Energy Storage Integration – Settlements

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Overview

- **Background**
  - Previous discussions
  - Modeling Enhancements
- **Phase 1: Scheduling Logic**
- **Settlements**
- **Next Steps**

Background

Background

Date	Working Group	Discussion points
08-04-16	Market Issues Working Group (MIWG)	Initial discussion on alternatives for Energy Storage in the NYISO markets
09-29-16	MIWG	Market Design ideas discussion
11-29-16	MIWG	Presentation providing more detail on the Market Design that the NYISO will pursue
05-05-17	MIWG	Presentation addressing the proposed modeling enhancements as the cornerstone of the Energy Storage Integration phase
07-19-17	MIWG	Presentation delving into the eligibility criteria and RT scheduling logic for Energy Storage Resources (“ESRs”).

Proposed ESR Offer Parameters

Registration		*Registration / Biddable*		*Biddable*	
Transition Time	*[minutes]*	Min. Load	*[MW]*	Incremental Bid Curve	*[$/MW]*
Upper Charge Limit	*[MWh]*	Min. Generation	*[MW]*	Beginning State of Charge	*[MWh]*
Lower Charge Limit	*[MWh]*	Min. Load Cost	*[$]*	Ending State of Charge	*[MWh]*
Charge Rate (Max. Load)	*[MW]*	Min. Generation Cost	*[$]*		
Discharge Rate (UOL)	*[MW]*	Start-up Cost	*[$]*	Bid Modes	*[-]*
Energy level (SoC)	*[Yes/No]*	Start-up Load Cost *	*[$]*		
Min. Charge Time	*[minutes]*				
Max. Charge Time	*[minutes]*				
Min. Run Time	*[minutes]*				
Max. Run Time	*[minutes]*				
Min. Downtime	*[minutes]*				
Withdrawing conversion losses	*[%]*				
Injecting conversion losses	*[%]*				
Through-Put *	*[MWh]*				
Response Rate(s)	*[MW/min]*				
Start-up Notification Time	*[minutes]*				
Maximum Stops per Day	*[n]*				

(*) Parameters not included in 5/5/17 MIWG presentation.

Key

Existing Parameter

Additional Storage Parameter

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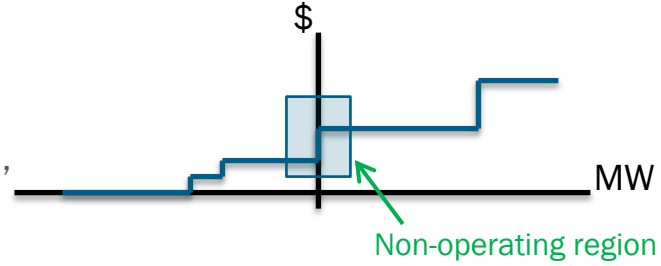
Feedback Received

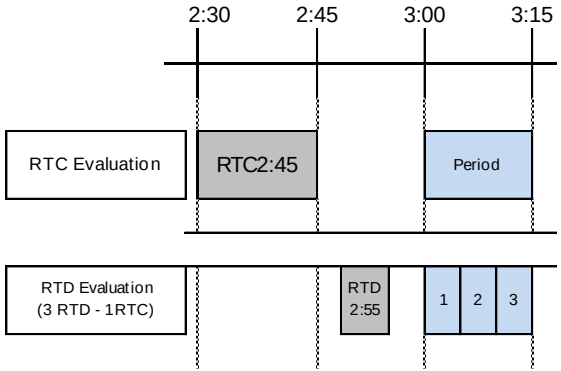
- **During the 7-19-17 MIWG, the NYISO requested feedback regarding the need for additional Response Rates available as bidding parameters.**
  - The NYISO has collected limited feedback from stakeholders and would value additional comments.
- **Stakeholders have expressed interest in the availability of an optional Energy Level (SoC) signal.**
  - The NYISO has taken this into consideration for the proposed Settlements logic that will be reviewed today.
- **Market participants have also reached out to the NYISO regarding LESR SoC management-like optimization alternatives for ESRs.**
  - During Phase 1 of this project, the NYISO is not proposing to make a SoC management alternative available for ESRs. Instead, the proposed scheduling logic will honor the Energy Level (SoC) of the resource ensuring that it is not dispatched above or below its storage capabilities.
- **ESRs that are in front of a customer meter and not serving Load at a facility will not be part of the NYISO's Pilot Project Program.**
  - Energy storage resources that are behind-the-meter may be part of a Pilot Project aggregation.

Phase 1
Scheduling logic

Commitment Decision Considerations

- **If a resource has a non-operating region and/or a transition time:**
  - Three possible operating states will be recognized;“Injecting”, “Withdrawing”, and “Idle”.
  - Decisions to change operating states will be made by RTC.
  - The resource must be able to maintain each state for a minimum of 15 minutes.
- **If a resource does not have a non-operating region or a transition time:**
  - RTD will have the capability to dispatch the resource through its full operating range (i.e. injecting/withdrawing).
- **To the extent that commitment parameters are associated with scheduling the resource, the state of the resource will have to be assigned by RTC.**





Example: RTC-RTD variability

- This example illustrates how an ESR would be dispatched under the proposed scheduling logic if the resulting LBMPs from RTC and RTD for the same interval were dramatically different.

Parameters	*Units*	*Value*
UOL	MW	5
Max. Load	MW	-3
Transition Time	Min	5
Min. Load	MW	-1
Min. Generation	MW	1
Withdrawing losses	%	4%
Injecting losses	%	4%
Energy Level (SoC)	-	Yes
Upper Charge Limit	MWh	5
Lower Charge Limit	MWh	0.5
Charge Rate	MW	-3
Discharge Rate	MW	5
Min. Charge Time	Min	0
Max. Charge Time	Min	240
Min. Run Time	Min	0
Max. Run Time	Min	500

Bid Curve	
MW	Value
-2	0
0	2
2	9
5	10

- The ESR is only providing Energy.
- The ESR has a non-operating region and therefore will be committed by RTC.
- Assumption: Min. Load and Min. Generation costs are low enough for the resource to be scheduled.
- The Energy Level is not binding during the period considered.

Example: RTC-RTD variability (Cont.)

RTC	LBMP [USD/MWh]	Optimal Dispatch [MW]	Actual Dispatch [MW]	Total withdrawing [MWh]	Total injecting [MWh]	Energy level [MWh]	**Assigned State** [Char./Idle/ Disc.]
t-1	-	-	-	-	-	4.00	
0:00	-1.00	-3.0	-3.0	-0.7	0.0	4.72	Charging
0:15	2.00	0.0	0.0	0.0	0.0	4.72	Idle
0:30	3.00	0.0	0.0	0.0	0.0	4.72	Idle
0:45	10.00	5.0	5.0	0.0	1.2	3.52	Discharging
1:00	11.00	5.0	5.0	0.0	1.2	2.32	Discharging
1:15	12.00	5.0	5.0	0.0	1.2	1.12	Discharging
1:30	9.00	2.0	2.0	0.0	0.5	0.64	Discharging
1:45	8.00	0.0	0.0	0.0	0.0	0.64	Idle
2:00	7.00	0.0	0.0	0.0	0.0	0.64	Idle
2:15	6.00	0.0	0.0	0.0	0.0	0.64	Idle

- RTC will produce LBMP and assign a State to the resource (Charging / Idle / Discharging).
- This State cannot be changed by RTD.

Example: RTC-RTD variability (Cont.)

RTC	LBMP [USD/MWh]	Dispatch [MW]	State [Char/Disch/Idle]	RTD	LBMP [USD/MWh]	Dispatch [MW]
0:00	-1.00	-3.00	Charging	0:00	-1.00	-3.0
				0:05	-1.00	-3.0
				0:10	2.00	-1.0
0:15	2.00	0.00	Idle	0:15	3.00	0.0
				0:20	4.00	0.0
				0:25	7.00	0.0
0:30	3.00	0.00	Idle	0:30	8.00	0.0
				0:35	7.00	0.0
				0:40	7.00	0.0
0:45	10.00	5.00	Discharging	0:45	10.00	5.0
				0:50	9.00	2.0
				0:55	10.00	5.0

- RTC will produce LBMP and assign a State to the resource (Charging / Idle / Discharging).
- This State cannot be changed by RTD.
- The binding RTD interval for the last 5 minutes of the 0:00 RTC produces an LBMP which indicates that the resource should be idle.
- RTD cannot change the "Charging" State of the ESR.
- It is dispatched to its Min. Load.

Binding interval

RTC-RTD Forecast Variability

- **System conditions in RT may vary, yielding differences between what RTC forecasts and how the system is optimized in the binding RTD interval.**
  - An ESR could be economically selected by RTC, yet be uneconomic for the binding RTD interval that determines its base point.
  - This can occur today to resources evaluated by RTC for commitment (quick-start units).
    - RTD can dispatch a resource to its minimum level, but it cannot change a resource's state (i.e. turn it off).
  - RTD will have the capability to dispatch an ESR to its minimum level, which could be either Min. Load or Min. Generation.

Settlements

We will be discussing:

- Penalties
  - -Examples
- Day-Ahead Margin Assurance Payments (DAMAP)
- Bid Production Cost Guarantee (BPCG)
  - -Examples

Existing Penalties for Over- and Under-Generation

- **Under the current NYISO Generator penalty structure for over/under generation, in general, an energy provider is expected to remain within a 3% of UOL tolerance from its Base Point.**
  - However, if a Generator's actual output deviates by more than 3%, it might be subject to penalties. Ordinarily, the penalties for a resource are structured as follows:
    - If a Generator over-generates by more than 3%, it is only compensated for an additional 3% of its UOL above its original Base Point.
    - If a Generator under-generates by more than 3%, it is only compensated for its actual output; and it incurs a penalty for the difference between its actual output and the lower bound of the 3% band created around the Base Point that the resource received.

Existing Penalties for Over- and Under-Generation - Example

- Assume a resource with a 100 MW UOL receives a Base Point of 50 MW.

	MW
UOL	100
BasePoint	50
3% of UOL	3

Actual Output		*Settlement*	
[MW]	-	[MW]	-
51	Acceptable	51	Settled for its actual output.
60	Over-generating	53	Only compensated for 3% of its UOL above the Base Point received. There is an implied penalty embedded in the operational costs.
40	Under-generating	40 MW + Additional Penalty	Compensated for its actual output but incurs a penalty for 7 MW (40 - (50 - 3))

Penalties for Over- and Under-Withdrawing: ESRs Proposal

- **The NYISO proposes to extend the current penalty structure to ESRs:**
  - ESRs will be expected to remain within 3% of the resource's maximum capability (UOL/Max. Load).
    - For generating/injecting states, 3% of the resource's UOL will be deemed acceptable.
    - For withdrawing states, 3% of the resource's Max. Load will be deemed acceptable.
  - Additionally, if an ESR is over-withdrawing energy from the grid, the NYISO proposes to apply a penalty, the same as when the resource is under-generating in a generating state.

Penalties for Over- and Under-Withdrawing: ESRs Proposal Example

- Assume an ESR with a -100 MW Max. Load receives a Base Point of -50 MW.

	MW
Max. Load	-100
BasePoint	-50
3% of Max. Load	-3

Actual Output		*Settlement*	
[MW]	-	[MW]	-
-51	Acceptable	-51	Settled for its actual output.
-60	Over-withdrawing	-60 MW + Additional Penalty	The resource will be settled for its actual output but incurs a penalty for 7 MW (60 - (50 - 3)).
-40	Under-withdrawing	-47 MW	Settled for 3% of its Max. Load above the Base Point received.

Day-Ahead Margin Assurance Payments (DAMAP)

- **The NYISO currently protects otherwise eligible resources with a DA schedule that would suffer a reduction in their DA margin as a result of NYISO instructions in RT.**
  - If a resource receives a RT dispatch level lower than its DA schedule, forcing it to buy-out from its DA position, the NYISO protects the resource's DA margin.
  - Day-Ahead Margin Assurance Payments (DAMAP) are calculated on an hourly-basis.
- **The NYISO proposes to maintain its existing DAMAP logic for ESRs in injecting states.**
  - Special eligibility provisions might be required for ESRs as they have additional operational capabilities and constraints.
- **For withdrawing states, the NYISO is considering making ESRs eligible for DAMAP if they were dispatched in RT to a lower withdrawing value than their DA schedule.**

Day-Ahead Margin Assurance Payments (DAMAP) (Cont.)

- **Among other provisions, the following are included in the current NYISO DAMAP logic:**
  - Resources that are dispatched by RTD or available for commitment by RTC could be eligible for DAMAP.
    - Energy Limited Resources with an ISO-approved real-time reduction in scheduled output from its Day-Ahead schedule could also be eligible for DAMAP.
  - Generators lagging behind RTD base point signals under their penalty limit for under-generation are not eligible for DAMAP.
  - In general, resources that make adjustments to their bids which make them less likely to be dispatched in RT, are precluded from receiving DAMAP. Specific causes include the following:
    - Increasing RT Incremental Energy Bids.
    - Increasing Start-up costs in RT.

Day-Ahead Margin Assurance Payments (DAMAP) (Cont.)

- The DAMAP construct aims to protect resources that could have honored their DA schedule in RT, had the NYISO not provided different instructions.
- If an ESR is providing an Energy Level (SoC) signal, the NYISO will take it into consideration when dispatching the resource in RT.
- To determine if an ESR is eligible for DAMAP in a given hour, the NYISO proposes to consider the Energy Level of the resource in RT as compared to its DA schedule, and if the resource is capable of honoring its DA schedule, then it will remain eligible for DAMAP.
- If an ESR does not provide an Energy Level (SoC) signal, it is at risk of receiving a dispatch signal in RT that it would not be able to meet . Not following NYISO instructions in RT would make the resource ineligible for DAMAP.
    - If an ESR does not provide its Energy Level, the NYISO will not have sufficient RT information of the resource's status and ability to follow its DA schedule.

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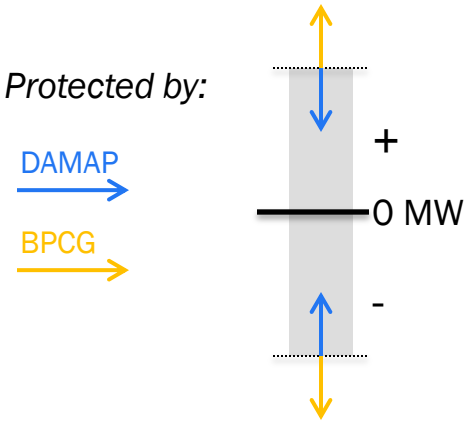
Bid-Production Cost Guarantee (BPCG)

- Currently, if a resource is committed, but the LBMP revenues are not enough to cover the resource's costs, it might be eligible for a BPCG payment.
  - BPCG payments are calculated on a daily-basis.
- The NYISO proposes to maintain BPCG for ESRs.
  - If an ESR is uneconomically committed for either withdrawing or injecting, it could be eligible for BPCG.
- The NYISO is considering in its proposal that receiving DAMAP payments for one state (withdrawing/injecting) would not necessarily preclude an ESR from being eligible for BPCG payments for another state during the same hour.

DAMAP and BPCG simultaneous eligibility

- The NYISO is considering in its proposal that receiving DAMAP payments for one state (withdrawing/injecting) would not necessarily preclude an ESR from being eligible for BPCG payments for another state during the same hour.



- Under the NYISO's current proposal, if an ESR was providing energy, deviations from base points received could be covered by different protection payments (DAMAP / BPCG).
  - Movements in the same direction would be covered by different protection payments, depending on the state of the resource.
  - An ESR could satisfy the eligibility criteria for both payments simultaneously.

Current DAMAP Construct Example

	Description	Units	Value	
DA	Bid	[USD/MW]	10	a
	LBMP	[USD/MW]	30	b
	Schedule	[MW]	10	c
	DA Settlement	[USD]	300	d = b * c
	Margin	[USD]	200	e = (b - a) * c
RT	LBMP	[USD/MW]	35	f
	Schedule	[MW]	8	g
	Schedule difference (RT - DA)	[MW]	-2	h = g - c
	RT Settlement	[USD]	-70	j = h * f
	DA Cost for MWs not delivered	[USD]	20	k = h * a
	DAMAP	[USD]	50	l = -j -k

- In RT, a resource is dispatched down from its DA schedule.
- It is forced to buy-out of its DA position.
- This decreases its DA margin.
- Provided that the resource is eligible for DAMAP, its margin would be protected.
- The resource would receive DAMAP payment of $50.

Proposed ESR DAMAP Construct Example 1

	Description	Units	Value	
DA	Bid Withdrawing	[USD/MW]	5	a
	LBMP	[USD/MW]	3	b
	Schedule	[MW]	-10	c
	DA Settlement	[USD]	-30	d = b * c
	"Margin"	[USD]	20	e = (b - a) * c
RT	LBMP	[USD/MW]	2	f
	Schedule	[MW]	-8	g
	Schedule difference (RT - DA)	[MW]	2	h = g - c
	RT Settlement	[USD]	4	j = h * f
	DA value of MW not withdrew	[USD]	-10	k = h * a
	DAMAP	[USD]	6	l = -j -k

- A resource is dispatched to a lower withdrawing value in RT.
- It is forced to sell-out of its DA position.
- This decreases its DA "margin" or implied surplus.
- Provided that the resource is eligible for DAMAP, its margin would be protected.
- The resource would receive a DAMAP payment of $6.

Proposed ESR DAMAP Construct Example 2

	Description	Units	Value	
DA	Bid Withdrawing	[USD/MW]	5	a
	LBMP	[USD/MW]	1	b
	Schedule	[MW]	-10	c
	DA Settlement	[USD]	-10	d = b * c
	"Margin"	[USD]	40	e = (b - a) * c
RT	LBMP	[USD/MW]	4	f
	Schedule	[MW]	-6	g
	Schedule difference (RT - DA)	[MW]	4	h = g - c
	RT Settlement	[USD]	16	j = h * f
	DA value of MW not withdrew	[USD]	-20	k = h * a
	DAMAP	[USD]	4	l = -j -k

- A resource is dispatched to a lower withdrawing value in RT.
- Provided that the resource is eligible for DAMAP, its margin would be protected.
- The resource would receive a DAMAP payment of $4.

Proposed ESR BPCG Construct Example 3

	Description	Units	Value	
RT	Bid Withdrawing	[USD/MW]	20	a1
	Bid Injecting	[USD/MW]	50	a2
	LBMP	[USD/MW]	9	b
	Schedule	[MW]	8	c
	Costs	[MW]	400	d = a2 * c
	RT Settlement	[USD]	72	e = b * c
	BPCG (Injecting State)	[USD]	328	f = d - e

- A resource is uneconomically committed to satisfy reliability requirements.
- The LBMP is not high enough for the resource to recoup its costs.
- The resource would be protected by a BPCG payment.

Proposed ESR BPCG Construct Example 4

	Description	Units	Value	
RT	Bid Withdrawing	[USD/MW]	20	a1
	Bid Injecting	[USD/MW]	50	a2
	LBMP	[USD/MW]	25	b
	Schedule	[MW]	-10	c
	Costs	[MW]	-200	d = a2 * c
	RT Settlement	[USD]	-250	e = b * c
	BPCG (Withdrawing State)	[USD]	50	f = d - e

- A resource is uneconomically committed to satisfy reliability requirements.
- The LBMP is not low enough to make withdrawing electricity from the grid economically attractive to the resource.
- The resource would be protected by a BPCG payment.

Proposed ESR Settlements Logic Example 5 – Dual Eligibility

	Description	Units	Value	
DA	Bid Withdrawing	[USD/MW]	20	a1
	Bid Injecting	[USD/MW]	50	a2
	LBMP	[USD/MW]	12	b
	Schedule	[MW]	-10	c
	DA Settlement	[USD]	-120	d = b * c
	"Margin"	[USD]	80	e = (b - a1) * c
RT	LBMP	[USD/MW]	9	f
	Schedule	[MW]	8	g
	Schedule difference (RT - DA)	[MW]	18	h1 = g - c
	RT Settlement	[USD]	162	j1 = h1 * f
	Based on a -10 MW DA schedule			
	Schedule difference (RT - DA) [10 MW]	[MW]	10	h2 = g - c
	RT Settlement [10 MW]	[USD]	90	j2 = h2 * f
	DA value of MWs not withdrew	[USD]	-200	k = h2 * a1
	DAMAP	[USD]	110	l = -j2 -k
	BPCG (Injecting State)	[USD]	328	m = (a2 - f) * g

- In this example, the resource is uneconomically scheduled to inject in RT.
- The "withdrawing" portion of the schedule would be eligible for DAMAP.
- However, the resource is uneconomically committed for injecting in RT, and therefore, it would also be eligible for a BPCG payment for the "injecting" portion of the RT-DA variation.
- The DAMAP calculation would consider the "margin" harmed due to not withdrawing the 10 MW scheduled in DA.

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Next Steps

- The NYISO will continue to evaluate the operational feasibility of the proposed ESR scheduling logic.
- During Q3-2017, the NYISO will discuss additional ESR modeling and settlements considerations with stakeholders pertaining the following:
  - DA scheduling logic
  - Ancillary services

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Feedback

- The NYISO seeks feedback on the materials presented today.

- Email additional feedback to: Daniel F. Noriega
  dnoriega@nyiso.com

Questions?

We are here to help.

The Mission of the New York Independent System Operator, in collaboration with its stakeholders, is to serve the public interest and provide benefits to consumers by:

- Maintaining and enhancing regional reliability
- Operating open, fair and competitive wholesale electricity markets
- Planning the power system for the future
- Providing factual information to policy makers, stakeholders and investors in the power system

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