of Measure
Normal Upper Operating Limit (UOL _N)	Maximum level at which the ESR is willing to operate	MW
Emergency Upper Operating Limit (UOL _E)	Maximum level at which the ESR is willing to operate, at the request of the ISO during extraordinary conditions. It needs to be equal to or greater than the Normal UOL	MW
Lower Operating Limit (LOL)	Minimum MW level at which the ESR is willing to operate	MW
Upper Storage Limit	Maximum amount of Energy an ESR is physically capable of storing	MWh
Lower Storage Limit	Minimum amount of Energy an ESR is physically capable of storing	MWh
ESR Outage Type	Reporting mechanism for ESR outage that identifies type of outage experienced, if applicable	Normal (N) Planned Outage (P) Forced Outage (F)

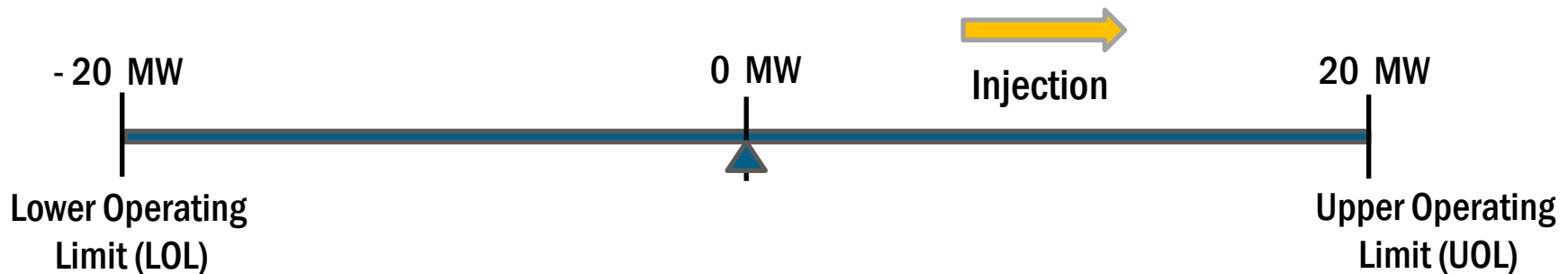
ESR- Bid Parameters



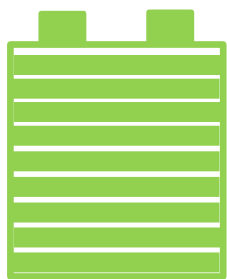
Upper Operating Limit:

Max amount of MW the ESR can supply in its injecting state
(or)

Min amount of MW an ESR can withdraw in the withdrawing state



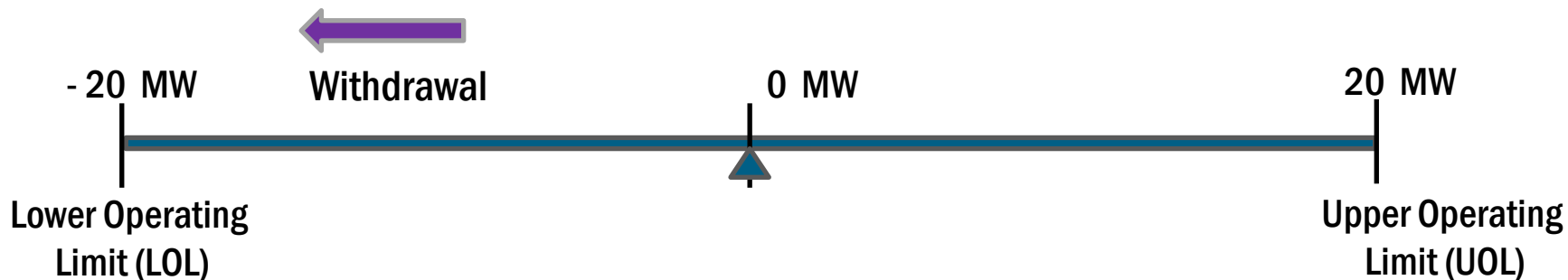
ESR- Bid Parameters



Lower Operating Limit (LOL):

Max amount of MWs resource can consume from the grid if withdrawing energy
(or)

Min amount of MWs of energy it can supply the grid if it cannot withdraw

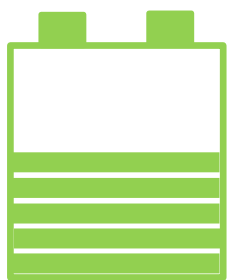


ESR Bid Parameters (cont'd)

- ESRs will submit the following bid parameters with economic offers:

Parameter	Definition	Unit of Measure
Incremental Bid Curve	Series of monotonically increasing steps that indicate the quantities of Energy for a given price that an ESR is willing to supply to the ISO	\$/MW
Market Choice	Identifies which market, Day Ahead or Real Time, the bid parameters apply to	DAM RT
Beginning Energy Level	Total amount of Energy stored by the Resource at the beginning of a market interval	MWh
Unit Operation Modes	Parameters that indicate whether ESR is to be evaluated based on economic parameters and whether its output will be a fixed value	ISO-Committed Flexible ISO-Committed Fixed Self-Committed Flexible Self-Committed Fixed
Energy Level Management Modes	Parameter that indicates how Energy Level Constraints will be managed	ISO-Managed Self-Managed
Opportunity Cost	Economic parameter to be utilized by NYISO's Market Monitoring and Mitigation Analysis (MMA) team in Reference Levels	\$/MW

ESR- Bid Parameters



Energy Level:

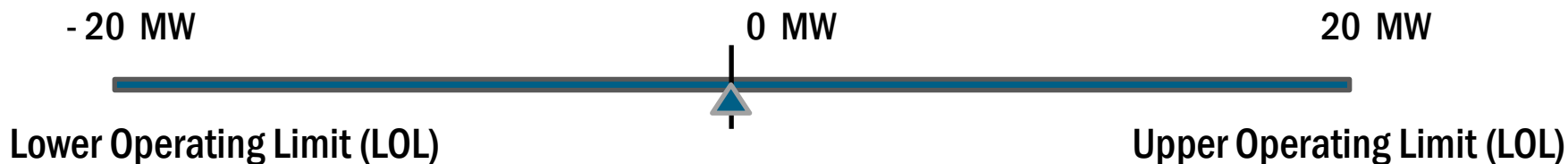
The amount of energy stored in the ESR

Beginning Energy Level:

Total amount of energy stored by the resource at start of interval

Day Ahead Intervals: estimated value provided by resource

Real Time intervals: 6 second telemetry data



Unit Operation Modes

Economics	MWs
<ul style="list-style-type: none"> – ISO Committed <ul style="list-style-type: none"> • Economically Selected – Self Committed <ul style="list-style-type: none"> • Price Taker 	<ul style="list-style-type: none"> – Fixed <ul style="list-style-type: none"> • Fixed Output/Operating Levels • No Change to in-hour Schedule – Flexible <ul style="list-style-type: none"> • Flexible Output • Following NYISO Base Point Fluctuation

- ISO Committed Flex
- Self Committed Flex
- Self Committed Fixed
- ISO Committed Fixed



Energy Level Management

- **ISO-Managed**
 - NYISO market optimization directly accounts for resource's Energy Level constraints to ensure physically feasible DAM & RT schedules
 - Beginning Energy Level
 - Lower and Upper Storage Limits
 - Round Trip Efficiency
 - DAM optimization applies to entire 24 hour period
- **Self-Managed**
 - NYISO market optimization does not account for resource's Energy Level constraints
 - Energy Level constraints managed by ESR through offers
- **ESRs can alternate Energy Level Management Modes between DAM & RT**
- **Energy Level Management Mode can be changed between hours in RT Market only**
- **Bid defaults to Self-Managed If no Energy Level Management Mode is selected**

Unit Operation & Energy Level Management Modes

DAM Offer		Permitted RTM Offers	
Energy Level Mode	Unit Operation Mode	Energy Level Mode	Unit Operation Mode
ISO-Managed	ISO-Committed Flex	ISO-Managed	ISO-Committed Flex
		Self-Managed	ISO-Committed Flex Self-Committed Flex Self-Committed Fixed*
Self-Managed	ISO-Committed Flex	ISO-Managed	ISO-Committed Flex
		Self-Managed	ISO-Committed Flex Self-Committed Flex Self-Committed Fixed*
Self-Managed	Self-Committed Flex	Self-Managed	Self-Committed Flex Self-Committed Fixed*
Self-Managed	ISO-Committed Fixed**	Self-Managed	Self-Committed Fixed
Self-Managed	Self-Committed Fixed	Self-Managed	Self-Committed Fixed
No DAM Offer		ISO-Managed	ISO-Committed Flex
		Self-Managed	ISO-Committed Flex Self-Committed Flex Self-Committed Fixed

- An ESR bidding Self-Committed Fixed or ISO-Committed Fixed will be ineligible to provide Regulation or Operating Reserves

* Only with approval from the NYISO

** Units may only bid as ISO-Committed Fixed if qualified by the NYISO

Mock-Up
Generator Bid
Screen

Generator Bid

Generator Name: v **ESR Beginning Energy Level MWh** Fuel Type: v Burdened Fuel Price (\$/mmbtu)

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

Energy Bid

Lower Storage Limit (MWh) <input type="text"/>	Upper Storage Limit (MWh) <input type="text"/>	ESR Energy Management Mode <input type="radio"/> ISO <input type="radio"/> Self	Lower Operating Limit (MW) <input type="text"/>	ESR Outage Type <input type="text"/> v	
Upper Operating Limit (MW) <input type="text"/>	Emergency Upper Operating Limit (MW) <input type="text"/>	Minimum Generation (MW) <input type="text"/>	Minimum Generation Cost (\$) <input type="text"/>		
Self Scheduled (MW)				Unit Operations	
00 Minute MW <input type="text"/>	15 Minute MW <input type="text"/>	30 Minute MW <input type="text"/>	45 Minute MW <input type="text"/>	<input type="radio"/> ISO Committed Flex <input type="radio"/> Self Committed Flex	Host Load (MW) <input type="text"/>
				<input type="radio"/> Self Committed Fixed <input type="radio"/> ISO Committed Fixed	Start-Up Cost (\$) <input type="text"/>

Bid Curve (Block Format)

MW (Basepoint)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
\$/MW	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
\$/MW (Opportunity Cost)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Ancillary Services

Item	MWs	\$/MW
10 Minute Spinning Reserves	<input type="text"/>	<input type="text"/>
10 Minute Non-Synchronized Reserves	<input type="text"/>	<input type="text"/>
30 Minute Spinning Reserves	<input type="text"/>	<input type="text"/>
30 Minute Non-Synchronized Reserves	<input type="text"/>	<input type="text"/>
Regulation Capacity	<input type="text"/>	<input type="text"/>
Regulation Movement	<input type="text"/>	<input type="text"/>

ESR Scheduling – DA & RT Markets

ESR Scheduling in Day-Ahead Market

- ESR bids considered along with all other supply type DAM offers via SCUC evaluation
 - DAM optimization produces a schedule that is financially binding for a full 24-hour period
 - If ISO-Managed, Energy Level constraints ***will be*** optimized over the entire 24 hour horizon
 - Must offer as ISO-Committed Flexible
 - If Self-Managed, Energy Level constraints ***will not be*** considered in the optimization
 - May offer as:
 - » ISO-Committed Flexible
 - » Self-Committed Flexible
 - » ISO-Committed Fixed**
 - » Self-Committed Fixed

** Units may only bid as ISO-Committed Fixed if qualified by the NYISO

ESR Scheduling in Real-Time Market

- **Real-Time Dispatch feasible operating ranges will be calculated for ESRs considering the following:**
 - Consistency with its prior schedule
 - ESR Bid Capacity Limits in MW
 - ESR Bid Storage Limits in MWh
 - For ISO-Managed ESRs only
 - Response Rate in MW/min
 - Telemetered MW Output of the ESR
 - Telemetered ESR State of Charge MWh
- **ESR operating characteristics provided to both RTC and RTD**
 - Allows for Real-Time market optimization to prevent ESR from receiving dispatch instructions it cannot meet

ESR Scheduling in Real-Time Market (cont'd)

■ ISO-Managed

- Energy Level constraints will be respected for binding and advisory intervals
 - Must offer as ISO-Committed Flexible

■ Self-Managed

- Energy Level constraints *will be* considered only in the binding interval to determine feasible schedules in the optimization
- RT Market software will use all other physical and economic characteristics provided to make commitment and dispatch decisions
 - *May offer as:
 - ISO-Committed Flexible
 - Self-Committed Flexible
 - Self-Committed Fixed

**Refer to chart on slide 27 for appropriate combinations*

Scheduling of Market-Based Ancillary Services

- Ancillary Services will be scheduled following same principles as traditional Generators
- Eligible to provide Regulation and Reserves while withdrawing
- ESRs will only be scheduled to provide Operating Reserves that can be sustained for at least one hour if the Operating Reserves are converted to Energy
 - Real-Time Energy Level telemetry will be used to determine appropriate Operating Reserves schedule for both *ISO-Managed* and *Self-Managed* ESRs

ESR Financial Settlements

ESR Energy Market Settlements

Settlement	Purpose	Calc. Interval
Day-Ahead Energy Settlement	Assessed to ESRs with accepted Day-Ahead schedules	Hourly
Balancing Market Settlement	Accounts for energy variations in an ESRs Real-Time Dispatch from its Day-Ahead Schedule	Nominal 5 Minute
Day-Ahead Bid Production Cost Guarantee	Intended to guarantee ESRs that a net loss will not be incurred if committed in the Day-Ahead based on their accepted or mitigated Day-Ahead Bids	Daily
Real-Time Bid Production Cost Guarantee	Intended to guarantee ESRs that a net loss will not be incurred based on their accepted or mitigated real-time Bids if committed above that initially committed in the Day-Ahead	Daily
Day-Ahead Margin Assurance Payment	Payment made to ESRs when required to purchase or sell energy and/or ancillary services in the Balancing Market as a result of being dispatched below its Day-Ahead Schedule. Only applies when ESR is OOM for reliability.	Hourly

ESR Energy Market Settlements

Settlement	Purpose	Calc. Interval
Transmission Service Charge (TSC)	Cost recovery of the Transmission System embedded costs. Transmission owner specific and billed directly by the Transmission Owner	RTD
New York Power Authority Transmission Adjustment Charge (NTAC)	Cost recovery of the New York Power Authority's Transmission System revenue requirement. These are embedded costs not recovered through the TSC and billed by NYISO on behalf of NYPA	RTD

ESR Ancillary Services Settlements: *Cost Based*

Settlement	Purpose	Calc. Interval
Rate Schedule 1	Intended to recover a portion of NYISO's operating costs and FERC fees	Hourly
Voltage Support Service	Intended to compensate ESRs that offer reactive capacity as Voltage Support Service	Hourly
Voltage Support Lost Opportunity Cost	Intended to provide ESRs payment to offset any lost revenue in the Energy Markets, as a result of being dispatched out of merit in real-time to provide Voltage Support Service	Nominal 5 Minute

ESR Ancillary Services Settlements: *Market Based*

Settlement	Purpose	Calc. Interval
Day-Ahead Regulation Capacity	Intended to compensate ESRs offering injection capacity as Regulation Service in the Day-Ahead	Hourly
Balancing Regulation Capacity	Intended to compensate ESRs offering injection capacity as Regulation Service in the Real-Time	Nominal 5 Minute
Real-Time Regulation Movement	Intended to compensate Regulation-Scheduled ESRs responding to NYISO's six second dispatch, correcting for Area Control Error	Nominal 5 Minute
Regulation Performance Charge	Intended to charge Regulation Response Service ESRs not responding or responding poorly to NYISO's six second dispatch, correcting for Area Control Error	Nominal 5 Minute
Regulation Revenue Adjustment	Intended to properly compensate ESRs for balancing energy if also providing Regulation Capacity Service in real-time	Nominal 5 Minute

ESR Ancillary Services Settlements: *Market Based (cont'd)*

Settlement	Purpose	Calc. Interval
Persistent Under Generation Penalty	Intended to penalize ESRs that are not providing Regulation Service causing regulation burden due to under-injecting below its RTD Basepoint (MW) outside of acceptable tolerance levels	Nominal 5 Minute
Persistent Over Withdrawal Charge	Intended to charge ESRs that are not providing Regulation Service causing regulation burden due to over-withdrawal above its RTD Basepoint (MW) outside of acceptable tolerance levels	Nominal 5 Minute
Day-Ahead Operating Reserves Availability	Intended to compensate ESRs offering injection capacity as Operating Reserve Service in day-ahead	Hourly
Balancing Operating Reserves Availability	Intended to compensate ESRs offering injection capacity as Operating Reserve Service in real-time	Nominal 5 Minute

Additional Resources

- **MST & OATT**
- **Technical Bulletin 117**
- **Market Participant User's Guide**
- **Ancillary Services Manual**
- **Accounting and Billing Manual**
- **Day-Ahead Scheduling Manual**
- **Transmission and Dispatch Manual**

Energy Market Mitigation Measures for ESRs

Outline

- **Calculating ESR Reference Levels**
- **ESR Specific Energy Mitigation Measures**
 - Price Spread Evaluation
 - Mitigation accounting for ESR's Round Trip Efficiency
 - High Energy Withdrawal Offers
 - Uneconomic Withdrawal
 - Self-Scheduling
 - Failure to Follow Dispatch Instructions
 - Offer Price Capping
 - Decrease in RT Energy Offers with Adjacent Virtual Supply Bid

Calculating ESR Reference Levels

- ESR Reference Levels will be Cost based
- ESRs cannot have Bid based or LBMP based Reference Levels
- ESR Reference Level is calculated as:

$$\text{ESR Reference Level} = \begin{array}{c} \text{Opportunity Cost} \\ + \\ \text{Variable Operating and Maintenance adders} \\ + \\ \text{Risk Adders} \end{array}$$

- The ESR's Opportunity Cost is expected to be the largest component of the ESR's Reference Levels for Incremental Energy

Calculating ESR Reference Levels

- Opportunity costs for ESRs will be calculated in the Reference Level System (RLS) for every segment of the incremental energy curve
- The main steps to calculate the opportunity cost for an ESR:
 1. Determining an expected LBMP path for the day to use as a baseline
 2. Determining the ESR's maximum revenue for each MW segment included in the unit's Reference Curve in the RLS for every hour of the day
 3. The difference in the maximum revenue between the MW segments is used to determine the opportunity cost for that MW range for each hour

Calculating ESR Reference Levels (cont'd)

- **Expected LBMP Path:**
 - **Day-Ahead Market:** Expected LBMP Path will be the average LBMP for every hour from the Day Ahead LBMPs for the past 30 days and will be used as a baseline in the reference level calculation
 - **Real-Time Market:** Day-Ahead LBMPs for each hour of that market-day will be used as Expected LBMP Path and will be used as a baseline in the reference level calculation

Calculating ESR Reference Levels (cont'd)

- ESR-specific constraints used in calculation of maximum revenue for each MW segment for every hour of the day:
 - State of Charge Energy Level at the start of HB 0, assumed to be zero
 - State of Charge Energy Level at the end of the hour used for calculation
 - Lower Operating Limit
 - Upper Operating Limit
 - Lower Storage Limit
 - Upper Storage Limit
 - Round Trip Efficiency
 - Maximum number of Round trips allowed in the day

Note: Please click the Resources tab on the top right for an additional document that explains the methodology of calculating Opportunity Costs for ESRs with a numerical example

Opportunity Cost Adjustments

- **ESRs can reflect changes to their Opportunity Costs**
- **Updated opportunity costs will be reflected in the unit's Reference Levels**
 - Implementation is similar to the existing Fuel Cost Adjustment functionality
 - An MP must be able to justify the opportunity costs it submits
 - Financial sanctions may be assessed for inaccurate opportunity cost submission that result in Bid(s) failing conduct and impact tests
 - Updates to the ESRs opportunity cost are subject to a MMA review, similar generator-updates to their Fuel Costs

New Mitigation Measures

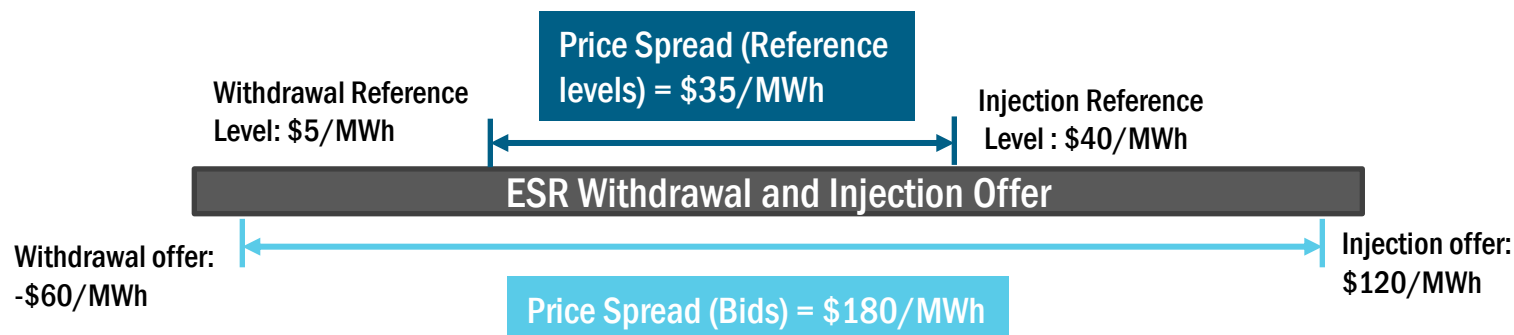
New Energy Mitigation Measures for ESRs

ESRs Injecting Energy	ESRs Withdrawing Energy
Price Spread Evaluation	
	High Withdrawal Offers
	Uneconomic Withdrawal
	Decreasing Real Time Bids and Virtual Supply Bidding
Mitigation and Offer Price Capping may be adjusted to account for Round Trip efficiency	

Other current Energy Mitigation rules for Generators will be followed, as per MST Attachment H- ISO Market Power Mitigation Measures

Price Spread Evaluation

- This mitigation measure applies to ESRs with ISO-Managed Energy Levels because they are expected to be dispatched based on the price spread between their Bids to withdraw and offers to inject Energy
- For ESRs that enter offers to withdraw and inject energy using a single bid, thresholds used for review of bids will be evaluated as a price spread:
 - Constrained Areas: Load Pocket Thresholds
 - ROS: Lower of 300% or \$100/MWh

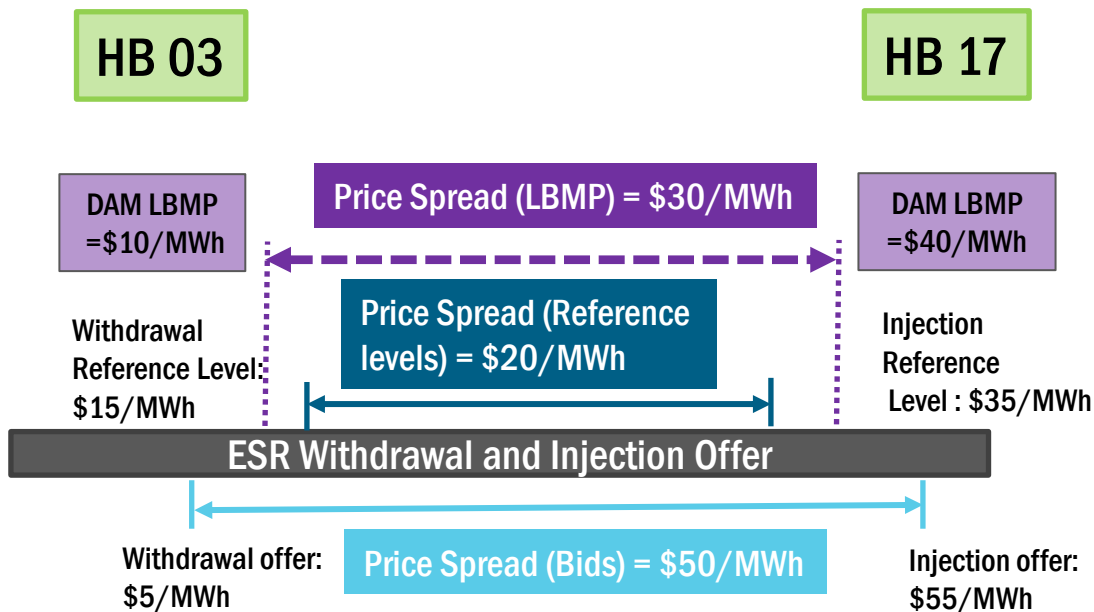


- This would fail the conduct test as the difference in Price Spreads exceeds the threshold ($\$180 - \$35 > \$100$)

Price Spread Evaluation

- **Constraint areas with an active constraint: Price spreads represented by a single bid will be reviewed ex-ante**
 - Through the AMP process
- **For ROS areas, price spreads will be reviewed ex-post**
- **Intertemporal price spreads in the Day-Ahead Market will also be reviewed ex-post**
 - Ex-post reviews might result in potential financial sanction if there is LBMP impact

Intertemporal DAM LBMP Impact Example



- The unit would not be scheduled to withdraw in HB 03 or to inject in HB 17
 - Based on the ESR's Bids in each hour
 - Also, price spread (LBMP) between HB 03 and HB 17 \$30/MWh > the minimum price spread required by its bids (\$50/MWh)
- If the ESR is mitigated to its reference levels,
 - Price spread (Reference levels) (\$20/MWh) < Price spread LBMP (\$30/MWh)
 - ESR will be scheduled to charge at the \$10/MWh LBMP in HB 03, and then scheduled to inject in HB 17 so long as the HB 17 LBMP is at least \$30/MWh
- Scheduling the ESR to withdraw in HB 03 and inject in HB 17 could displace more expensive generation and reduce the HB 17 LBMP from \$40/MWh to as low as \$30/MWh
- If the change in LBMP exceeds the tariff defined impact threshold, then financial sanctions may be imposed on the ESR

Mitigation of High Withdrawal Offers

- **New mitigation measures for ESRs that are withdrawing energy**
 - Developed to address the possibility that an ESR might be willing to withdraw Energy at a loss in order to set a high LBMP that benefits affiliated generators
 - Applies to ESRs that Bid a higher price to withdraw Energy than the price an ESR would reasonably be expected to pay in the absence of market power
- **The thresholds for Conduct test for ESR offers to withdraw energy:**
 - Constrained areas with active constraint: Load Pocket Thresholds
 - Reliability Schedules: Greater of 10% or \$10/MWh
 - ROS: Lower of 300% or \$100/MWh, with a minimum of \$75/MWh

Mitigation Measures for Uneconomic Withdrawals

- This measure will address uneconomic withdrawals achieved by self-scheduling or by failure to follow dispatch instructions that could cause or contribute to congestion
 - It does not apply to ESRs that are scheduled based on the economics of their Bid
- Applies to energy withdrawn at an LBMP that exceeds the applicable reference level by the lower of 300% or \$75/MWh
- Applies if the withdrawals differ from the ESR's dispatch by:
 - More than (15 minutes * Response Rate / minute of the ESR)
 - 100 MW for a Generator, or
 - 200 MW for a market party and its Affiliates
- If a conduct-failing withdrawal causes or contributes to congestion, mitigation will apply if impact is determined

ESR RT Incremental Energy Offer and Virtual Bidding – Market Monitoring

- For ESRs that have a Day-Ahead schedule to withdraw and a Virtual Supply bid affecting the same Load Zone in the same hour
 - NYISO will monitor submitted Real-Time Incremental Energy offers that are lower than the submitted Day-Ahead Incremental Energy offers
- Market Party may be subject to potential penalty and a loss of ability to submit Virtual Bids in the Load Zone where an ESR is located, if:
 - RT Incremental Energy offer < ESR Reference Level, by more than
 - ROS: Lower of 300% or \$100/MWh
 - Constrained Areas with active constraint: Load Pocket Threshold

Mitigation Accounting for Round-Trip Efficiency

- New Bid Validation rule for ESRs: A Day-Ahead or Real-Time offer curve for ESR must include a MW segment at 0
- Bid Validation check to ensure an ESR's offer curve properly accounts for Round-Trip Efficiency:

$$(\$) \text{ Bid for 0 MW} \leq [(\$)\text{Bid for next MW segment} * \text{Unit's Round trip efficiency}]$$

MWh	-10	0	10
\$	A	B	C

Here, $(\$)B$ must be $\leq [(\$)C * \text{Round-Trip Efficiency}]$

Mitigation accounting for Round-Trip Efficiency

- If ESR offer curve has been altered by Offer Capping or Mitigation it will be adjusted to ensure that it is monotonically increasing after accounting for Round-Trip Efficiency:
 - Upon market close, the mitigated or capped offer for injecting energy will be adjusted to incorporate Round-Trip Efficiency

MWh	-10	0	10
\$	A	B	C

If $(\$)B > [(\$)C * \text{Round trip efficiency}]$, then $(\$)C$ will be adjusted to $[(\$)B / \text{Round Trip efficiency}]$

Offer Price Capping

- For ESRs that submit Incremental Energy Bids to inject Energy that exceed \$1000/MWh:
- Bids to inject Energy will be capped at the lowest of:
 - Price of the Energy offer (no cap applied), or
 - Price allowed by current capping logic
- Bids to withdraw Energy will be capped at the lowest of:
 - Price of the Energy offer (no cap applied),
 - Price allowed by current capping logic, or
 - Price required to account for the unit's round trip efficiency

Additional Resources

- **Market Services Tariff, Section 23 -ISO Market Power Mitigation Measures**
- **Reference Levels Manual**
- **Reference Level Software User's Guide**

Capacity Market Participation

ESR – Capacity Market Participation

■ Capacity Market Rules

- Capacity Market Qualification Rules
- Capacity Market Eligibility and Participation Rules
- Derating Factors for Energy Storage Resources
- Obligations and Other Capacity Market Rules
- Capacity Market Mitigation

ESR – Capacity Market Qualifications

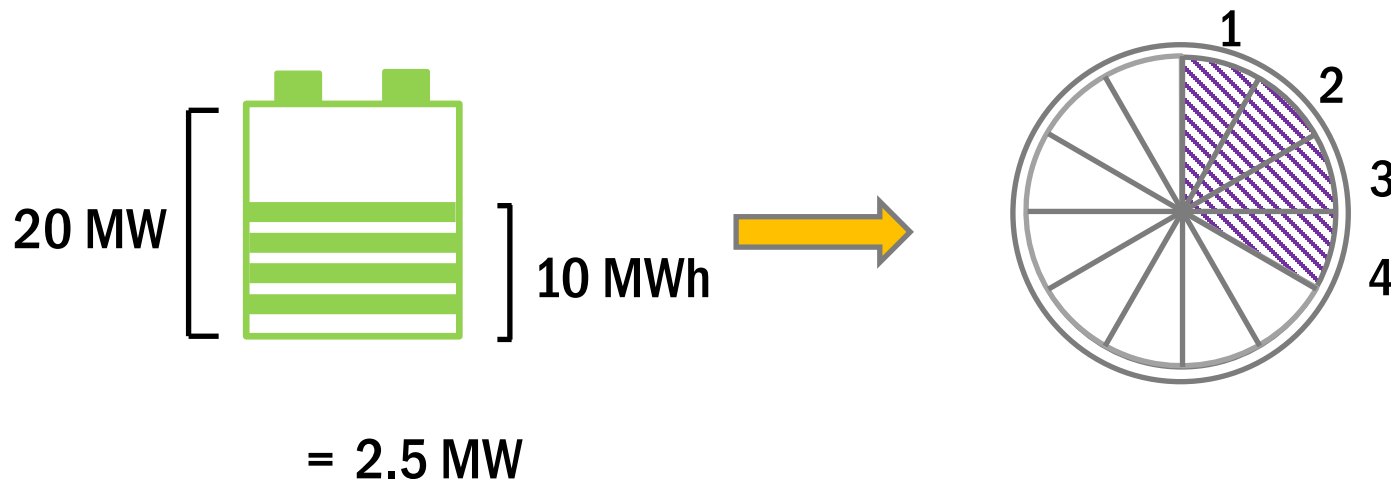
- Satisfaction of all registration requirements as per tariff rules
- Effective Interconnection Agreement that allows wholesale market participation with the
 - Connecting Transmission Owner, or
 - Connecting Transmission Owner and the NYISO, if the resource is subject to the NYISO's interconnection procedures
- Have a minimum injection capability of 0.1 MW
- Outage Schedules two years forward from the anticipated date of first offer into the capacity market
- ESRs with an Energy Duration limitation (EDL)* will be able to elect, on an annual basis, an Energy Duration Limitation that is consistent with their capability
 - An ESR with an EDL may elect a 2, 4, 6, or 8 hour duration

* Refer to [New Rules for ICAP Market Participation – ECE and TAM](#) on Market Training website
Course material > Installed Capacity folder

ESR – Capacity Market Qualifications

- **Capability to operate twenty four hours of each dispatch day for ESRs without an Energy Duration Limitation**
- **ESRs unable to sustain the injection to the grid for 24 hours, may participate in the ICAP market as Resources with an Energy Duration Limitation (EDL)**
 - **An ESR with EDL may derate its output to meet the applicable run-time requirement, as specified in the tariff**

ESR - Capacity Market Qualifications



For example, a 10 MWh battery with the capability of injecting 20 MW would be able to reduce its capacity to 2.5 MW for 4 hours to meet the duration requirement

ESR - CRIS Rights

- CRIS obtained through existing NYISO processes
 - Consistent with current practice, CRIS will only be for the Injection capability of the Energy Storage Resource

Maximum Requested CRIS

= Min (Max sustained 4 hour injection capability, Nameplate capacity, Sum of facility's requested and existing ERIS)

An example ESR:

Nameplate capacity (maximum injection capability) = 20 MW

Injection capability = 10 MWh

Sustained 4 hour injection capability = 10 MWh/4 = 2.5 MW

ERIS = 15 MW

Max Requested CRIS = 2.5 MW

ESR – Demonstrated Maximum Net Capacity (DMNC)

- **Valid DMNCs for Energy Storage Resources that utilize electrochemical technology (for example, a lithium ion battery) are determined by the following:**
 - The sustained maximum net output over one (1) hour
 - An Energy Storage Resource may derate its output to meet the applicable run-time requirement, specified in the tariff
- **Valid DMNCs for Energy Storage Resources that do not utilize electrochemical technology are determined by the following:**
 - The sustained maximum net output over four (4) consecutive hours.
 - An Energy Storage Resource may provide a derated output to meet the four-hour duration applicable run-time requirement, specified in the tariff
- **Currently, temperature correction for DMNC tests will not be necessary**
 - Resources that are temperature sensitive will need to reflect that in their Real Time UOL, which will derate their capability
- **An ESR will not be eligible for Ambient Condition Dependent status**
- **ESR’s Generation Type in the ICAP AMS will be “Storage”**

ESR – Adjusted ICAP and UCAP

- **Adjusted ICAP**: The amount of ICAP an ESR has available, taking into account the Resource's applicable Duration Adjustment Factor

$$\text{Adjusted ICAP} = \text{ICAP} * \text{Duration Adjustment Factor}$$


$$\text{ICAP} = \text{Min}(\text{CRIS}, \text{DMNC})$$

- UCAP for ESRs will be the Adjusted ICAP times the quantity 1 minus the Derating Factor, for a specific Capability Period

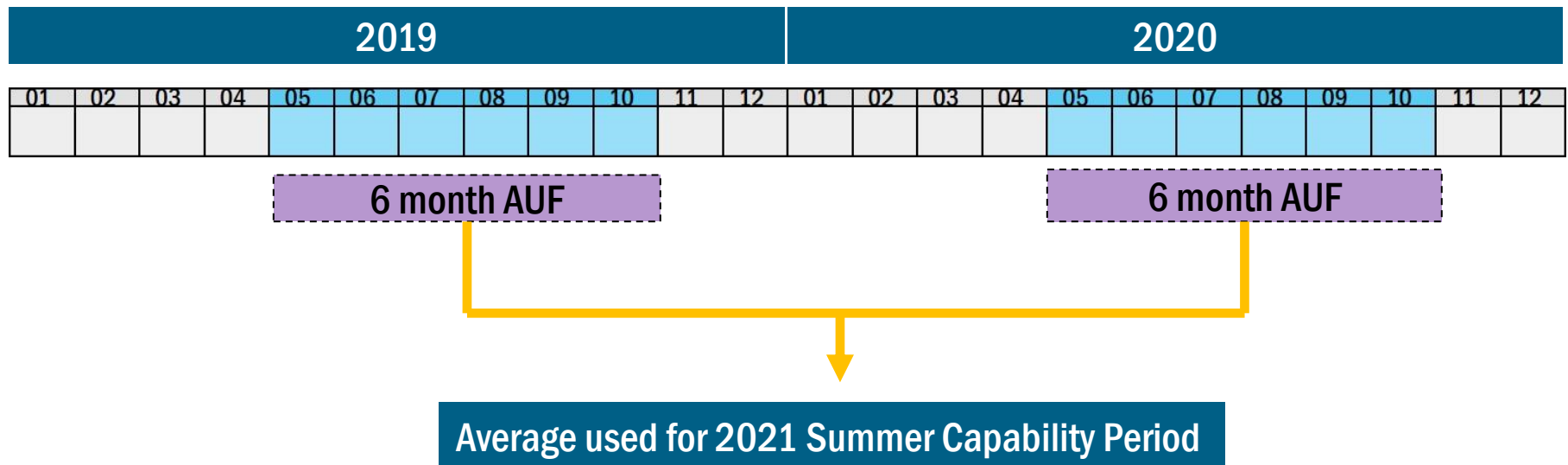
$$\text{UCAP} = \text{Adjusted ICAP} * (1 - \text{Derating Factor})$$

- For ESRs, Derating Factor is calculated as the Average Unavailability Factor (AUF), based on the resource's availability to the Real Time Market System

ESR -Calculating Derating Factors

Summer UCAP Calculation

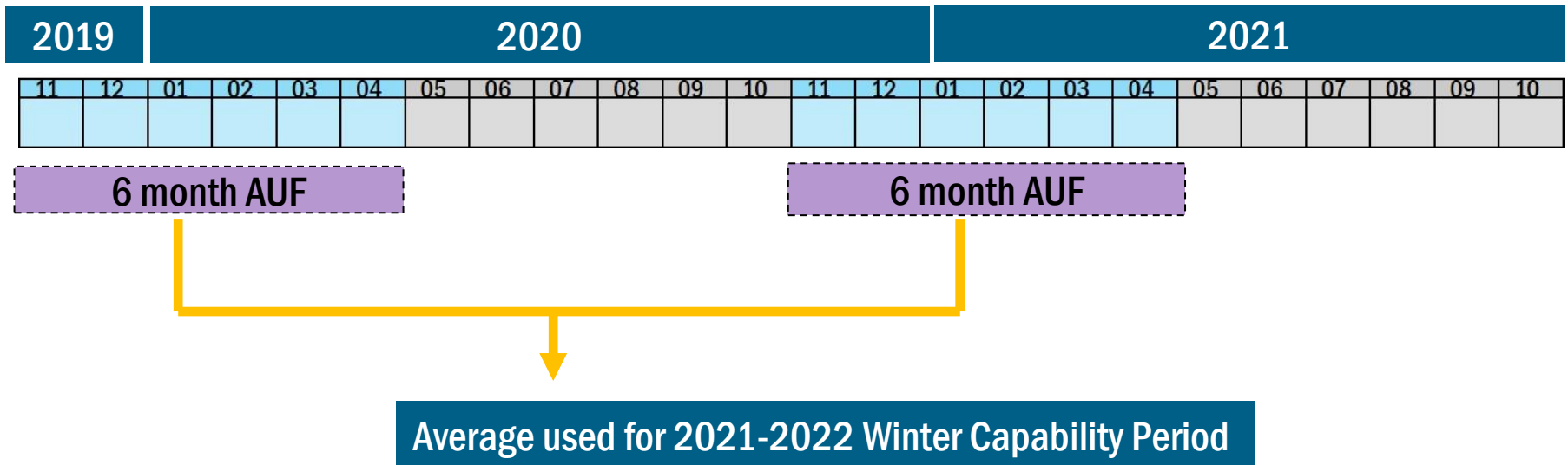
NYISO uses an average of two six-month AUF calculations to establish a Summer ICAP to UCAP derating factor (Avg AUF, AUF_{summer})



- For ESRs with an Energy Duration Limitation (EDL):
 - Derating Factor will be measured in real time over the applicable Peak Load Window for applicable months
 - Activity that occurs outside of the applicable Peak Load Window will not affect the Derating Factor calculation

Winter UCAP Calculation

NYISO uses an average of two six-month AUF calculations to establish a Winter ICAP to UCAP derating factor (Avg AUF, AUF_{winter})



- For ESRs with an Energy Duration Limitation (EDL):
 - Derating Factor will be measured in real time over the applicable Peak Load Window for applicable months
 - Activity that occurs outside of the applicable Peak Load Window will not affect the Derating Factor calculation

ESR - Unavailability Factor Calculation

- For each 6 month Capability Period:

$$\text{Unavailability Factor} = 1 - \left(\frac{\text{Total Available ICAP seconds}}{\text{Total Expected ICAP seconds}} \right)$$

Where:

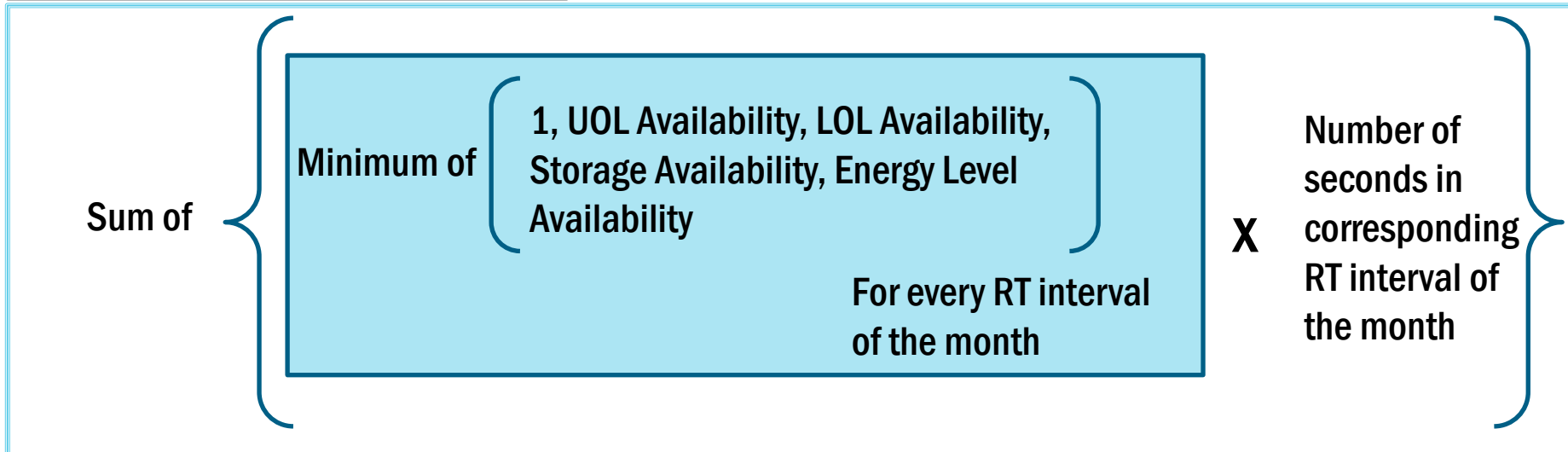
Total Available ICAP Seconds = Sum of all Available ICAP Seconds in every month of the each 6 month Capability Period

Total Expected ICAP seconds = Sum of all RT intervals in every month of each 6 month Capability Period, excluding periods when the ESR is on a planned or a scheduled outage

ESR - Unavailability Factor Calculation

For every month in each 6 month Capability Period:

Total Available ICAP seconds =



This calculation will exclude intervals where ESR is in scheduled or planned outage

ESR -Unavailability Factor Calculation

UOL Availability (for every RT interval of a given month)	Ratio of the resource's UOLN that is available to the ICAP equivalent of UCAP sold
LOL Availability (For every RT interval of a given month)	Ratio of the resource LOLN that is available to the negative ICAP equivalent of UCAP sold
Storage Availability (For every RT interval of a given month)	Ratio of the resource RT storage limits to the ICAP equivalent of storage sold

Please refer ICAP manual Attachment J, section 3.7 for further details about Unavailability Factor calculations for ESRs

ESR - Unavailability Factor Calculation

Energy Level Availability

Ratio of the resource RT Energy Level at the first interval of hour to the sum of its DAM Energy and DAM Reserves schedule for that hour

- Energy Level Availability will be applicable to all real-time intervals occurring within hour
- If a resource is adjusted due to a NYISO or TO reliability need, Energy Level Availability will be 100% for all remaining RT intervals of the applicable day

Please refer ICAP manual Attachment J, section 3.7 for further details about Unavailability Factor calculations for ESRs

ESR – Calculating Derating Factors

- **Default Derating Factors for ESRs just entering the market:**
 - Until there are 3 or more ESRs, the NYISO will use the 1-year NERC reported EFORd for Pumped Storage
 - The current 1-year average EFORd for Pumped Storage is 4.17%
 - Once 3 or more ESRs have entered the market and have data available to calculate derating factors, the NYISO class average for ESRs will be used

ESR -Calculating Derating Factors (cont'd)

- Resources that have availability data for some, but not all, of the required timeframe will use the default values for the timeframes that are missing
 - Units returning from an Outage State which precluded participation in the Installed Capacity market will have the time that they are in an Outage State ignored
 - The NYISO will use previous data from that resource

ESR - Calculating Derating Factors

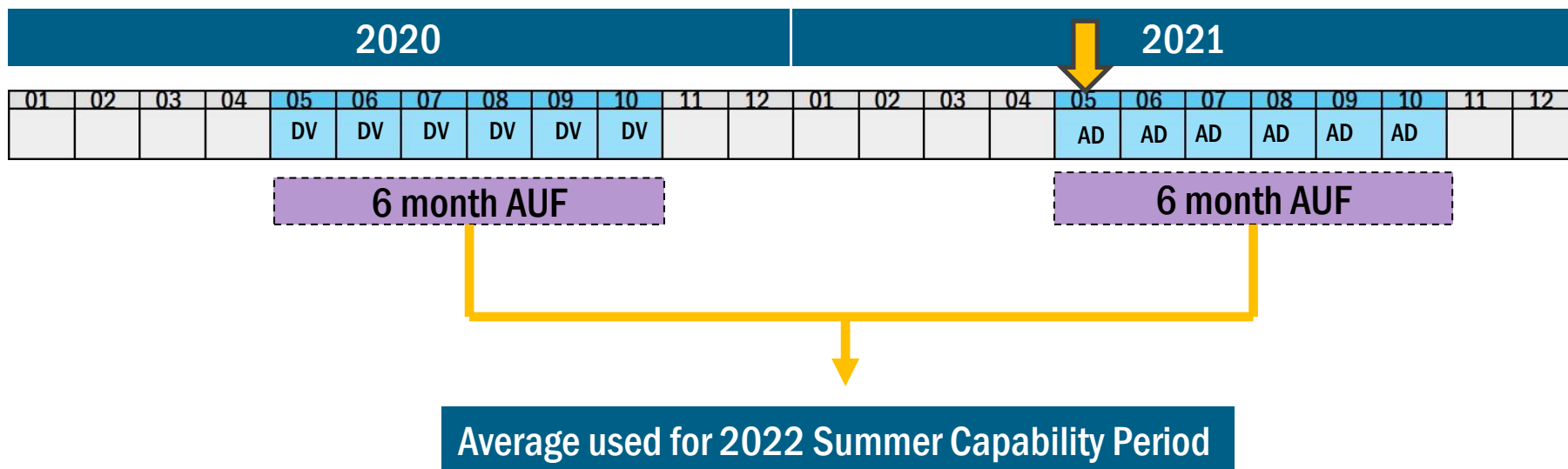
- The following example shows the Derating Factor calculation for the Summer 2022 Capability Period for an ESR that entered the ICAP market in May 2021

DV

Months where default value is used for calculation

AD

Months where availability data is used for calculation



Capacity Market Obligations

ESR - Outage Scheduling

- **ESR Resources are required to follow the same outage scheduling process as all other Generators**
 - Outage Schedules two years forward from the anticipated date of first offer into the capacity market, submitted through the Outage Management System (OMS)
 - ESRs must notify NYISO and their TOs about maintenance outages and derates following prescribed timelines
- **Reductions in the availability of Self-Managed ESRs due to Energy Level constraints will be classified as forced outages**
 - Self-Managed ESRs are expected to adjust their operating characteristics to reflect their availability. Failure to do so will result in forced derates

ESR - Reporting GADS Data

- The required GADS data will be reported by the ESR similar to a generator via the GADS Portal
- GADS data will not be the basis of determining Derating Factors for ESRs
 - The Unavailability Factor for ESRs will be based on the resource's availability to the Real-Time Market System

ESR – Selling Capacity as an ICAP Supplier

- Selling capacity as an ICAP supplier
 - NYISO Auctions
 - Capability Period or Strip Auction
 - Monthly Auction
 - Spot Market Auction
 - Bilateral transactions
 - In accordance to current rules, similar to all other generators

ESR - Certification

- **ESRs that have sold capacity as a supplier in NYISO auctions, or have sold capacity in Bilateral Transactions must follow all current Certification rules and obligations for an ICAP Supplier**
- **Exact timelines and deadlines for Certification obligations identified in the ICAP Event Calendar**

ESR - Determining ICE of the UCAP Supplied

- ICE is the Installed Capacity Equivalent of the amount of Unforced Capacity that the ESR supplies in a specified month
- For every month that the ESR receives UCAP supplier payments:

$$\text{Installed Capacity Equivalent Of UCAP Supplied (ICE)} = \frac{\text{UCAP Supplied for given month}}{1 - \text{Unavailability Factor for given month}}$$

ESR – Day-Ahead Market Obligations

- ESRs that have sold UCAP, must do one or more of the following:
 - Bid [Offer] Energy in the DAM
 - Schedule a Bilateral Transaction
- **AND/OR**
 - Notify the NYISO of any outage
- ESRs with an Energy Duration Limitation (EDL) must, on a daily basis, B/S/N to inject for the entire applicable Peak Load Window
 - The total amount of Energy bid, scheduled, and/or declared to be unavailable must equal the ICAP equivalent of UCAP sold for the unit
- ESRs with an Energy Duration Limitation must also, on a daily basis, B/S/N to withdraw outside of the applicable Peak Load Window
 - Bid, Schedule or Notify for the maximum of the ESR's negative ICAP Equivalent of UCAP sold or Lower Operating Limit

ESR - Example DAM Bid Obligation

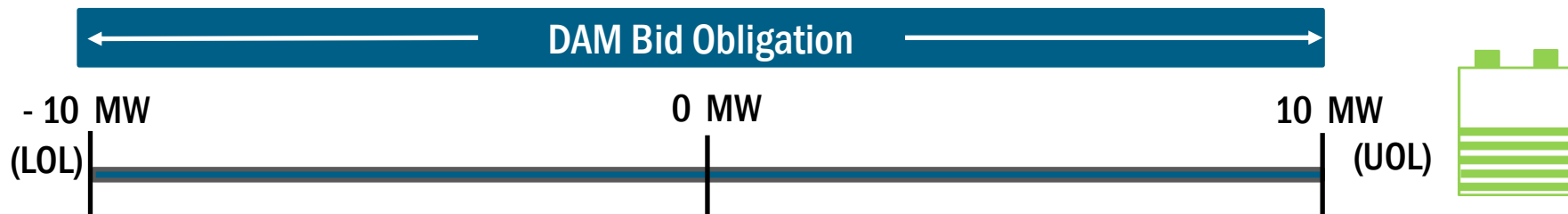
ESR Parameters:

10 MW/40 MWh storage

Upper Operating Limit: 10 MW

Lower Operating Limit: -10 MW

Installed Capacity Equivalent of UCAP sold (ICE) : 10 MW



ESRs – Other Capacity Market Obligations

- **ESRs must:**
 - Respond to a NYISO Supplemental Resource Evaluation (SRE)
 - Provide State of Charge Telemetry to the NYISO
 - Captures information about resource's availability to the Real-Time market system
 - Will be used in calculation of Unavailability factors and in determining forced derates for Self-Managed ESRs
- **ESRs will be subject to penalties/shortfall charges for:**
 - Over sale of capacity
 - Failure to Bid/Schedule/Notify

ESR- Other Capacity Market Obligations

- A new ESR may have an effective delivery month starting within a capability period
 - Registered ELRs or LESRs may undergo a one time switch to ESRs within the capability period
 - ESR must be effective for the entire delivery month
- A PTID configured in the MIS as a BTM:NG Resource cannot participate as an ESR
- An ESR with an effective Reliability Must Run (RMR) contract will be treated similar to other RMRs
 - ESRs operating as RMRs cannot export capacity from internal to external locations

ESR – Capacity Settlements

- **Capacity Payments based on MWs awarded in an auction and the applicable auction clearing price (\$/kW-month)**
 - Convert MWs to kW by multiplying by 1000
 - Then multiply by auction clearing price
 - This monthly capacity payment is then allocated to the weekly invoice accordingly

Capacity Market Mitigation

ESR - Supply Side Mitigation

- **ESRs in Zone J and the G-J Locality (MCZs) will be subject to existing Supply Side Mitigation measures (*i.e.*, the Pivotal Supplier rules)**
 - Must identify all “Affiliated Entities” each month based on the criteria in the Market Services Tariff, Attachment H
 - The ICAP Event Calendar specifies the deadlines for identifying Affiliated Entities
 - Will have a “must offer” obligation if their MW are under the control of a Pivotal Supplier

ESR – Buyer Side Mitigation

- **Buyer Side Mitigation rules apply for resources present in the Mitigated Capacity Zones (New York City and Zones G-J)**
 - Buyer Side Mitigation (BSM) is to prevent uneconomic entry from artificially suppressing Installed Capacity prices
- **Energy Storage Resources (ESRs) will not be subject to review by the NYISO under BSM rules or otherwise be subject to an Offer floor**
 - An ESR is considered an Excluded Facility as it is qualified to satisfy the goals specified in the New York State Climate Leadership and Community Protection Act (CLCPA)
 - [Please refer to MST Section 23.2 for a full definition of Excluded Facilities](#)

Additional Resources

- **Market Services Tariff (MST)**
- **Open Access Transmission tariff (OATT)**
- **Installed Capacity Manual**
- **Attachment J, Unforced Capacity for Installed Capacity Suppliers, ICAP Manual**
- **Attachment K, Reportable Operating Data, ICAP Manual**
- **Installed Capacity Automated Market System (AMS) User's Guide**
- **MST Attachment H, Section 23.4.5 Installed Capacity Market Mitigation Measures**
- **Market Training Course Materials, Intermediate ICAP Course – MT 305**
- **Market Training Course Materials, ICAP AMS Software Changes for Energy Storage Resources (ESR)**

Questions?

For any future assistance, please contact NYISO Stakeholder Services at stakeholder_services@nyiso.com or by phone at (518) 356-6060