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

# 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

# Purpose

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

# 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

# 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)

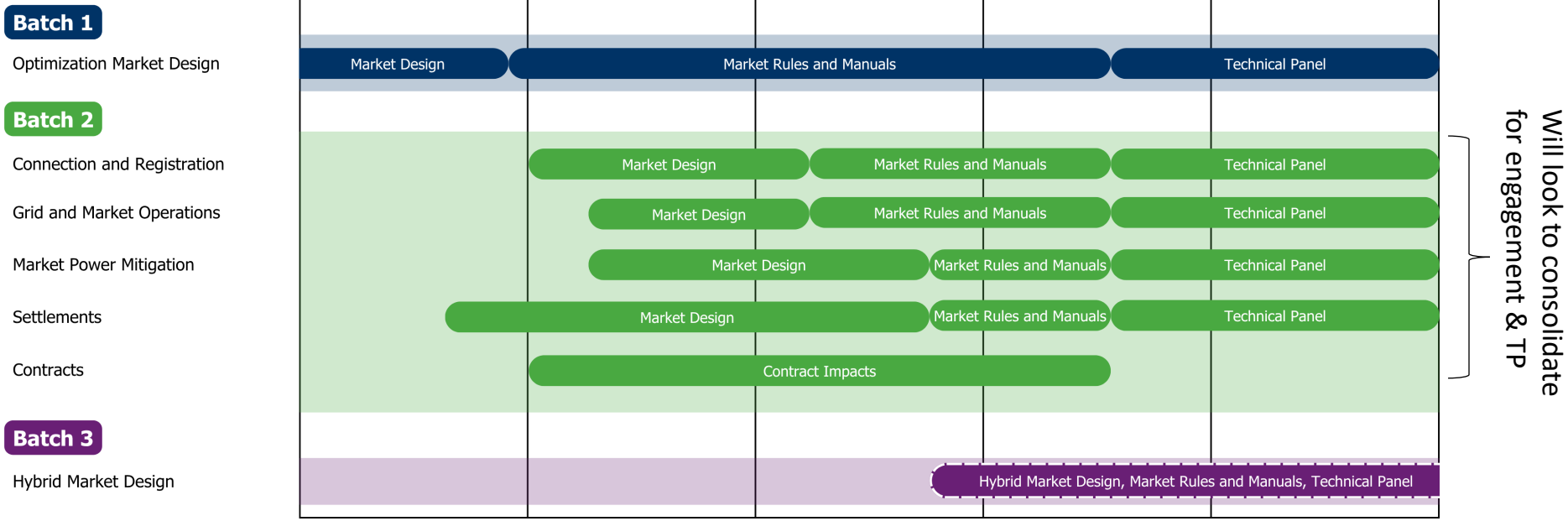
- ✓ Bi-directional single resource model (battery only)
- ✓ State of Charge (SoC) management

## Future Phases (TBD)

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

# Proposed Timeline: Engagement on S/H Design Elements

**timelines are subject to change*



# 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.

# 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.<br>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.<br>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.<br>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). |

# 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. |

# Optimization Design Decisions

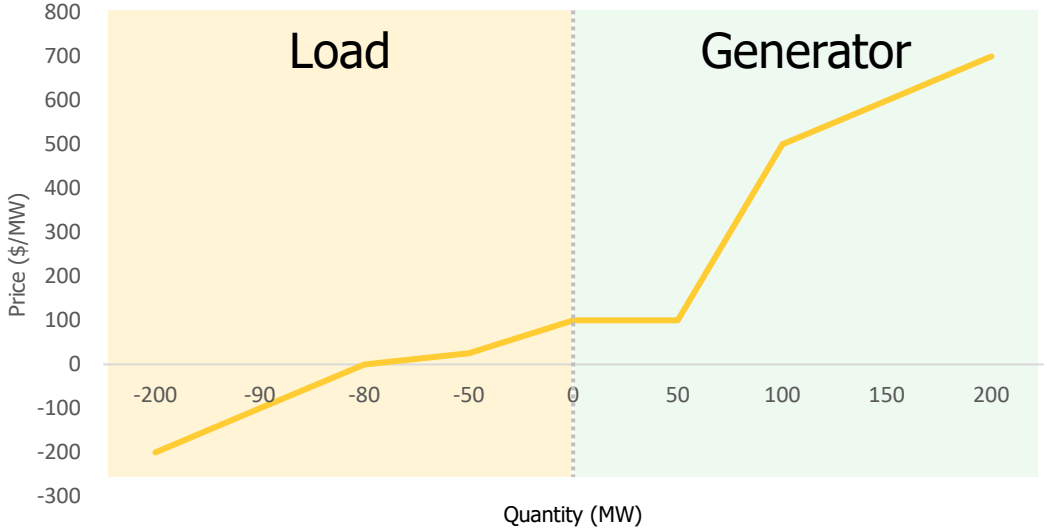
# Single Resource Model

# 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

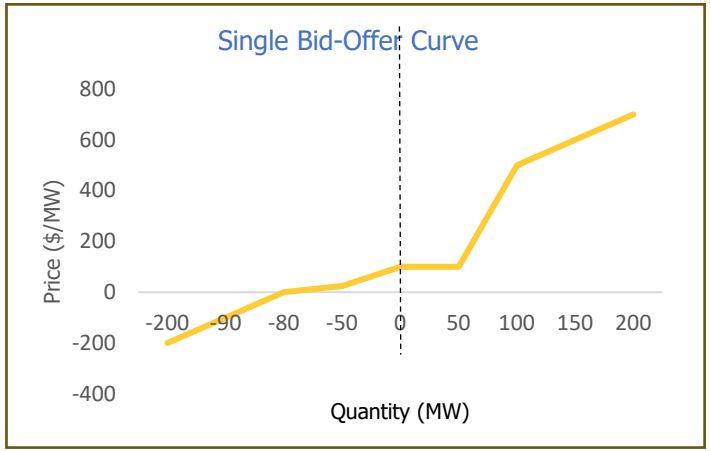
# Commissioning

- 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.

# 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.




| | 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 |

# 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 |

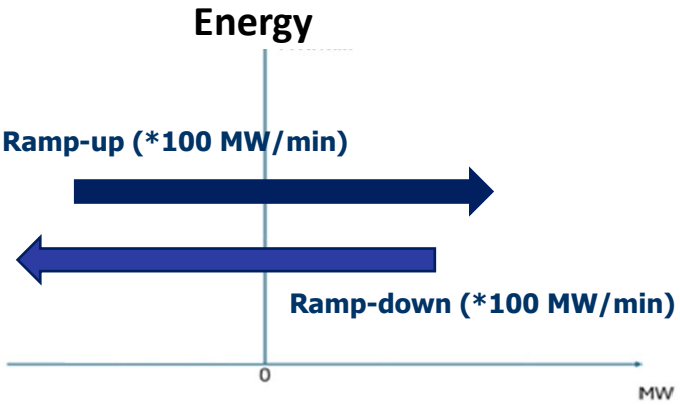
# Ramp Rates

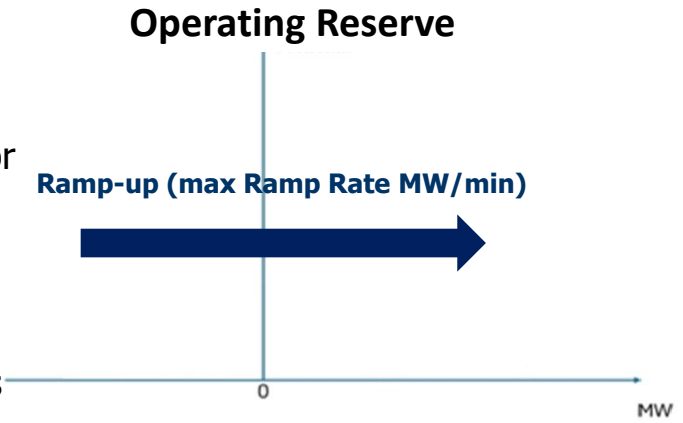
**Energy Ramp Rate:**

- 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 Rate Design Rationale

ERP is implementing a maximum ramp rate of 100MW/min for only energy to dampen response to 5-minute energy dispatch instructions. The following provides supportive rationale for this design decision:

- As the Balancing Authority, the IESO is required to comply with North American Electric Reliability Corporation (NERC) standards, including standards to maintain the interconnection frequency close to 60Hz
- The IESO relies on regulation services to help compensate for the fast output changes and correct the variations in power system frequency to maintain system stability
- The IESO has experienced negative impacts to system frequency resulting from the fast-moving capabilities of BESS
- In some cases, IESO control room operators have had to take additional out-of-market control actions such as constraining-on resources and sending one-time dispatches to help rebalance the system
- Events such as these significantly impact system and market operations, jeopardizing the IESO's ability to meet NERC standards
- With 25 BESS facilities coming online over the short term, fast ramping is expected to impact system frequency
- Implementing ramping restrictions to address system concerns is in alignment with other jurisdictions such as California and Soutwest Power Pool (SPP)

# 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. |

# 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 |

# 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. |

# 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

# 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

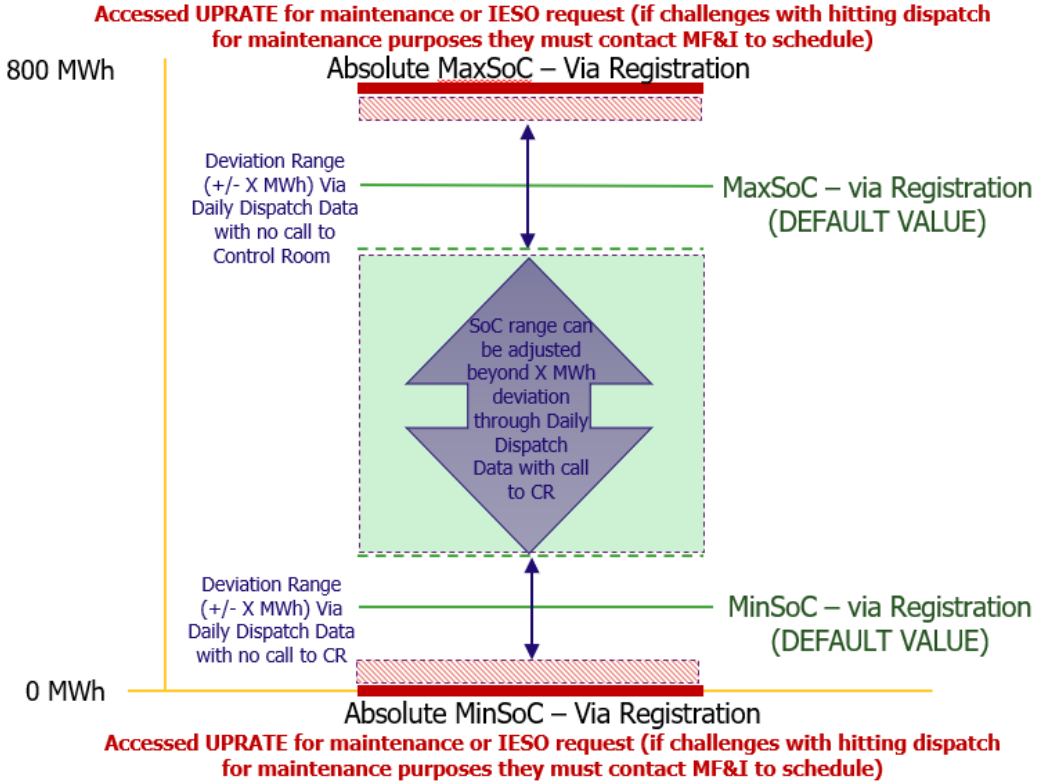
# Data Monitoring/Telemetry Requirements

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.

# 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.

# 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

# 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.

# 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

# Price-Setting Eligibility and Constraint Violations

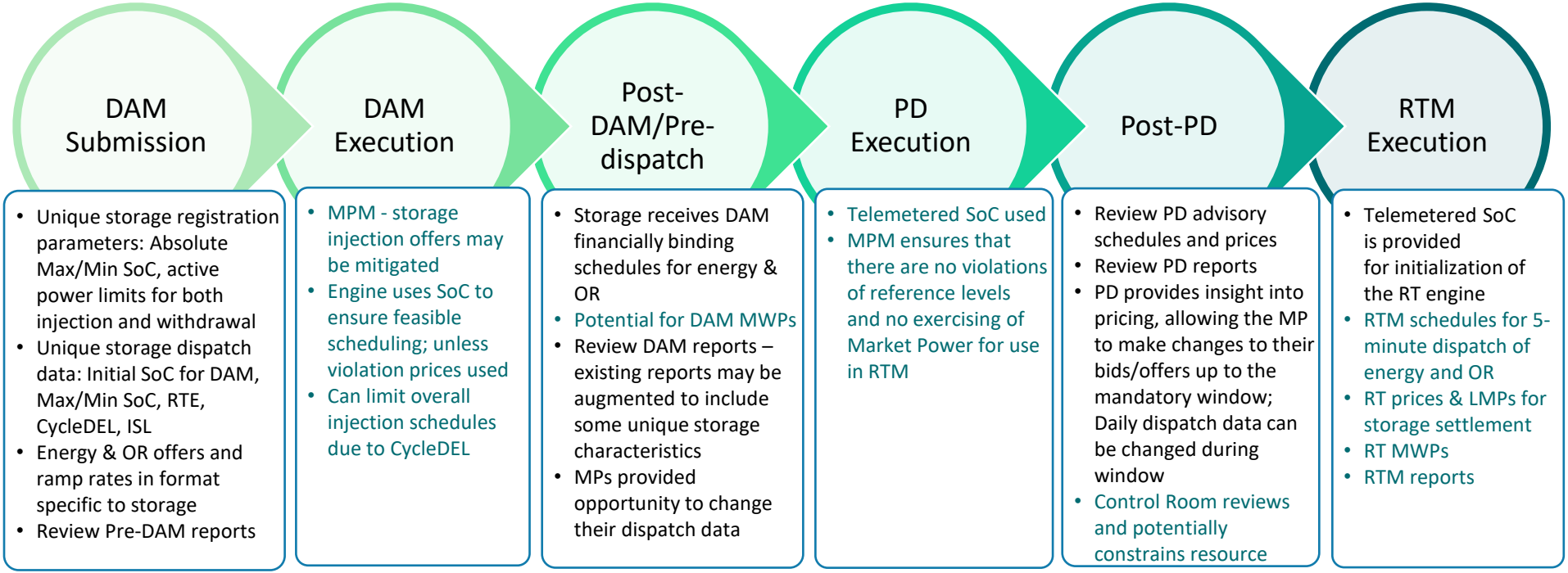
- Below represents similar requirements for other Energy Limited Resources
- The storage resource will not be able to set price when hitting various parameter limits – Max/MinSoC, CycleDEL
- The IESO will institute violation pricing on several of the parameters enabling them to be "soft constraints". 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.

# A Day In The Life

# A Day In The Life


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)




Text Colours: MP Action; IESO Action

# 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 |

# 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 |

# Energy and OR Co-optimization

| 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 |

# Energy and OR Co-optimization

| 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 |

# Energy and OR Co-optimization

| 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 |

# 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.
    - 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.

# 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 | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **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 SCHEDUL | 150.0 | 150.0 | 200.0 |
| DAM OR SCHEDULE | 50 | 50 | 0 |
| *STATE OF CHARGE (SoC) (beginning of hou | 645.0 | 492.0 | 339.0 |
| *AVAILABLE SoC (beginning of hou | 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 SCHEDUL | 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

| | HE9 | | HE10 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Hour Ending | INT11 | INT12 | 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 |

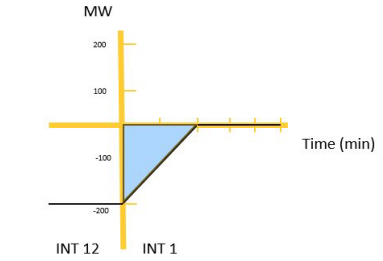
| | INT11 | INT12 | INT1 | INT2 | INT3 | INT4 | INT5 | INT6 | INT7 | INT8 |
|---|---|---|---|---|---|---|---|---|---|---|
| ENERGY SCHEDULE | -50.0 | -50.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | 100.0 |
| OR SCHEDULE | 50 | 50 | 200 | 200 | 200 | 200 | 200 | 200 | 100 | 100 |
| **STATE OF CHARGE (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 |

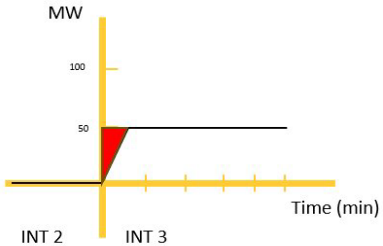
Going back to the HE9 – HE11 example, there are two moments where the effect of ramping on SoC can be seen.

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)
  - Feedback is being requested by **October 30, 2025**
- Please submit to IESO Engagement engagement@ieso.ca

# Next Steps – Draft S/H Project Engagement Sessions

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

# Questions?

Please submit feedback forms to IESO Engagement@ieso.ca

or contact us with any questions/concerns

# Thank You

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