

Energy Storage Market Design Update

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Market Issues Working Group

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Agenda

- Background
- Energy Market Design Overview
- ESR Participation Model Prototyping
- Market Design Timeline
- Next Steps

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Background

Previous Presentations

Date	Working Group	Discussion points
12-20-17	MIWG	Market Design Concept Proposal Summary
02-21-18	MIWG	Ancillary Services Treatment in the ESR Participation Model
04-24-18	MIWG	Capacity Market Rules for Energy Storage Resources
04-26-18	MIWG	ESR Participation Model: Energy Level Monitoring
05-23-18	MIWG	ESR Settlements
06-19-18	MIWG	ESR Metering
06-25-18	MIWG	ESR Settlements: Charges when deviating from NYISO Base Points
07-10-18	MIWG	Energy Market Mitigation Measures for ESRs

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Background

- In 2017, the NYISO developed a market design concept for a participation model that will enable ESRs to offer their full capabilities into the NYISO's wholesale Energy, Capacity, and Ancillary Services markets.¹
 - The ESR Participation Model was prioritized as a Key Project with a deliverable of Market Design Complete in Q3 of 2018.
- On February 15, 2018, FERC issued Order No. 841, directing “each RTO/ISO to revise its tariff 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.”²
 - The compliance filing deadline for Order No. 841 is December 3, 2018, with an implementation deadline of December 3, 2019.

1. See NYISO, *Energy Storage Integration: Market Design Concept Proposal* (Dec. 20, 2017) at http://www.nyiso.com/public/webdocs/markets_operations/committees/bic_miwg/meeting_materials/2017-12-20/2017%20ESR%20Market%20Design%20Concept%20Proposal.pdf

2. 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”).

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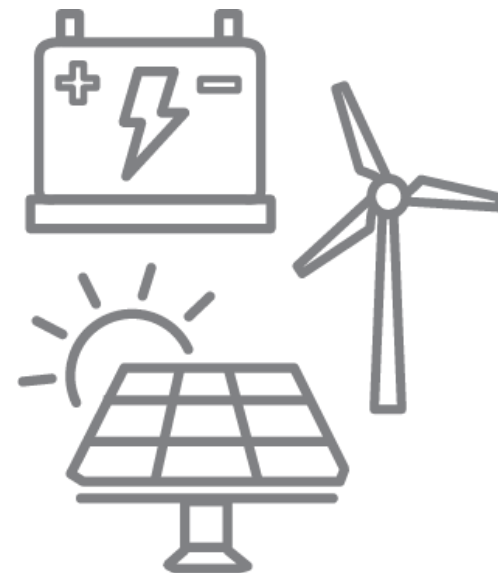


Energy Market Design Overview

For Energy Storage Resources in the NYISO's
markets

Energy Market Design Overview

- **Technology neutral participation model.**
 - Accommodates all storage types (e.g. flywheel, battery, pumped storage).
 - Market optimization will include unit commitment (not dispatch-only).
- **Minimum offer size for Energy, Capacity, and Ancillary Services: 100 kW.**
 - Energy and A/S will be scheduled following the same principles used for other suppliers.
 - ESR's will be eligible to provide Reserves and Regulation while withdrawing.
- **While withdrawing from the grid, energy consumed by ESR's will be treated as negative generation rather than load.**
 - Consistent with treatment of ELR's and LESR's today and directives in FERC Order No. 841.



Energy Market Design Overview (Cont.)

- **ESR's with non-continuous operating regions will be able to offer both injecting and withdrawing capabilities during the same market intervals.**
 - Today, suppliers (e.g., pumped storage) that have non-continuous operating regions between their minimum withdrawal and injection operating points must offer either withdrawal or injection capabilities in a given market interval to avoid receiving infeasible schedules.
- **No special treatment for metering or interconnection; will qualify as “Generators” under NYISO tariff.**
- **Will be eligible to use all existing Generator offer parameters, as well as additional operating characteristics identified by NYISO and the FERC:**

Upper Storage Limit
Lower Storage Limit
Maximum Load
Minimum Load
Minimum Withdrawing Time

Maximum Withdrawing Time
Maximum Run Time
Start-up Load Cost
Minimum Load Cost
Withdrawing Response Rates

Roundtrip Efficiency
State of Charge

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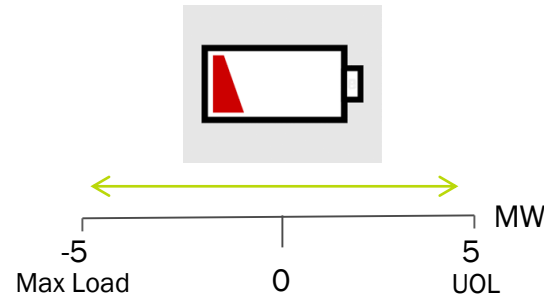
Energy Market Design Overview (Cont.)

- ESRs will be allowed to participate in one of two modes:
 1. NYISO-monitored energy level:
 - NYISO will use State of Charge (SoC), Roundtrip Efficiency, Lower and Upper Storage limits to ensure that ESR's receive physically feasible schedules in the DAM and RTM.
 - For example: once an ESR reaches its Upper Storage Limit, it will not be scheduled to withdraw more energy, regardless of its bid.
 2. Self-monitored energy level:
 - The NYISO will not use SoC, Roundtrip Efficiency, Lower or Upper Storage limits to schedule ESRs that self-monitor their energy level.
 - Self-monitoring ESR's will be responsible for managing their energy level constraints through their offers.

ESR Participation Model Prototyping

ESR Participation Model Prototyping

- Continuous ESR's do not require commitment to transition between withdrawing and injecting states.
 - Example: Lithium-ion batteries like those used in cell phones or laptops can easily transition from withdrawing to injecting states without down time and without passing through infeasible operating regions.

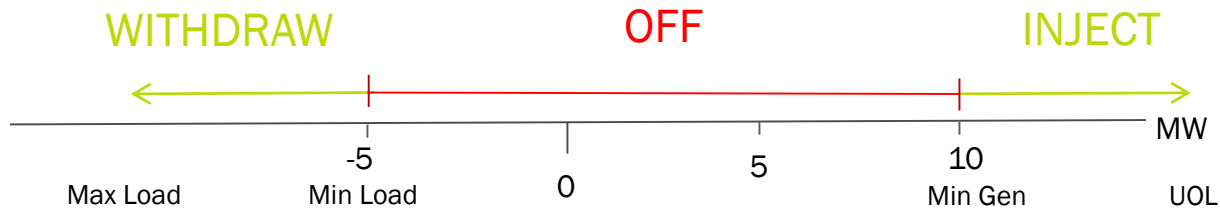


- The resource can either be ON or OFF.
- In this example, Max Load is equivalent to Min Gen from the market software's perspective.

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ESR Participation Model Prototyping

- Non-continuous ESR's have infeasible operating regions between Min Load and Min Gen.
 - Example: pumped storage facilities typically have a minimum pumping level that requires a minimum withdrawal from the grid (e.g. -5 MW), and a minimum generation level for injections (e.g. 10 MW). They cannot be scheduled to operate in the region between their Minimum Load and Minimum Generation levels.

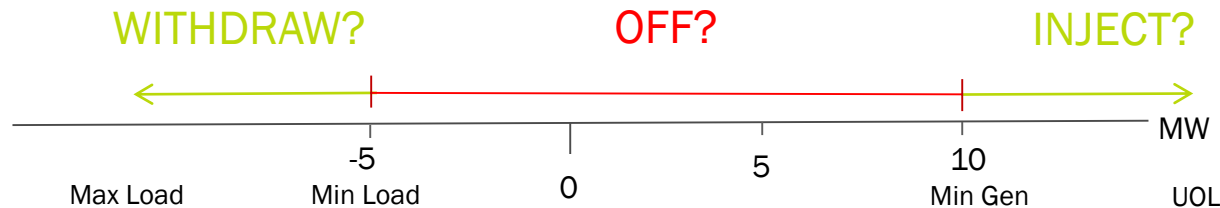


- The resource can be Withdrawing, Generating, or Off.

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ESR Participation Model Prototyping

- Non-continuous ESR's present a ternary commitment problem:
 - Three states available for commitment: Withdrawing, Injecting, or Off.
 - Traditional generators have just two states: On or Off.
 - Enabling ESR's to offer all 3 states for each market interval complicates the market optimization.



ESR Participation Model Prototyping

- In addition to the ternary commitment problem, ESRs have operating constraints that the NYISO does not manage for conventional resources:
 - State of Charge (SoC), Upper and Lower Storage Limits
 - Min Load, Max Load, Start-Up Load Cost, Withdrawing Time, Roundtrip Efficiency, Withdrawing Response Rates
 - Each additional parameter has the potential to increase solution time.
- Adding more ESRs will also increase the time it takes to solve the problem.

ESR Participation Model Prototyping

- **NYISO is working closely with software vendor ABB to prototype the NYISO's ESR market design, starting with the Day-Ahead Market.**
 - Initially focused on modeling non-continuous ESRs that have infeasible operating regions between Min Load and Min Gen.
 - Adding operating parameters, Ancillary Services, and additional ESRs gradually to evaluate effects on solution time.
- **The NYISO and ABB are using the latest software platforms and technology to improve the solution time of the ternary commitment problem.**
- **Results expected from ABB by 9/30/18.**

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ESR Participation Model Prototyping

- **The NYISO's prototyping effort will inform our stakeholders and the FERC of how ESRs will initially be allowed to participate in the NYISO's markets.**
 - If prototyping results indicate that RTM or DAM solution times cannot meet current performance standards, the NYISO may not enable unit commitment for ESR's as part of the December 2019 deployment.
 - Certain parameters may be either available on a limited basis or unavailable until such time that solution performance time is satisfactorily improved.
- **ABB will work with NYISO to implement the storage participation model in the new EMS/BMS platform next year.**

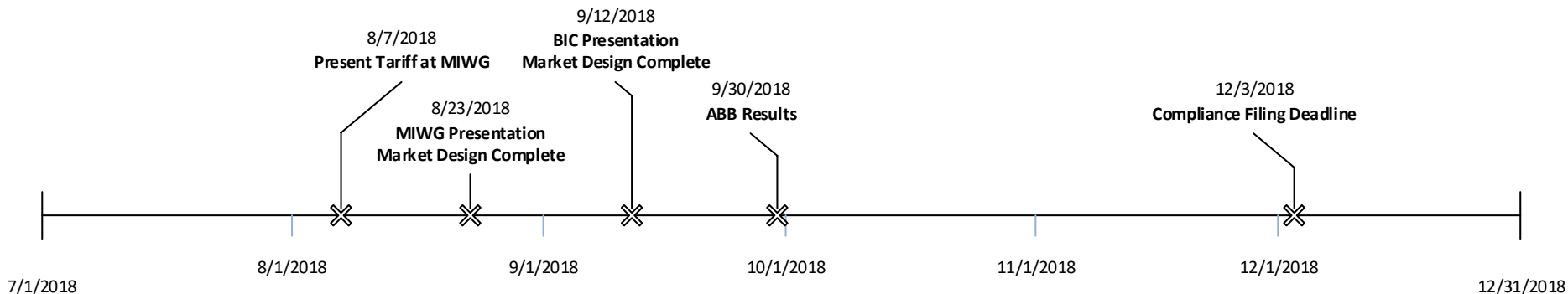
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Market Design Timeline

For the development of the Energy Storage Resource participation model

Market Design Timeline

The NYISO is working towards the following milestones for the ESR participation model:



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Next Steps

- Prepare draft Tariff language and Market Design Complete materials for August MIWG and September BIC.
- Continue working with ABB to evaluate solution time impacts.

Questions?

We are here to help. Let us know if we can add anything.

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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