IESO Engagement Session

Storage and Co-located Hybrid Integration Project Meeting #2

Enabling Resources Program (ERP)
October 16, 2025

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Territory Acknowledgement

The IESO acknowledges the land we are delivering today's webinar from is the traditional territory of many nations including the Mississaugas of the Credit, the Anishnabeg, the Chippewa, the Haudenosaunee and the Wendat peoples and is now home to many diverse First Nations, Inuit and Métis peoples. We also acknowledge that Toronto is covered by Treaty 13 with the Mississaugas of the Credit First Nation.

As we have attendees from across Ontario, the IESO would also like to acknowledge all of the traditional territories across the province, which includes those of the Algonquin, Anishnawbe, Cree, Oji-Cree, Huron-Wendat, Haudenosaunee and Métis peoples.

Engagement Principals and Process

- The Enabling Resources Program ('ERP' or 'Program') will be conducted according to the **IESO Engagement Principles**

- Today's session will be **recorded** and available for viewing online

- **Meeting materials** are posted on the ERP Storage & Co-located Hybrid Integration Project engagement webpage

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Meeting Logistics and Participation

- For questions and comments, click on the "**raise hand**" icon (hand symbol) at the top of the application window. This will indicate to the host you would like to speak

- To **unmute** audio, click on the microphone icon at the top of the application window

- Audio should be **muted** when not speaking

- **Connection issues** contact engagement@ieso.ca or Microsoft Office Support directly

ERP Engagement Webpages

ERP engagement webpage: ERP webpage

- Landing page for program-level updates, information and documents

ERP project webpages: Storage and Hybrid Integration Project

- ERP projects (e.g. Storage & Co-located Hybrid and DERs) have their own engagement webpage to communicate the meeting schedule, materials and related information

- A DERs ERP engagement webpage will be published in November 2025

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Purpose

- Provide an update on the S/H Integration (S/H) Project

  o Finalize Optimization design element (see Design Memo)

- Review feedback received from the last engagement session

- Share project schedule for 2026

- Feedback on key areas of the design from the sector

Agenda

Today's session will cover the following topics:

- Overview: Storage & Co-located Hybrid (S/H) Project
- Summary of Feedback from July 24th Session
- Relevant Decisions Made
- A "Day in the Life" in the new design
- Next Steps

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S/H Project Overview

Enabling Resources Program: Scope

The Enabling Resources Program is a set of projects that will further enable key emerging resources, specifically electricity storage ("storage"), hybrid generation-storage pairings ("hybrids") and aggregations of Distributed Energy Resources ("DERs") into the IESO-administered markets, tools, and processes to provide required system services and contribute to the safe and reliable operation of the bulk power system in Ontario.

Program Overview: ERP Projects

Storage and Co-located Hybrid (S/H) Integration Project (*Transmission/Distribution Resources*)

- **Storage** – ERP will implement an enhanced storage model, building upon the interim storage model that was implemented in 2018

- **Co-located Hybrids** – ERP will implement an enhanced co-located model which applies the enhanced storage model to the storage resource within a hybrid facility, building on the foundational co-located model implemented in 2023

Distributed Energy Resources (DER) Integration Project *(Distribution Resources)*

- **Distributed Energy Resources** – ERP will enable aggregated DERs and, potentially, smaller standalone DERs to participate in wholesale electricity markets. This work will include improving DER information sharing between LDCs and the IESO for enhanced visibility and, in the future, coordination

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Storage and Hybrid Integration Project

Drivers for change:

~3,000MW of contracted storage resources are scheduled to be in service by 2028

Limitations of the current two-resource model is creating **operational challenges** and reducing market efficiency

The project is taking a phased approach to fast-track key storage design features that will improve scheduling, reduce manual work for the Control Room, and enhance operations for battery storage market participants.

Phase 1 (2027-2028)

- ✓ Bi-directional single resource model (battery only)
- ✓ State of Charge (SoC) management

Future Phases (TBD)

- ✓ Regulation (AGC) from storage resources
- ✓ Uplift Exemptions
- ✓ Additional features and improvements

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Proposed Timeline: Engagement on S/H Design Elements

timelines are subject to change

	Q4 2025	Q1 2026	Q2 2026	Q3 2026	Q4 2026
Batch 1					
Optimization Market Design	Market Design	Market Rules and Manuals			Technical Panel
Batch 2					
Connection and Registration		Market Design	Market Rules and Manuals		Technical Panel
Grid and Market Operations		Market Design	Market Rules and Manuals		Technical Panel
Market Power Mitigation		Market Design		Market Rules and Manuals	Technical Panel
Settlements	Market Design			Market Rules and Manuals	Technical Panel
Contracts		Contract Impacts			
Batch 3					
Hybrid Market Design				Hybrid Market Design, Market Rules and Manuals, Technical Panel	

Will look to consolidate for engagement & TP

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Summary of Feedback from July 24th Session

Purpose and Context

Purpose: To provide a summary of external feedback received following the July 24 engagement session

Context:

- Feedback has been incorporated into the Optimization Design Element

- Some feedback received was out of scope of the S/H Integration Project Phase 1; however, it is valuable for other internal initiatives (e.g. ERP DER Integration Project, S/H Integration Phase 2) or involvement from other teams within the IESO (e.g. Contract Management).

- At times, differing opinions were noted on certain topics from sector participants. The feedback was reviewed by the IESO S/H design team which helped inform design decisions.

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Summary of Feedback

Topic	Summary of Feedback Received	Action/Decision
CycleDEL	Support for the CycleDEL, but request specific examples to be provided. CycleDEL should be passed to RT.	CycleDEL will be an MP submitted Daily Dispatch parameter. CycleDEL cannot be incorporated into RT. Example in memo.
Derates/RTE	General support of concept due to operational and maintenance challenges. Treat Energy and Power derates separately.	Derates will only apply to Power and can be submitted via CROW. Energy parameters and RTE will be submitted as Daily Dispatch parameters and can be updated.
Exceeding Min/Max SoC Limits	General support for the concept as exceeding limits may need to occur during maintenance or exceptional market conditions. MPs concerned about risks related to accelerated degradation, warranty invalidation, and voltage imbalances.	Introduce MinSoC and MaxSoC as Daily Dispatch parameters. Introduce Absolute MinSoC and Absolute MaxSoC as registered parameters. Can adjust Min/MaxSoC down/up to these values.
Uprates	Support for adopting a specific procedure related to uprates.	Discussed under the "Exceeding Min/Max SoC Limits" topic
Operating Reserve Offers	MPs strongly support the concept of branching from withdrawal to injection. Concern about only 5 P/Q pairs for offering.	Design currently includes branching. To discuss with Contract Management on impacts to contracts.
Ramp Rates	MPs generally opposed to static Ramp Rate as it may limit revenue opportunities. Concerns about fairness for Dx resources.	Limit was implemented to help dampen BESS response to 5-minute energy dispatch instructions and mitigate the challenges these facilities pose to Area Control Error (ACE).
Telemetered SoC	Concern related to incremental setup costs associated with the 4-second requirement.	4-second requirement is per existing market rules and applicable for all storage resources (existing and new).

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Summary of Feedback

Topic	Summary of Feedback Received	Action/Decision
Contract Management involvement	IESO contract management must participate in the ERP design process so that MPs can understand the full impact of market design changes for Ontario rate-payers & MP operating obligations.	Module on Contract Management in batch 2.
Funding for Metering	Clarify funding responsibilities for required investments such as additional metering for station service and auxiliary load requirements.	For optimization, the IESO introduced Internal Service Load (ISL) estimate. No additional requirements set at this time.
Lasting Market Design	MPs want to avoid the requirement to register and operate under one market design for a short period and then need to make changes for a new market design so early in the life of the asset. Requests for inclusion of other storage types.	As stated in previous engagement the IESO intends to operate in a phased approach, design will be constantly evolving for keeping the market design efficient and support more opportunities for storage.
Demand Charge Adjustment	Suggests that IESO consider how load offers during peak hours interact with demand charges and Global Adjustment (GA) costs, especially for Class A customers. These costs may discourage participation unless exemptions are provided.	As part of Phase 2 the IESO will further explore uplifts. MP's must be cognizant of their contract requirements.
Other	Received feedback regarding Market Data, shortening the mandatory window, and local grid coordination.	These factors are out of scope for the storage and hybrid design. Information will be passed forward to other departments, as necessary.

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Optimization Design Decisions

Single Resource Model

Single Resource Model

Consistent with other jurisdictions, the new single resource model will have a continuous offer curve.

The load portion will operate as a "negative generator" (negative MWs) and the generator portion as a "positive generator" (positive MWs).

The resource will be considered a "*bi-directional generator*" and "*quick start*".
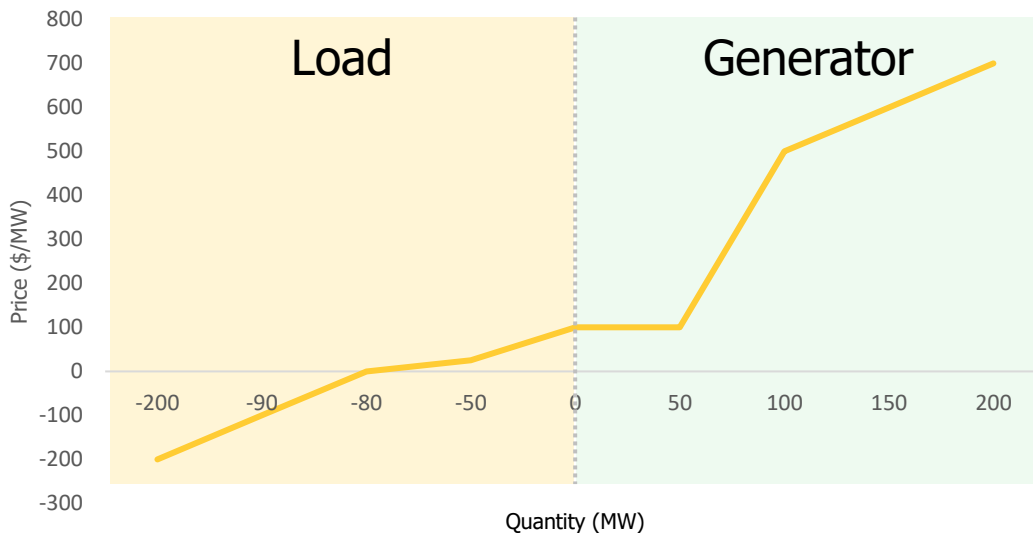
Example: Capacity 200 MW, Energy Limit 800MWh

Commissioning

- The resource will still operate under a single resource model with exclusions and requirements to support this period of the resource's operation as follows:

    - Participation as a self-scheduling generator under existing requirements but utilizing negative generator characteristics
    - When injecting, provide self-schedule with a positive MW quantity
    - When withdrawing, provide–self-schedule with negative MW quantity.
    - LMP pricing will apply whether injecting or withdrawing during all time frames.
    - The resource must submit self-schedules that respects its own state of charge limitations.

- Existing storage resources that are currently operating under the two-resource self-scheduling model will not be impacted by the new self-scheduling model, and that model will persist as is.

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MP Data Submission

Single Bid-Offer Curve for Energy

- Storage participants will be able to submit between 2 to 20 price-quantity (P-Q) pairs ($/MW) for energy.

- For storage, the quantities will monotonically increase and branch from withdrawal to injection crossing over 0 MW (as in example), if they offer to provide both injection and withdrawal in the same dispatch hour.

- Negative quantity indicates buying energy from the grid and positive denotes selling to the grid.

- For hours when the storage only wants to withdraw, the offer will range from a negative MW to 0. For hours when the storage only wants to inject, the offer will range from 0 MW to a positive MW.
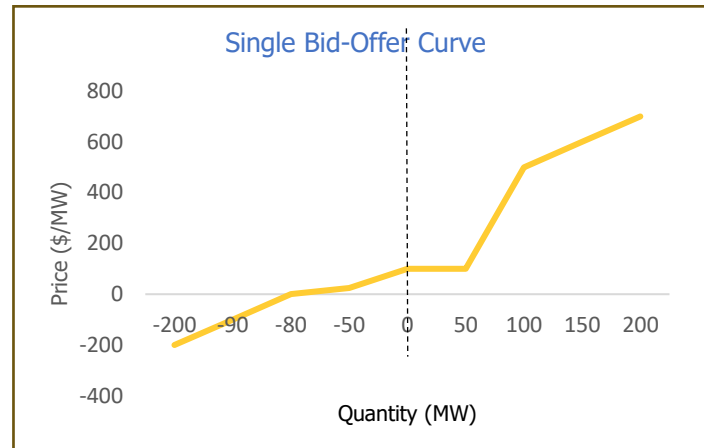
Single Bid-Offer Curve

|	Price ($/MW)	Quantity (MW)
Pair 1	-200	-200
Pair 2	-100	-90
Pair 3	0	-80
Pair 4	25	-50
Pair 5	100	0
Pair 6	100	50
Pair 7	500	100
Pair 8	600	150
Pair 9	700	200

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Operating Reserve

- Can participate in each class of operating reserve (10S, 10N, 30R) for each dispatch hour

- The IESO will support an OR offer that leverages the maximum activation response of a storage i.e., branching from withdrawal to injection (reducing charging and moving into discharge mode)

- This implies that, for any given hour, the participant will be able to submit an offer for any of these: injection, withdrawal or branching. Engine should respect SoC and feasibility of method to provide OR.

Example Energy Offer		
P/Q Pair	**Price ($/MW)**	**Quantity (MW)**
Pair 1	-200	-200
Pair 2	-100	-90
Pair 3	0	-80
Pair 4	25	-50
Pair 5	100	0
Pair 6	100	50
Pair 7	500	100
Pair 8	600	150
Pair 9	700	200

Example OR offer		
P/Q Pair	**Price ($/MW)**	**Quantity (MW)**
Pair 1	0	0
Pair 2	0.1	50
Pair 3	5	80
Pair 4	10	200
Pair 5	10.01	400

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Ramp Rates

Energy Ramp Rate:

- Max ramp rates will be utilized, currently MPs are expected to limit to 100 MW/Min ramp up and down rate for energy at a facility level. 100 MW/Min will also apply as the max cap at the resource level. Max ramp restriction is needed to support grid stability and limit ACE impacts from energy dispatch

- Energy ramp up rates would refer to increasing generation or decreasing withdrawal (MW moving in the "positive" direction).

- Energy ramp down rates would refer to decreasing generation or increasing consumption (MW moving in the "negative" direction).

OR Ramp Rate:

- OR ramp rate will be a single max ramp rate in MW/Min (always in the positive direction). No restrictions applied

Energy

Ramp-up (*100 MW/min)

Ramp-down (*100 MW/min)

0

MW

Operating Reserve

Ramp-up (max Ramp Rate MW/min)

0

MW
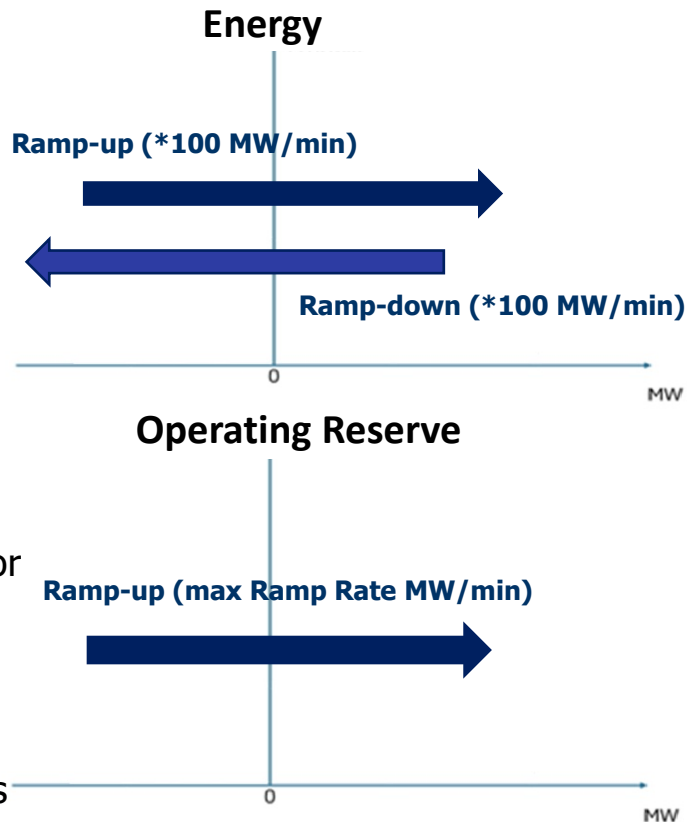
Justification for Energy Ramp Rate

- The 100 MW/min limit was implemented to help dampen BESS response to 5-minute energy dispatch instructions and mitigate the challenges these facilities pose to Area Control Error (ACE).

- An upper limit of 100 MW/min will allow all new BESS connecting to the grid to ramp from 0 MW to either their Pmax or Pmin within a single 5-minute interval

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New/Updated Parameters for Storage [1/3]

Parameter	Unit	Timeframe	Definition
Maximum Generator Resource Active Power Capability (PMax)	MW	Registration	Existing parameter for dispatchable generators, but in this case refers to the maximum active **injection** capability of the resource to validate the submission of offers for energy or Operative Reserves as dispatch data (note – MPs use a combination of Pmax and Pmin for OR; "branching")
Maximum Negative Generator Resource Active Power Capability (PMin)	MW	Registration	The maximum **withdrawal** active power capability of the resource to validate the submission of offers for energy or Operative Reserves as dispatch data
Absolute MaxSoC	MWh	Registration	The maximum SoC availability of the battery that could be utilized by the IESO. Indicates the MWh max that the battery will ever be charged to. Generally, need access for maintenance. Value will be used to validate MaxSoC submission
Absolute MinSOC	MWh	Registration	The minimum SoC availability of the battery that could be utilized by the IESO. Indicates the MWh min that the battery will ever be discharged to. Generally, need access for maintenance. Value will be used to validate MinSoC submission. Can be zero or another value as determined by MP.

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New/Updated Parameters for Storage [2/3]

Parameter	Unit	Timeframe	Definition
Lower Energy Limit (MinSoC)	MWh	Registration/Daily Dispatch	The lowest energy amount the electricity storage system can be consistently discharged beyond expected degradation from normal use
Upper Energy Limit (MaxSoC)	MWh	Registration/Daily Dispatch	The maximum energy amount the electricity storage system can be consistently charged beyond expected degradation from normal use
Maximum Internal Service Load / Internal Service Load (ISL)	MW	Registration/Daily Dispatch	The maximum amount of load consumed from the battery bank to service the resource when idle. Expected to account for Auxiliary Load or Station Service Load impacting SoC calculations; Submission should be maximum value that will be utilized to validate ISL Daily Dispatch submissions; ISL is only used in DAM and PD
Cycle/Round-trip efficiency	% or decimal	Registration/Daily Dispatch	Ratio of the energy discharged to the energy charged expressed in percentage, degrades very gradually over time. Applied at time of withdrawal and used to discount the SoC based on total efficiency losses to reinject energy

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New/Updated Parameters for Storage [3/3]

Parameter	Unit	Timeframe	Definition
CycleDEL	MWh	Daily Dispatch	Submitted daily dispatch parameter that limits the maximum amount of energy that the resource can be scheduled to inject for that day. The CycleDEL only applies in DAM and PD to assist the MP to avoid over cycling their battery if deemed necessary to avoid degradation.
Initial SoC	MWh	Daily Dispatch	Submitted daily by the MP and used to initialize the DAM engine. The engine will use this value as the starting point when calculating schedules throughout the day.

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Cycling Daily Energy Limit (CycleDEL)

- CycleDEL is a submitted daily dispatch parameter that limits the maximum amount of energy that the resource can be scheduled to inject for that day.

- Specific request from MPs to have a method to avoid overcommitting their battery to support their warranties.

- Applies in DAM, potentially limiting financial binding schedules, as well as PD.

- Due to RT computational complexity, it will not apply in RT.

    - Reaching the CycleDEL in RT does **not** exempt a resource from following dispatch or justify declaring unavailability. MP's are encouraged to proactively adjust offers prior to the mandatory window, which will still be subject to MPM protocols

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SoC Management

SoC Management

- SoC will be managed in all engines and timeframes, i.e., DAM, DAPD, PD, RT
- SoC constraints are utilized by the engines for scheduling to avoid overcommitting resource beyond their operational capability.
- Specific SoC levels or limits for the resource are required to be scheduled or dispatched; e.g. can they feasibly achieve the dispatch with their existing or future SoC?
- To verify SoC across the different engines and passes the IESO will utilize various estimates or telemetered values
- The IESO will utilize the following variables to set SoC constraints:
  - SoC Tracker – a rolling total of SoC across timeframes
  - Initial SoC (DAM) – PD estimate to the next dispatch day, or MP submitted
  - Min/Max SoC limits – The max and min that a battery may be charged or discharged to
  - Internal Service Load (DAM and PD) – to track various facility loads to discount from the battery SoC calculation
  - RTE/Cycle efficiency – losses on energy from dispatching the battery; applied on withdrawals

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Data Monitoring/Telemetry Requirements

All facilities must comply with data monitoring requirements, including providing the following telemetered information:

- Active Power

- Reactive Power

- State of Charge (MWh)

The IESO will continue to consider further telemetering requirements that may be required outside of optimization and as part of subsequent modules of design.

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Summary of Min/Max SoC Limits
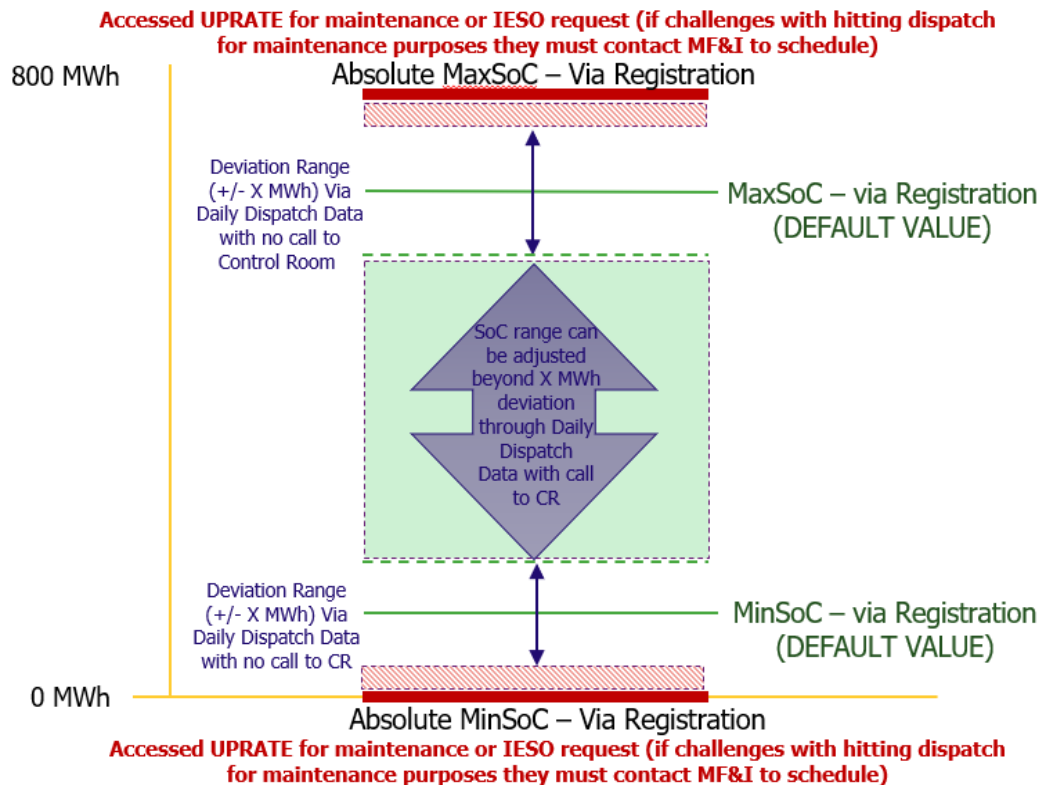
The IESO has made some changes in how the following SoC parameters are defined:

- **Absolute MaxSoC** – Registered parameter, may or may not be 100% (800 MWh in this example), can uprate to this value for maintenance or at request from the IESO
- **MaxSoC/MinSoC**
  - Registered parameter (typical max)
  - Daily dispatch parameter: Deviation from their typical value up to X% due to certain reasons (primarily temperature-related, and can incorporate some ageing %)
  - Update allowed within the mandatory window
- **Absolute MinSoC** – Registered parameter, may or may not be zero, can uprate to this value for maintenance or at request from the IESO

Internal Service Load

- Internal Service Load (ISL) represents the maximum hourly forecast energy consumption (in MW) on the battery to meet internal resource needs.

- It is composed of the Auxiliary, Station Service, and any other marginal loads that are consumed by the resource from the batteries SoC.

- MPs submit a registered and daily value. Registered value will be the max ISL expected to validate daily dispatch (to limit errors from MP submission). Daily dispatch value can be adjusted by the MP throughout the day.

- ISL is considered in DAM and PD engine runs to ensure the resources are not overcommitted. The ISL is discounted in the hourly SoC calculations. Not applicable in RT due collecting telemetered SoC for each interval run.

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Round Trip Efficiency/Cycle Efficiency

- Round Trip Efficiency (RTE)/Cycle Efficiency - This value takes charging energy which is returned by the storage resource via discharging and reduces this value by this %.

- This value is applied to the withdrawal MWh. It should not account for other draw on the battery, such as aux load etc.

- Though it is a registered value, it can be overwritten with a Daily Dispatch Submission to provide additional context into the availability of the resource.

* Please note this is different than RTE that is stipulated in recent procurement contracts

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MPM and Pricing Constraints

Market Power Mitigation

- Reference levels and reference quantities will be used to support the Ex-Ante, Settlement and Ex-post Market Power Mitigation processes in the market.

- Ex-ante mitigation takes place in DAM and PD; mitigated offers get passed into RT from PD.

- Settlement mitigation process is implemented in Commercial Reconciliation System (CRS), using mitigated for conduct financial dispatch data.

- Ex-post mitigation takes place after market clearing and settlement to assess potential instances of physical withholding.

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Market Power Mitigation

- Ex-ante mitigation requirements:

  - Energy offers will be mitigated on the injection side based on reference pricing.

  - If a withdrawal offer overlaps with reference pricing when mitigated these will be reduced to $0.01 below the mitigated injection offer to ensure monotonic offer curve

  - OR supply offers are also mitigated in cases of charging, discharging, or bridging for all classes of OR

- MPM module in Batch 2 will look into Settlement and Ex-post mitigation requirements

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Price-Setting Eligibility and Constraint Violations

- Below represents similar requirements for other Energy Limited Resources

- The storage resource will not be able to set price when hitting various parameter limits – Max/MinSoC, CycleDEL

- The IESO will institute violation pricing on several of the parameters enabling them to be "soft constraints". However, these violation prices are expected to be among the highest among all violation prices and will apply in the pricing run (provide additional compensation when violating).

- Violation prices will be applied to Max/MinSoC and CycleDEL.

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A Day In The Life

A Day In The Life

DAM Submission → **RTM Execution**

The following slides illustrate how key features of the Optimization market design are intended to function together in the "day in the life" of a battery storage market participant.

Daily Market Execution (Storage-specific)

DAM Submission

- Unique storage registration parameters: Absolute Max/Min SoC, active power limits for both injection and withdrawal
- Unique storage dispatch data: Initial SoC for DAM, Max/Min SoC, RTE, CycleDEL, ISL
- Energy & OR offers and ramp rates in format specific to storage
- Review Pre-DAM reports

DAM Execution

- MPM - storage injection offers may be mitigated
- Engine uses SoC to ensure feasible scheduling; unless violation prices used
- Can limit overall injection schedules due to CycleDEL

Post-DAM/Pre-dispatch

- Storage receives DAM financially binding schedules for energy & OR
- Potential for DAM MWPs
- Review DAM reports – existing reports may be augmented to include some unique storage characteristics
- MPs provided opportunity to change their dispatch data

PD Execution

- Telemetered SoC used
- MPM ensures that there are no violations of reference levels and no exercising of Market Power for use in RTM

Post-PD

- Review PD advisory schedules and prices
- Review PD reports
- PD provides insight into pricing, allowing the MP to make changes to their bids/offers up to the mandatory window; Daily dispatch data can be changed during window
- Control Room reviews and potentially constrains resource

RTM Execution

- Telemetered SoC is provided for initialization of the RT engine
- RTM schedules for 5-minute dispatch of energy and OR
- RT prices & LMPs for storage settlement
- RT MWPs
- RTM reports

Text Colours: MP Action; IESO Action

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MP offers Example

Consider a resource with the following characteristics and strategy:

Example Energy offer with 9 laminations

P/Q Pair	Price ($/MW)	Quantity (MW)	Price to Schedule ($/MW)
Pair 1	-200	-200	-200 or less
Pair 2	-100	-90	-199.99 to -100
Pair 3	0	-80	-99.99 to 0
Pair 4	25	-50	0.01 to 25
Pair 5	100	0	25.01 to 99.99
Pair 6	100	50	100 to 499.99
Pair 7	500	100	500 to 599.99
Pair 8	600	150	600 to 699.99
Pair 9	700	200	700 or more

Example OR offer with 5 laminations

P/Q Pair	Price ($/MW)	Quantity (MW)
Pair 1	0.1	0
Pair 2	0.1	50
Pair 3	5	80
Pair 4	10	200
Pair 5	10.01	400

Maximum Injection Rating	PMAX	200MW
Maximum Withdrawal Rating	PMIN	-200MW
Maximum SoC	MaxSoC	900MWh
Minimum SoC	MinSoC	50MWh
Round-trip efficiency	RTE	0.9
Internal Service Load	ISL	3MW
CycleDEL	CycleDEL	700MWh
Ramp Rate	SoCR	100 MW/min

MP offers Example

*The offers and prices in this example are exaggerated for effect; MPs will be mitigated by the MPM process

Example Energy offer with 9 laminations

P/Q Pair	Price ($/MW)	Quantity (MW)	Price to Schedule ($/MW)	MP's Intended Action
Pair 1	-200	-200	-200 or less (more negative)	Charge 200MW if price is -$200 or below
Pair 2	-100	-90	-199.99 to -100	Charge 90MW if the price is between-$100 and -$199.99
Pair 3	0	-80	-99.99 to 0	Charge 80MW if the price is between -$99.99 and $0
Pair 4	25	-50	0.01 to 25	Charge 50MW if the price is between $0.01 and $25
Pair 5	100	0	25.01 to 99.99	Do nothing if price is between $25.01 and $99.99
Pair 6	100	50	100 to 499.99	Inject 50MW if price is between $100 and $499.99
Pair 7	500	100	500 to 599.99	Inject 100MW if price is between $500 and $599.99
Pair 8	600	150	600 to 699.99	Inject 150MW if price is between $600 and $699.99
Pair 9	700	200	700	Inject 200MW if price is $700 or above

Consider the following DAM prices; how will our battery be scheduled in the DAM based on these prices?

HE1	HE2	HE3	HE4	HE5	HE6	HE7	HE8	HE9	HE10	HE11	HE12	HE13	HE14	HE15	HE16	HE17	HE18	HE19	HE20	HE21	HE22	HE23	HE24
-$ 10.00	-$ 0.06	-$ 200.00	-$ 200.00	-$ 200.00	$ 5.00	$ 10.00	$ 15.00	$ 15.00	$ 30.00	$ 500.00	$ 500.00	$ 550.00	$ 550.00	$ 600.00	$ 650.00	$ 710.00	$ 100.00	-$ 250.00	$ 500.00	$ 20.00	$ 10.00	$ 5.00	$ 5.00

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DAM Energy Schedule

Hour Ending	HE1	HE2	HE3	HE4	HE5	HE6	HE7	HE8	HE9	HE10	HE11	HE12	HE13	HE14	HE15	HE16	HE17	HE18	HE19	HE20
DAM LMP	-$ 10.00	-$ 0.06	-$ 200.00	-$ 200.00	-$ 200.00	$ 5.00	$ 10.00	$ 15.00	$ 15.00	$ 30.00	$ 500.00	$ 500.00	$ 550.00	$ 550.00	$ 600.00	$ 650.00	$ 710.00	$ 100.00	-$ 250.00	$ 500.00

	HE01	HE02	HE03	HE04	HE05	HE06	HE07	HE08	HE09	HE10	HE11	HE12	HE13	HE14	HE15	HE16	HE17	HE18	HE19	HE20
DAM ENERGY SCHEDULE	-80.0	-50.0	-200.0	-200.0	-200.0	-50.0	-50.0	-50.0	-50.0	0.0	0.0	0.0	100.0	100.0	150.0	150.0	200.0	0.0	-200.0	0.0
**STATE OF CHARGE (SoC) (beginning of hour)	50.0	119.0	161.0	338.0	515.0	692.0	734.0	776.0	818.0	860.0	857.0	854.0	851.0	748.0	645.0	492.0	339.0	136.0	133.0	310.0
*AVAILABLE SoC (beginning of hour)	0.0	69.0	111.0	288.0	465.0	642.0	684.0	726.0	768.0	810.0	807.0	804.0	801.0	698.0	595.0	442.0	289.0	86.0	83.0	260.0
Daily injection	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	200.0	350.0	500.0	700.0	700.0	700.0	700.0
CycleDEL Tracker (End of Hour)	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	600.0	500.0	350.0	200.0	0.0	0.0	0.0	0.0

This example discusses the effect of the following parameters:
- ISL effect (3 MW)
- RTE (0.9)
- CycleDEL effect
- Energy scheduling

Hour Ending	HE11	HE12
DAM LMP	$ 500.00	$ 500.00

	HE11	HE12
DAM ENERGY SCHEDULE	0.0	0.0

	HE11	HE12
*STATE OF CHARGE (SoC) (beginning of hour)	857.0	854.0
*AVAILABLE SoC (beginning of hour)	807.0	804.0

	HE11	HE12
Daily injection	0.0	0.0
CycleDEL Tracker (End of Hour)	700.0	700.0

Hour Ending	HE18
DAM LMP	$ 100.00

	HE18
DAM ENERGY SCHEDULE	0.0

	HE18
*STATE OF CHARGE (SoC) (beginning of hour)	136.0
*AVAILABLE SoC (beginning of hour)	86.0

	HE18
Daily injection	700.0
CycleDEL Tracker (End of Hour)	0.0

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Hour Ending	HE1	HE2	HE3	HE4	HE5	HE6	HE7	HE8	HE9	HE10	HE11	HE12	HE13	HE14	HE15	HE16	HE17	HE18	HE19	HE20
DAM LMP	-$ 10.00	-$ 0.06	-$ 200.00	-$ 200.00	-$ 200.00	$ 5.00	$ 10.00	$ 15.00	$ 15.00	$ 30.00	$ 500.00	$ 500.00	$ 550.00	$ 550.00	$ 600.00	$ 650.00	$ 710.00	$ 100.00	-$ 250.00	$ 500.00
DAM OR LMP	$ 0.10	$ 15.00	$ 0.10	$ 0.10	$ 15.00	$ 15.00	$ 1.00	$ 1.00	$ 1.00	$ 10.00	$ 10.00	$ 15.00	$ 15.00	$ 4.00	$ 15.00	$ 10.00	$ 10.00	$ 4.00	$ 4.00	$ 4.00

	HE01	HE02	HE03	HE04	HE05	HE06	HE07	HE08	HE09	HE10	HE11	HE12	HE13	HE14	HE15	HE16	HE17	HE18	HE19	HE20
DAM ENERGY SCHEDULE	-80.0	-50.0	-200.0	-200.0	-200.0	-50.0	-50.0	-50.0	-50.0	0.0	0.0	0.0	100.0	100.0	150.0	150.0	200.0	0.0	-200.0	0.0
DAM OR SCHEDULE	50	116	50	50	400	250	50	50	50	200	200	200	100	50	50	50	0	0	0	0
*STATE OF CHARGE (SoC) (beginning of hour)	50.0	119.0	161.0	338.0	515.0	692.0	734.0	776.0	818.0	860.0	857.0	854.0	851.0	748.0	645.0	492.0	339.0	136.0	133.0	310.0
*AVAILABLE SoC (beginning of hour)	0.0	69.0	111.0	288.0	465.0	642.0	684.0	726.0	768.0	810.0	807.0	804.0	801.0	698.0	595.0	442.0	289.0	86.0	83.0	260.0
Daily injection	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	200.0	350.0	500.0	700.0	700.0	700.0	700.0
CycleDEL Tracker (End of Hour)	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	600.0	500.0	350.0	200.0	0.0	0.0	0.0	0.0

When co-optimizing for OR, the engine looks at the OR offers submitted and schedules the resource based on their SoC and scheduled action for that hour.

Based on the OR offers submitted on the right, co-optimized with our Energy offers, we receive the above Energy and OR schedule in the DAM.

Example OR offer with 5 laminations

P/Q Pair	Price ($/MW)	Quantity (MW)
Pair 1	0.1	0
Pair 2	0.1	50
Pair 3	5	80
Pair 4	10	200
Pair 5	10.01	400

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Hour Ending	HE1	HE2	HE3	HE4	HE5	HE6	HE7	HE8	HE9	HE10	HE11	HE12	HE13	HE14	HE15	HE16	HE17	HE18	HE19	HE20
DAM LMP	-$ 10.00	-$ 0.06	-$ 200.00	-$ 200.00	-$ 200.00	$ 5.00	$ 10.00	$ 15.00	$ 15.00	$ 30.00	$ 500.00	$ 500.00	$ 550.00	$ 550.00	$ 600.00	$ 650.00	$ 710.00	$ 100.00	-$ 250.00	$ 500.00
DAM OR LMP	$ 0.10	$ 15.00	$ 0.10	$ 0.10	$ 15.00	$ 15.00	$ 1.00	$ 1.00	$ 1.00	$ 10.00	$ 10.00	$ 15.00	$ 15.00	$ 4.00	$ 15.00	$ 10.00	$ 10.00	$ 4.00	$ 4.00	$ 4.00

	HE01	HE02	HE03	HE04	HE05	HE06	HE07	HE08	HE09	HE10	HE11	HE12	HE13	HE14	HE15	HE16	HE17	HE18	HE19	HE20
DAM ENERGY SCHEDULE	-80.0	-50.0	-200.0	-200.0	-200.0	-50.0	-50.0	-50.0	-50.0	0.0	0.0	0.0	100.0	100.0	150.0	150.0	200.0	0.0	-200.0	0.0
DAM OR SCHEDULE	50	116	50	50	400	250	50	50	50	200	200	200	100	50	50	50	0	0	0	0
*STATE OF CHARGE (SoC) (beginning of hour)	50.0	119.0	161.0	338.0	515.0	692.0	734.0	776.0	818.0	860.0	857.0	854.0	851.0	748.0	645.0	492.0	339.0	136.0	133.0	310.0
*AVAILABLE SoC (beginning of hour)	0.0	69.0	111.0	288.0	465.0	642.0	684.0	726.0	768.0	810.0	807.0	804.0	801.0	698.0	595.0	442.0	289.0	86.0	83.0	260.0
Daily injection	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	200.0	350.0	500.0	700.0	700.0	700.0	700.0
CycleDEL Tracker (End of Hour)	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	600.0	500.0	350.0	200.0	0.0	0.0	0.0	0.0

This example demonstrates the effects of OR scheduling and demonstrates how these resources can "branch".

Hour Ending	HE1	HE2	HE3	HE4	HE5	HE6
DAM LMP	-$ 10.00	$ 0.06	$ 200.00	-$ 200.00	-$ 200.00	$ 5.00
DAM OR LMP	$ 0.10	$ 15.00	$ 0.10	$ 0.10	$ 15.00	$ 15.00

	HE01	HE02	HE03	HE04	HE05	HE06
DAM ENERGY SCHEDULE	-80.0	-50.0	-200.0	-200.0	-200.0	-50.0
DAM OR SCHEDULE	50	116	50	50	400	250
*STATE OF CHARGE (SoC) (beginning of hour)	50.0	119.0	161.0	338.0	515.0	692.0
*AVAILABLE SoC (beginning of hour)	0.0	69.0	111.0	288.0	465.0	642.0
Daily injection	0.0	0.0	0.0	0.0	0.0	0.0
CycleDEL Tracker (End of Hour)	700.0	700.0	700.0	700.0	700.0	700.0

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Hour Ending	HE1	HE2	HE3	HE4	HE5	HE6	HE7	HE8	HE9	HE10	HE11	HE12	HE13	HE14	HE15	HE16	HE17	HE18	HE19	HE20
DAM LMP	-$ 10.00	-$ 0.06	-$ 200.00	-$ 200.00	-$ 200.00	$ 5.00	$ 10.00	$ 15.00	$ 15.00	$ 30.00	$ 500.00	$ 500.00	$ 550.00	$ 550.00	$ 600.00	$ 650.00	$ 710.00	$ 100.00	-$ 250.00	$ 500.00
DAM OR LMP	$ 0.10	$ 15.00	$ 0.10	$ 0.10	$ 15.00	$ 15.00	$ 1.00	$ 1.00	$ 1.00	$ 10.00	$ 10.00	$ 15.00	$ 15.00	$ 4.00	$ 15.00	$ 10.00	$ 10.00	$ 4.00	$ 4.00	$ 4.00

	HE01	HE02	HE03	HE04	HE05	HE06	HE07	HE08	HE09	HE10	HE11	HE12	HE13	HE14	HE15	HE16	HE17	HE18	HE19	HE20
DAM ENERGY SCHEDULE	-80.0	-50.0	-200.0	-200.0	-200.0	-50.0	-50.0	-50.0	-50.0	0.0	0.0	0.0	100.0	100.0	150.0	150.0	200.0	0.0	-200.0	0.0
DAM OR SCHEDULE	50	116	50	50	400	250	50	50	50	200	200	200	100	50	50	50	0	0	0	0
*STATE OF CHARGE (SoC) (beginning of hour)	50.0	119.0	161.0	338.0	515.0	692.0	734.0	776.0	818.0	860.0	857.0	854.0	851.0	748.0	645.0	492.0	339.0	136.0	133.0	310.0
*AVAILABLE SoC (beginning of hour)	0.0	69.0	111.0	288.0	465.0	642.0	684.0	726.0	768.0	810.0	807.0	804.0	801.0	698.0	595.0	442.0	289.0	86.0	83.0	260.0
Daily injection	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	200.0	350.0	500.0	700.0	700.0	700.0	700.0
CycleDEL Tracker (End of Hour)	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	600.0	500.0	350.0	200.0	0.0	0.0	0.0	0.0

This example demonstrates the effects of SoC and CycleDEL on OR scheduling in the DAM

Hour Ending	HE16	HE17	HE18
DAM LMP	$ 650.00	$ 710.00	$ 100.00
DAM OR LMP	$ 10.00	$ 10.00	$ 4.00

	HE16	HE17	HE18
DAM ENERGY SCHEDULE	150.0	200.0	0.0
DAM OR SCHEDULE	50	0	0
*STATE OF CHARGE (SoC) (beginning of hour)	492.0	339.0	136.0
*AVAILABLE SoC (beginning of hour)	442.0	289.0	86.
Daily injection	500.0	700.0	700.0
CycleDEL Tracker (End of Hour)	200.0	0.0	0.0

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PD Operation

- Mandatory window is applicable for hourly dispatch data; resources must update their offers to consider two settlement impacts whether intending to follow DAM schedule or chase economic opportunities. Please note MPM will apply to offers in either circumstance

- Daily dispatch parameters can be updated in PD and are all utilized for advisory schedules.

   o Considering no commitments and no real time applicability CycleDEL updates don't have a direct financial implications for storage.

- Based on PD outcomes the Control Room may still be involved in the decision making and intervention of storage for Phase 1. The CR may have to constrain the resource from RT to preserve the SoC of the battery for what are deemed to be more impactful hours forecasted in PD.

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RT Operation

- Storage resources that are economic in RT intervals will be dispatched regardless of their DAM or PD schedules as it does not have any commitments. To ensure the resource will be utilized effectively, it is up the MP to update offers to reflect changing system conditions, or the control room constrain the resource (will limit energy and OR).

  - MPs must manage their two-settlement risk because of interval price changes, and how their SoC may need to be preserved to avoid economic loss

- CycleDEL and ISL are not considered in RT. A resource may be dispatched beyond its CycleDEL if the engine determines that the resource has the available SoC. SoC will be provided by telemetry, therefore ISL is no longer subtracted.

- RT telemetry is utilized and updated for each interval to address differences in SoC calculation due to Ramp, RTE and other dispatch effects.

RT Snapshot

Consider the period below (HE9 INT11 – HE11 INT5)

DAM Schedule

Hour Ending	HE9	HE10	HE11
DAM LMP	$ 15.00	$ 30.00	$ 500.00
DAM OR LMP	$ 1.00	$ 10.00	$ 10.00

	HE09	HE10	HE11
DAM ENERGY SCHEDULE	-50.	0.0	0.0
DAM OR SCHEDULE	50	200	200

*STATE OF CHARGE (SoC) (beginning of hour)	818.0	860.0	857.0
*AVAILABLE SoC (beginning of hour)	768.0	810.0	807.0

	HE9		HE10												HE11				
Hour Ending	INT11	INT12	INT1	INT2	INT3	INT4	INT5	INT6	INT7	INT8	INT9	INT10	INT11	INT12	INT1	INT2	INT3	INT4	INT5
RT LMP	$ 15.00	$ 15.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	30.00	$ 500.00	$ 500.00	$ 500.00	$ 500.00	$ 500.00	$ 500.00	$ 500.00	$ 500.00	$ 500.00	$ 500.00	$ 500.00
RT OR LMP	$ 1.00	$ 1.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00

	INT11	INT12	INT1	INT2	INT3	INT4	INT5	INT6	INT7	INT8	INT9	INT10	INT11	INT12	INT1	INT2	INT3	INT4	INT5
ENERGY SCHEDULE	-50.0	-50.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
OR SCHEDULE	50	50	200	200	200	200	200	200	100	100	100	100	100	100	100	100	100	100	100

	INT11	INT12	INT1	INT2	INT3	INT4	INT5	INT6	INT7	INT8	INT9	INT10	INT11	INT12	INT1	INT2	INT3	INT4	INT5
**STATE OF CHARGE (SoC)	771.5	775.0	778.5	778.3	778.0	777.8	777.5	777.3	777.0	768.4	759.8	751.3	742.7	734.1	725.5	716.9	708.3	699.8	691.2
*AVAILABLE SoC (beginning of Interval)	721.5	725.0	728.5	728.3	728.0	727.8	727.5	727.3	727.0	718.4	709.8	701.3	692.7	684.1	675.5	666.9	658.3	649.8	641.2

This example provides a snapshot of a situation where a resource has not updated their offers, and is scheduled outside of their DAM schedule in RT.

RT Snapshot

Consider the period below (H15 INT11 – HE17 INT6)

DAM Schedule

Hour Ending	HE15	HE16	HE17
DAM LMP	$ 600.00	$ 650.00	$ 710.00
DAM OR LMP	$ 15.00	$ 10.00	$ 10.00

	HE15	HE16	HE17
DAM ENERGY SCHEDULE	150.0	150.0	200.0
DAM OR SCHEDULE	50	50	0
*STATE OF CHARGE (SoC) (beginning of hour	645.0	492.0	339.0
*AVAILABLE SoC (beginning of hour	595.0	442.0	289.0

	HE15		HE16												HE17				
Hour Ending	INT11	INT12	INT1	INT2	INT3	INT4	INT5	INT6	INT7	INT8	INT9	INT10	INT11	INT12	INT1	INT2	INT3	INT4	INT5
RT LMP	$ 600.00	$ 600.00	$ 650.00	$ 650.00	$ 650.00	$ 650.00	$ 650.00	$ 650.00	$ 650.00	$ 650.00	$ 650.00	$ 650.00	$ 650.00	$ 650.00	$ 710.00	$ 710.00	$ 710.00	$ 710.00	$ 710.00
RT OR LMP	$ 1.00	$ 1.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00
	INT11	INT12	INT1	INT2	INT3	INT4	INT5	INT6	INT7	INT8	INT9	INT10	INT11	INT12	INT1	INT2	INT3	INT4	INT5
ENERGY SCHEDULE	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	148.0	0.0	0.0	0.0
OR SCHEDULE	50	50	50	50	50	50	50	50	50	50	50	50	50	50	0	0	0	0	0
**STATE OF CHARGE (SoC)	254.0	241.3	228.5	215.8	203.0	190.3	177.5	164.8	152.0	139.3	126.5	113.8	101.0	88.3	75.5	58.6	46.0	45.8	45.5
*AVAILABLE SoC (beginning of Interval)	204.0	191.3	178.5	165.8	153.0	140.3	127.5	114.8	102.0	89.3	76.5	63.8	51.0	38.3	25.5	8.6	-4.0	-4.3	-4.5

This example provides a snapshot of a situation where a resource has not updated their offers,
and the effect this can have on their SoC throughout the day.

RT Operation

Hour Ending	HE9 INT11	INT12	HE10 INT1	INT2	INT3	INT4	INT5	INT6	INT7	INT8
RT LMP	$ 15.00	$ 15.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 500.00	$ 500.00
RT OR LMP	$ 1.00	$ 1.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00	$ 10.00

|	INT11	INT12	INT1	INT2	INT3	INT4	INT5	INT6	INT7	INT8
ENERGY SCHEDULE	-50.0	-50.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0
OR SCHEDULE	50	50	200	200	200	200	200	200	100	100
**STATE OF CHARGE (SoC)	771.5	775.0	778.5	778.3	778.0	777.8	777.5	777.3	777.0	768.4
*AVAILABLE SoC (beginning of Interval)	721.5	725.0	728.5	728.3	728.0	727.8	727.5	727.3	727.0	718.4

Going back to the HE9 – HE11 example, there are two moments where the effect of ramping on SoC can be seen.

When the resource moves from a –50MW withdrawal to 0, the ramping in HE10 INT1 while the resource is trying to get to 0MW adds an additional 1.4MWh of charge to the battery.

On the flip side, in HE10 INT7 the re resource begins to ramp, it the is a shortfall of 0.83MWh in energy delivered for that initial interval, meaning there is extra SoC in the battery compared to what would result from an instantaneous ramp.

While this may not seem like a significant variance, across a massive fleet of storage resources, the differences will grow significantly.
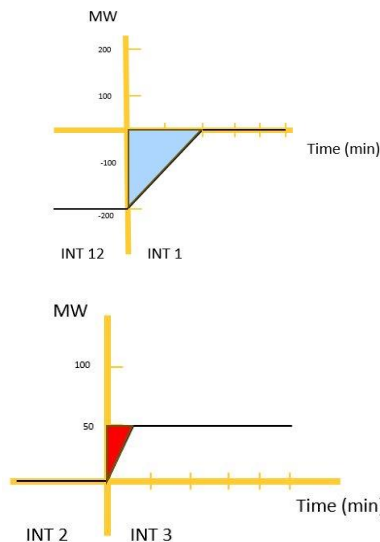
Next Steps

Submitting Feedback

- Feedback from participants is an important engagement principal of the IESO's refreshed external engagement framework to ensure your input and perspectives are considered

- The IESO is requesting written feedback via the **IESO's Feedback Form** available on the ERP S/H webpage ([Project Webpage](#))

  o Feedback is being requested by **October 30, 2025**

- Please submit to IESO Engagement engagement@ieso.ca

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Next Steps – Draft S/H Project Engagement Sessions

Timing	Engagement Activity
October 16, 2025	Public Session – Storage and Hybrid Project (Meeting #2) Design Memo: Optimization design element
Q4-2025	Deadline for Feedback & IESO Response to Feedback
Q1-2026	Public Session – Storage and Hybrid Project (Meeting #3) Design Memo: Batch 2 elements
Q1/2-2026	Deadline for Feedback & IESO Response to Feedback
2026	Ongoing Public Engagement Sessions with Targeted Outreach (1:1) with Impacted Resources

Questions?

Please submit feedback forms to IESO Engagement@ieso.ca

or contact us with any questions/concerns

Thank You

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