Enabling Resources Program: Storage and Hybrid Integration Project

Connection and Registration Design

Memo 1.0

Engagement Topic: Connection and Registrations Design Element for Storage Resources

Date: January 22, 2026

Purpose

The purpose of this document is to provide detail on the IESO's market design work with respect to the 'Connection and Registration Design Element' for the storage resource participation model. It articulates how the IESO undertook the design and the decisions that are relevant to stakeholders for the enhanced storage participation model.

The IESO will utilize this document and materials from subsequent design phases to support the implementation of the design work for the Storage and Hybrid Integration Project. This will be captured in future changes to Market Rules, Market Manuals, software interfaces with the IESO, and internal IESO systems and processes. These external changes will be reviewed for input with stakeholders. Any material changes to this design as a result of implementation discovery will be discussed with stakeholders.

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Background

ERP's Storage and Hybrid Implementation Project is focused on developing an enhanced participation model for storage resources and co-located hybrid facilities. During the design phase, the IESO is first proceeding with the core 'Optimization' element within the 'Grid and Market Operations' module, which is a main precursor to design decisions to support other design modules and elements. The design elements under 'Grid and Market Operations' module clarify how the storage facility participates in energy and Operating Reserve (OR) markets. This includes what the IESO requires to dispatch resources and consider in the optimization engine across all timeframes.

Phased Approach

The Storage and Hybrid Implementation Project is adopting a phased delivery approach to expedite and prioritize the implementation of essential functionalities, including:
- Bi-directional single resource model
- State of Charge (SoC) Management

As seen in **Figure 1**, subsequent design phases will implement:
- Regulation service
- Uplift exemptions
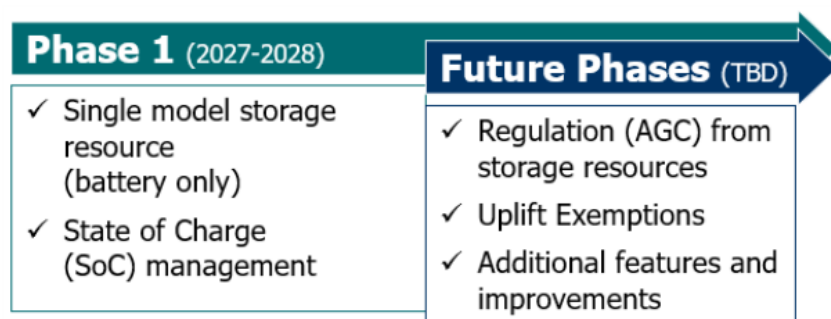- Any required enhancement resulting from Phase 1 implementation

Figure 1: Project Scope

The IESO is targeting a 2027-2028 Phase 1 implementation date.

Scope of Impact for Phase 1

For Phase 1 of the enhanced market design, the IESO will focus on Battery Energy Storage Systems (BESS), i.e., electro-chemical storage resources that have the sole purpose of withdrawing electricity from the electricity system, storing that electricity, and re-injecting it into the electricity system. In subsequent phases, the IESO will consider the applicability of other types of storage technologies and potential nuances that could require additional/different parameters.

The IESO's focus is on single-site, dispatchable storage resources. As registered facilities in the IESO-Administered Markets, each BESS facility should directly interface with the IESO and may be transmission or distribution connected.

High Level Storage Optimization Design Decisions

The following decisions for the Optimization design element of Phase 1 will be valid for providing Energy and OR services:

i) Storage will be able to participate in energy and OR from both the injection and withdrawal side of the resource, given that they have sufficient capability. Branching from withdrawal to injection within an OR offer will be permitted, under feasible[1] circumstances.

    a. Optimization will include the entire offer range to schedule charging and discharging of storage resources for energy and OR. For energy, the offer curve will start from a negative quantity for charging and increase towards the positive direction for discharging. For OR, the offer will span from 0 MWs to positive MWs. OR offer quantities will never be negative because when the storage is discharging, it increases its MWs further to provide OR; and when it is charging, it must decrease its charging MWs or stop charging to provide OR.

ii) The IESO will utilize the following variables to set SoC constraints:

    a. SoC Tracker – a rolling total of SoC across hours or intervals,

    b. Initial SoC – PD estimate to the next dispatch day, or MP submitted

    c. Min/Max SoC limits – Max and min that a battery resource may be scheduled or dispatched to

    d. Internal Service Load – to track various facility loads that discount from the battery SoC calculation

    e. Cycle / round-trip efficiency – energy losses resulting from dispatching the battery; applied on withdrawals

Connection & Registration Background

Connection and registration are the two primary elements required to initiate participation in the IESO Controlled Grid (ICG). Prospective participants will need to connect, authorize, and register their equipment prior to participating in the market, and the impacts from ERP design will have some impacts on these procedures.

Connection Assessment and Approval

Prospective participants planning to establish or modify a connection to the IESO-controlled grid must obtain IESO approval through the Connection Assessment and Approval (CAA) process. The CAA process allows the IESO to assess the impact of new or modified connections to the IESO-controlled grid on the reliability of the integrated power system.

Overview

Connection Assessment and Approval will encompass all processes and elements included in:

- Prepare Application
- Obtain conditional approval to connect
- Design and Build

The "Prepare Application" process is the first step in connecting a new resource to the IESO Controlled Grid (ICG). Outlined on the IESO website, this process involves identifying the connection points and preliminary design requirements of the new or modified connection

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[1] Feasible denotes the resource must have available SoC to complete the branching operation, and an offer than indicates they would like to branch.

facility, undergoing applicable Distributor's Connection Impact Assessment, and preparing a Connection Assessment with the IESO and Transmitter.

Once an application has been submitted and reviewed, qualifying applicants must submit an System Impact Assessment (**SIA)** and deposit to the IESO. The IESO's Connection Assessment team will evaluate the SIA application to determine if the applicant is eligible for an expedited process and will prepare an SIA agreement for execution by the applicant.

The team will assess the impact of the proposed new or modified connection on the reliability of the integrated power system and issue a draft SIA report to the connection applicant and the transmitter for review and comments. Finally, the Connection Assessments team will issue Notification of Conditional Approval or Notification of Disapproval with Reasons with the final SIA report.

Limited changes are expected to the SIA application as it already refers to electricity storage resources. Existing SLD requirements are standard and will not be affected by design. The Connection Assessments team will continue to require that the connection applicant includes Interconnection Data, System Specification, and equipment datasheet provided by the battery manufacturer.

Organization Authorization

Prior to registering equipment and resources at a facility, and organization must register and authorize with the IESO. This includes registering the organization with the IESO, being authorized to participate in the IESO-administered markets or programs and providing prudential support.

Register an organization

Prospective market participants initiate the Register Organization process by submitting information about their organization through the Register Organization webpage. An organization is expected to provide typical business information (Name, address, HST number, intent of registration, etc.). Additionally, the organization will need to provide a signed participation agreement, and mandatory contacts for the organization.

Once the Register Organization process is complete, the organization will continue to be granted access to Online IESO to start the Authorize Market Participation process.

No changes to the Register Organization process as a result of S/H Optimization Design.

Authorize Market and Program Participation

An organization must be authorized by the IESO to participate in the IESO-administered markets or programs, or to connect a physical facility to the IESO-controlled grid. To begin the process, an Equipment Registration Specialist (ERS) is assigned by the owner of the facility. The ERS is responsible for submissions of facility and equipment details, covered explicitly in the Record Equipment section.

Electricity storage resources are currently authorized for participation in the market as Electricity Storage Participants, and no changes to the AMP process is required. Existing Electricity Storage participation type will continue to apply.

Market Participants are also responsible for providing an operating license from the Ontario Energy Board (OEB); OEB Storage licenses are already being populated in Online IESO.

Set & Monitor Prudential Support

Prudential support is required in the IESO market to protect the IESO from consumers of electricity not being able to pay for the electricity they have consumed.

Set Prudential Support handles the work or tasks undertaken by the IESO and market participants in relation to the initial and ongoing assessment of market participants' prudential support obligation. The prudential obligation is calculated based on inputs such as expected injection and/or withdrawals for the highest exposure month (i.e. "maximum net exposure").

Prudential support will continue to be required from storage participants. Resources that supply energy or are net creditors may have a prudential obligation of 0. It is assumed that storage participants will be a net debtor as the withdrawals are greater than injections because of operational losses and various auxiliary loads. The storage participants may request a reassessment of their physical market prudential obligation if they've demonstrated to be a net creditor.

The Monitor Prudential Support process relies heavily on settlement outcomes. Specifically, it uses settlement data to monitor a Market Participant's exposure to the market.

As a result of the introduction of bi-directional resources, the business needs to ensure that MP dispatch data (withdrawal and injections) is captured in the monitoring tool. Along with understanding any new types of settlement information that will be provided because of ERP implementation, any modifications to existing exposure calculations will need to be evaluated to properly account for negative generation as well as any State of Charge implications.

Register Facilities, Resources, and Equipment

The information collected in this stage is necessary to ensure the reliability of the IESO-controlled grid. An organization should begin the process to register their facility equipment in Online IESO well ahead of its first energization to the grid. Organizations will be required to start their registration activities in advance of the minimum time periods specified in the Registration Timelines Guide.

A market participant will initially register equipment, resources and facilities to participate in the energy market. Once a resource has completed commissioning, they are able to submit a request to apply to participate in Operating Reserve (OR). Dispatchable generation and load resources at a facility with storage capability would continue to be eligible to provide offers for operating reserve.

As a result of optimization, several resource registration parameters will be introduced or updated. See a list of these new/updated parameters below:

Parameter	Units of Measure (if applicable)	Description	Edited / Proposed New Storage-specific Parameter	Value Range	Note
Maximum Generator Resource Active Power Injection Permitted (max injection) "Upper Power Operating Limit"	MW	Maximum positive active power capability of the resource to validate the submission of offers for energy or operating reserve as dispatch data *(derived from the list of registration parameters required for dispatchable generation)*	Existing (Updated parameter name)	0-999	This is the maximum injection capability. concept of "Upper Power Operating Limit" exists
Minimum Generator Resource Active Power Capability (max withdrawal) "Lower Power Operating Limit"	MW	Maximum negative active power capability of the resource to validate the submission of offers for energy or operating reserve as dispatch data	Existing (Value Range Updated)	-999 – 999	Value range will need to be updated to include negative range.
Bi-directional Resource Flag	Boolean (Yes/no)	Determines whether a resource has both a positive and negative dispatch range.	New	Y/N	
RTE (Roundtrip Efficiency)	% or decimal value; TBD	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.	New	0.0 – 1.0	Used as the default value to appropriately determine the SoC of the battery. This may be superseded by an optionally daily dispatch data submission.

Daily Cycles	# at or above 1, can include a single decimal point.	The number of cycles that the resource is normally willing to complete in a day. A cycle is considered the MWh as it relates to the SoC range of the battery , the difference between the upper and lower energy. limits submitted by the participant during registration.	New	0.0 – 9.9	This value is not used by DSOS. This will be collected to help the IESO understand cycling expectations of registered resources to help plan system operations.
Absolute Maximum State of Charge "Absolute MaxSoC"	MWh	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.	New	0-9999.9 MWh	Accessing the range between the registered MaxSoC and Absolute MaxSoC may be achieved through an optional daily dispatch data submission for MaxSoC which cannot exceed the Absolute MaxSoC. This validation will take place in MIM.
Absolute Minimum State of Charge "Absolute MinSoC"	MWh	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.	New	0-9999.9 MWh	Accessing the range between the MinSoC and Absolute MinSoC may be achieved through an optional daily dispatch data submission for MinSoC which cannot be lower than the Absolute MinSoC. This validation will take place in MIM.
Minimum State of Charge "MinSoC"	MWh	The lowest energy amount to which the electricity storage system can be consistently discharged without damage beyond expected degradation from normal use.	New	0-9999.9 MWh	This will be used primarily as informational and could be utilized for various IESO internal processes to verify the operating range of the resource or changes submitted via dispatch data.

Maximum State of Charge "MaxSoC"	MWh	The maximum energy amount to which the electricity storage system can be consistently charged without damage beyond expected degradation from normal use.	New	0-9999.9 MWh	This will be used primarily as informational and will be used for validation purposes, among other IESO internal processes to verify the operating range of the resource or changes submitted via dispatch data.

Record Equipment

The Record Equipment process will continue to start when market participants submit registration requests. Market Participants will submit facility, resource, and equipment information, and establish MP Owner, Operator, and Registered Market Participant role relationships for the resources that will participate in the market.

Online IESO will guide the Equipment Registration Specialist to define and submit equipment parameters that are required for their facility to be registered, including information about the physical equipment and information about the resources participating in the ICG.

As a result of Optimization design the IESO will need to modify an existing or introduce a new type of Generating Unit to facilitate the changes being introduced by Phase 1. This will involve updating various registration parameters to allow for negative values (bidirectionality), limited ramp rate, and SoC management. Some reporting tools that post on seasonal capabilities may use "Derived Parameters" computed at the resource level to create reports. Will need to add new derived Minimum values to ensure accurate accounting and reporting for withdrawal capabilities.

The existing "PV Inverter" equipment type will need to be enhanced, extended, or 'replaced' for Single model storage resources to manage new inputs because of Phase 1 Storage Optimization. The Equipment level will be used to record Absolute and Min and Max State of Charge values, among others. These updated parameters will propagate as new fields for single storage resources.

Information from the Generating Unit and connected Equipment are rolled up to form a resource that can participate in the market. New fields will need to be created for these resources so that information can be passed into the market. The IESO will continue to assign the resource name, resource ID, and delivery point identifiers for each registered resource associated with a physical facility.

Once the IESO reviews and approves the submitted equipment information, the IESO will collaborate with the market participant to create resource records for the equipment that will be modelled in the IESO network model and used to participate in the IESO-administered market.

Prepare for Operations

After the IESO verifies the facility registration information submitted by the market participant, the IESO will continue to complete a series of internal activities that are required to consider the facility, resources, and equipment as registered.

Prepare for Operations delivers IESO operational readiness and completes all IESO internal activities required to prepare staff and systems for commissioning or for in-service operations. This includes building the Network and Commercial models and completing all other tasks that are related to IESO operational readiness.

Participation in dispatch testing in Sandbox will continue to be required while the resource is being commissioned. No changes will be made to dispatch testing procedures.

Wholesale Metering

Metering data is the basis for producing settlement ready delivery point data for determination of the settlement amounts for all resources settled in IESO.

Some of the existing registered storage facilities will transition from the dual model storage resource to a single model storage resource. This transition will require de-registration and re-registration of the existing metering installations to consider the new storage resource(s).

The assessment provided below summarizes the assumptions and impact analysis for Wholesale Metering requirements related to new storage resource integration as part of the ERP Single Resource / Hybrid Integration (S/H) project. It outlines potential impacts on metering processes, systems, governance, metering re-registration, and energy uplifts, along with recommendations for implementation.

- The Energy Delivery Point associated with the new storage resource will have the same structure as the existing delivery points associated with other resources modeled in our commercial model.
- The Transmission Delivery Point (DP) associated with the storage facility containing new storage resources will have the same structure as the existing transmission delivery points associated with other facilities.
- The design solution regarding the exemptions from uplifts on energy withdrawn as fuel for the sole purpose of being able to provide services back to the grid at a future point in time will be similar to the generation station service rebate (GSSR)/energy station service reimbursement (ESSR) or rebate methodology outlined in the relevant Energy Storage Facility Agreement (ESFA) contracts.
- The dispatch instructions for the new storage resources are recorded in the Market Information Management (MIM) database as positive and negative dispatch instructions to indicate the injection or withdrawal of the storage unit.
- The ongoing Meter Data Management System (MDMS) Replacement project will not change the current metering business processes and functionality of the metering systems.

The roles, activities and tasks of the existing metering processes will remain the same.

Build Online Model

Online Model Build (OMB) process consists of Network Model Build (NMB) and Commercial Model Build (CMB). The commercial model which consists of market-only entities created from the Network Model to enable a more complex electricity market, primarily a single schedule market with Locational Marginal Pricing (LMP).

The single storage resource for battery storage will be modelled as generators in the network model. The change in the network model is that these generators will be bidirectional,

represented by positive active megawatt reading for injection and negative active megawatt readings for charging, generally referring to withdrawal capability of the storage resource.

To model a single storage resource in the online model, the following technical data and information must be collected:

1) Technical data of the equipment and resources, such as breakers/disconnects, buses, transmission lines, transformers, generators (market resources, single storage resource), auxiliary load or station service load, etc. The Minimum Active Power Capability of the generator will be negative.
2) Single Line Diagram that shows the connection between the facility and ICG, and the configuration of facility.
3) Operational telemetry information, including SoC in MWh and optional percentage SoC.
4) Delivery point, electrical bus, and price-location for commercial model.
5) Telemetered SoC will be mapped to the storage(s) modelled with bi-directional single resource (generator) when it is implemented in network model. A new NMB template will be created for network model build.
6) If a storage resource participates in OR, it will be handled in the same way that a current market resource with OR is handled, and no additional change is needed from online model (network model and commercial model) perspective.
7) Zonal Demand and Primary Demand calculations will be revised to exclude charging MW of bi-directional single storage resources.

SCADA/Energy Management System (EMS) will need to be updated to be able to manage negative generation and capability curve over both positive and negative active and reactive power output. Each storage resource will be modelled as a generator at a separate low-tension bus and will use the DPGen in the commercial model.

Station Service and Auxiliary loads associated to single model storage resources will not be treated as NDLs and therefore will not be included in the commercial model.

Commission Equipment

Commission Equipment implements all requests requiring commissioning tests to bring new or changed facility equipment into service. This includes verifying and approving commissioning test plans and updating equipment parameters based on commissioning test results. The end state of the commissioning process will be the validation that equipment meets requirements of the market rules, and completion of the market registration process.

A self-scheduling procedure will be developed for the purpose of the single storage resource to commission their facilities. This self-scheduling procedure will not be for enduring participation and only for the commissioning for those resources that will be newly registered or transitioned to this new dispatchable single storage resource mode.

When commissioning, the resource will still operate under a single storage resource model meaning that the online model requirements will apply, although they will participate as a self-scheduler during this time. There will be certain exclusions and requirements to support this period of the resource's operation and to adapt the self-scheduling model for the single resource model:

- Single model storage resources participate generally like a self-scheduling generator under existing requirements but utilizing negative generator characteristics. When injecting they will provide their self-schedule with a positive MW quantity, when withdrawing they will provide their self-schedule with negative MW quantity.
- LMP pricing will apply whether injecting or withdrawing during all time frames.
- SoC will not be modelled when entering self-schedules, the resource will manage these and must submit self-schedules that respects its own state of charge limitations.

SoC will not be modelled or submitted by MPs during this commissioning period. MPs will pay or be paid LMP.