Long-term Energy Storage Market Participation Options Paper

Energy Storage Roadmap

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Executive Summary

This options paper centres on and is limited to the scope of work defined within the market design component of the markets integration pillar of the AESO's Energy Storage Roadmap. The market design effort considers energy storage ("ES" or "storage") participation in the Energy and Ancillary Service (AS) markets, which includes the rules pertaining to offers and bids, dispatch and dispatch compliance.

Through a review of the existing rules and stakeholder feedback on the short-term implementation, the AESO has identified the following four areas which required additional clarification and consideration in the ISO rules to enable further integration of storage into the energy market:

1) The market operation issues caused by the aggregation of variable energy resources (wind and solar generation) and storage as a single energy market asset and possible implementation options designed to address the issues.

2) Compare the current half-range (discharge capability only) energy market participation model to a full-range participation model where storage resources submit price and quantity blocks for the charging and discharging capability, and possible implementation options for full-range participation.

3) The need to define State of Charge, and the use of this term within the ISO rules.

4) ISO Rule considerations for commissioning the charge portion of the ES facility.

This paper examines each consideration and the possible implementation options for stakeholders to consider.

Introduction

The Energy Storage Roadmap sets out the AESO's plan to facilitate the integration of energy storage technologies into AESO Authoritative Documents and the AESO grid & market systems. The Energy Storage Roadmap is structured around the four integration pillars of energy storage enablement – Transmission, Markets, Tools, and Regulatory. These are described in further detail in the Energy Storage Roadmap, and illustrated below. These integration pillars provide focus as the AESO progresses this complex initiative. The effort was also split into work that could be completed in the short term, and a longer term initiative to address the unique aspects of energy storage integration that are not addressed within the current AESO authoritative documents.

The markets integration pillar includes the following work streams; 1) Market design 2) Tariff design and 3) Operations planning & engineering. This paper focuses on the market design component of the Markets integration pillar. The market design effort includes storage participation in energy and ancillary services markets, which includes the rules pertaining to offers and bids, dispatch and dispatch compliance, settlement and credit, and supply surplus and short-term adequacy.

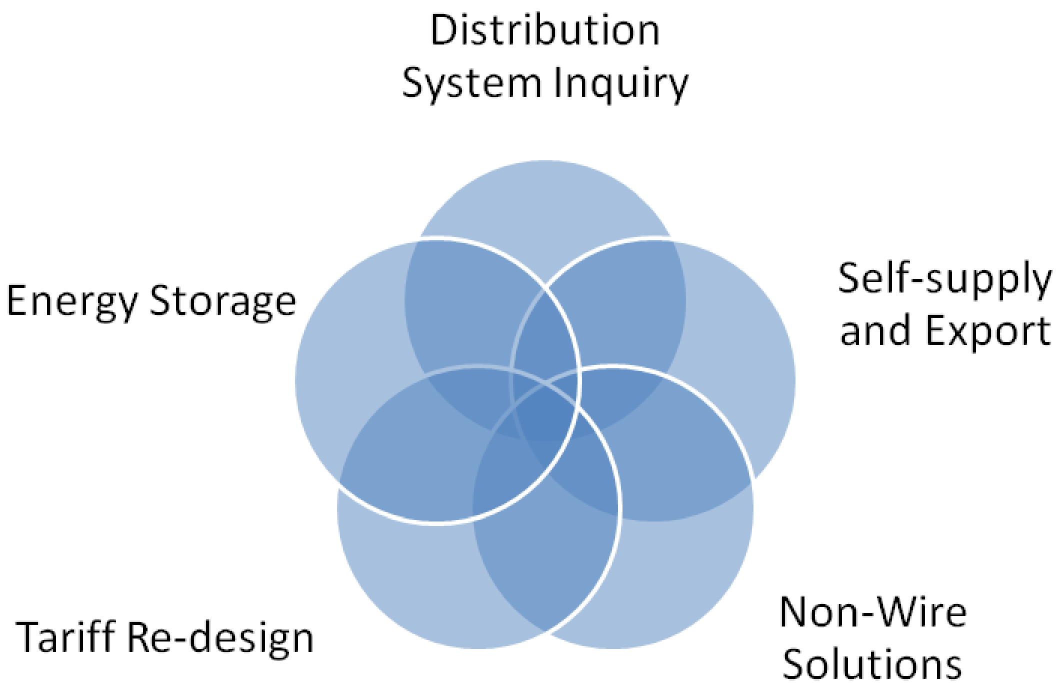
The term "market participation" is used in this document to describe the activities a participant must perform to in order to actively, rather than passively, participate in the electricity markets. This includes submitting priced offer and bids, restating those submissions when there is an acceptable operating reason to do so, and receive and comply to a dispatch instructions and directives issued by the System Controller.

Figure 1 - Integration pillars for energy storage

Design assumptions and dependencies

As illustrated in figure 2 below, there are a number of ongoing industry initiatives that are inter-related with the Energy Storage Roadmap. This paper makes certain assumptions about the outcome of each initiative. Should those assumptions be incorrect the AESO may be required to consider the market design implications to the storage implementation. This does not mean the AESO should wait until all the other initiatives are completed in order to progress the storage roadmap, but rather that the AESO should be agile in its approach and look for design solutions that fit multiple outcomes.

Figure 2 - Interdependencies between industry initiatives



1) AUC Distribution System Inquiry (DSI) and the AESO's positions

Storage connected on the distribution system is considered a Distributed Energy Resource (DER) and was a topic of discussion in the DSI. In the DSI, the AESO stated that DER and Transmission Connected Generation (TCG) should continue to be treated consistently and is moving forward with the assumption that this will continue to be the case in the future. If the future proceedings justify different treatment then the AESO's assumptions on storage will need to be re-evaluated.

The current assumption is that DER and TCG will have consistent treatment in the market, and the energy market continues to extend into the distribution system for the dispatch and settlement of DERs.

2) AUC Decision related to self-supply and export

In AUC Decision 23418-D01-2019 ("EL Smith"), the Commission concluded that the Alberta legislative scheme prohibits a generating unit from supplying electricity to a load on the same property and exporting excess to the Alberta Interconnected Electric System ("AIES"), subject to limited exceptions for sites with industrial system designations, micro-generation, and municipalities. Since storage is technically a load while charging, in response to the short-term market implementation requirements for energy storage[1], stakeholders have questioned whether a site with both generation and storage is a form of self-supply and export. Currently the AESO is relying on case by case power plant application decisions to determine

[1] https://www.aeso.ca/assets/Uploads/Overview-of-Short-term-Market-Implementation-Requirements-for-Energy-Storage-Participation-FINAL.pdf

the market treatment of these type of facilities. Should the AUC direction change the AESO will have to consider additional rules regarding the ability to charge the storage using on-site generation.

The current assumption is sites made up of solely a combination of generation and storage (no on-site end-use load) are not offside the regulatory framework regarding self-supply.

3) Alberta Department of Energy (ADOE) policy regarding storage, DER and Non-Wire Solutions (NWS)

This component considers the ability for the AESO and DFOs to use non-wires solutions as part of transmission and distribution system planning. Central to the discussion is the ability to use energy storage as a substitute for traditional wires infrastructure in some circumstances. While the scope of this effort is focused on the changes needed to better facilitate NWS, these changes could have implications on market participation of these resources.

The current assumption is storage will be a market asset that may provide non-wires solutions, rather than a regulated asset capable of participating in the energy and AS markets.

4) Broader ISO tariff re-design

Central to the treatment of storage within the market is the treatment of storage in the tariff. An efficient market design must consider the “all in” costs to the resource. The market and tariff signals should not be conflicting.

The assumption is the rate designed applicable to storage will not result in conflicting behaviors caused by competing price signals.

Background

Short-term storage implementation summary

The short-term market participation solutions for storage are limited by the current ISO rules. To facilitate storage participation, the AESO revised the information documents supporting the rules to explain how the existing ISO rules apply to storage applications. The primary way in which storage would be treated is by requiring the asset to offer the discharge capability into the energy market and allow the asset to use state of charge as an Acceptable Operational Reason (“AOR”) when the state of charge is at 0 or 100%. Accordingly, the storage resource may need to be out-of-merit in the energy market in order to charge the storage device or risk being in dispatch non-compliance.

In the operating reserve market, the storage facility may qualify for their full-range, which is their charge and discharge capability, subject to meeting the technical requirements under the applicable ISO Rules.

Losses and GUOC apply to storage assets under the current ISO rules.

Long-term participation solution design

The long-term solution must provide clarity for energy storage assets given their unique operating characteristics. The solution should allow operators of these energy storage facilities to be able to intuitively submit bid and offer data into and operate their assets in the energy and ancillary services markets in a manner that supports the operation of the facility while at the same time provides a coordinated approach to the market rules. The long-term participation solution must support the AIES needs for reliability, provide the AESO System Controllers the necessary software applications to monitor and control these energy storage facilities in support of power delivery and balancing across the AIES. Finally the solution should support the facilitation of a FEOC market, considering that the market design of the rules should be as technology agnostic as possible and minimize the need to grandfather assets to existing rules. To guide the design, the following design principles were developed.

Table 1- Market design principles for storage implementation

Design Principles	Rationale
Technology Agnostic	In order to facilitate FEOC principles the market treatment needs to be consistent across all participating technologies and applies to all storage applications
Minimizes Complexity	Strive for a simple elegant solution that is effective. Allow participants to intuitively submit bid and offer data into and operate their assets in the energy and ancillary services markets in a manner that supports the operation of the facility while at the same time provides a coordinated approach to the market rules. Complex designs lead to confusion and acts as a barrier to entry
Maximizes Participation	Maximizing participation in the market improves competition, and price fidelity
Participation Flexibility	Allow some flexibility to how the asset can best participate given its technical configuration in order to remove barriers to entry and prevent overly constraining rules while maintaining the FEOC principles
Dispatch-ability	Reduce the variability in delivered volumes resulting from System Controller dispatch. The design should give the system controller the ability to monitor and control energy storage facilities in support of power delivery and balancing across the AIES
No Grandfathering required	The solution should avoid the need to grandfather existing assets as much as possible

Using these principles the AESO is able to assess the validity of the design options.

Considerations for the long-term implementation

The short-term implementation allowed for clarity around expectations for storage participation and assessed the flexibility of the current ISO rules. However, there were outstanding issues that could only be addressed through rule changes. The AESO has identified the following 4 areas which required additional clarification and consideration in the rules to enable further integration of storage in the energy market. These are introduced below.

1) Variable Energy Resources (VER) & storage hybrid participation – assess the issues caused by the aggregation of VERs (wind or solar resources) and storage as a single energy market asset and possible implementation options. How can the issues be addressed?

2) Energy offer submissions – maintain half-range (discharge capability only) or implement full-range (charge and discharge capability). What are the options for full-range implementation?

3) State of Charge – how should it be defined?

4) Commissioning requirements – what are the considerations for commissioning the charge portion of the ES facility?

1) Hybrid participation of VERs combined with storage

There are two possible market configurations for facilities that have multiple technologies on a single site:

a) define a market asset for each on-site technology that participates independently.

b) define a single hybrid asset made up of multiple technologies that participates as an aggregate asset.

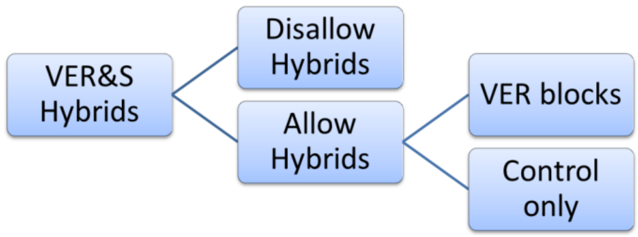
The hybrid asset concept was not considered in the current market design. Energy market source assets are currently classified as either generating units or aggregated generating facilities (AGF) of like technology based on AUC power plant applications. Currently wind or solar farms, are classified as AGF. While this distinct classification does not align with the design consideration of trying to keep the AESO rules as technology agnostic as possible, it was necessary because variable energy resources (VERs), such as wind and solar generation, were unable to comply with rules originally designed for thermal and hydro generators. To that end, the AESO developed two different terms to describe the behaviour of assets in the market – dispatchable and controllable. The term “dispatchable” is used to describe any source asset at least 5 MW in maximum capability. Dispatchable assets are subject to the participation rules and must offer their maximum capability into the energy market. This includes wind and solar resources. The term “controllable” means the asset operators can control the volume and timing of energy injections, and withdrawals, if applicable, within tight tolerances regardless of the size of the resource. Table 2 below provides examples of technologies and their dispatchable and controllable nature and is not intended to be an extensive list of all known technologies.

Table 2- Example of dispatchable and controllable technologies

Technology	Dispatchable	Controllable
Thermal generation under 5 MW MC	No	Yes
Thermal generation 5 MW MC or greater	Yes	Yes
Hydro generation 5 MW MC or greater	Yes	Yes
Solar generation 5 MW MC or greater	Yes	No
Wind generation 5 MW MC or greater	Yes	No
Wind or solar generation under 5 MW MC	No	No
Biomass generation 5 MW MC or greater	Yes	Yes
Storage 5 MW MC or greater	Yes	Yes
Storage less than 5 MW MC	No	Yes

Stand-alone storage is considered controllable; however, it is energy limited by the storage capacity and state of charge. The existing market rules regarding dispatch and the delivery requirements for energy apply to and are feasible for storage facilities because there are already capabilities within the rules to allow the participant to remove capacity from the market when the asset is physically unable to provide the energy. For wind and solar resources, the market rules were amended so that these assets could participate in the same “must offer/must comply” manner as thermal generating units but conditions were added to give different allowable dispatch tolerances with respect to dispatch compliance. For VER & Storage hybrid assets made up of both controllable and non-controllable technologies, neither the AGF (wind/solar) nor generating unit dispatch requirements are suitable. The AESO’s approach to addressing this issue is to first discuss the merits and drawbacks of VER and storage hybrid participation and second outline possible implementation mechanisms should these types of hybrid assets be included in the market.

Figure 3 - VER & Storage (S) Hybrid design decision tree



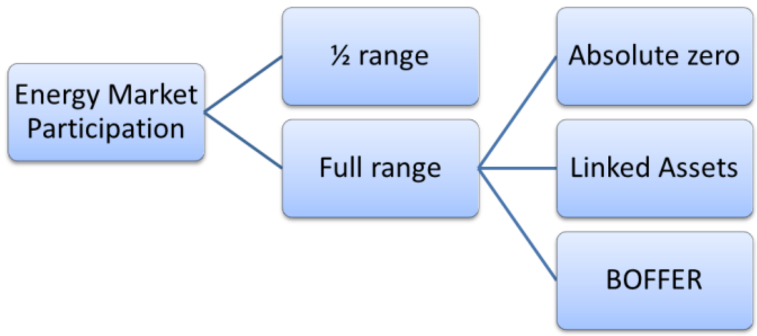
Section 1 of the document explores different approaches to addressing this current short-coming within the energy market.

2) Half-range energy offers versus full-range participation

Under the current market rules, assets are either sources that inject energy onto the AIES, or sinks that withdraw energy from the AIES. This structure has served the market well for the last 25 years. Even prior to the introduction of storage, there are facilities that both inject and withdraw energy to and from the grid. For those facilities, the AESO provides these dual-use sites both source and sink assets to facilitate market participation and financial settlement. While it is possible for load assets to bid into the market, providing a price and quantity for inclusion in the merit order to indicate the amount of load that would be reduced at certain system marginal prices, there is no obligation to submit the load bid. As it stands there has been little to no bidding into the energy market short of extra-provincial exports, which technically cannot price their export bid at any other price than the offer cap. Loads are simply served by generation dispatch and consume the electrical energy for some other off-grid purpose. In order for loads to be dispatchable, they must reduce and restore their consumption when instructed. As loads consume electricity for some end-use purpose, having to comply with dispatch instructions may not align with the purpose of energy withdrawal from the AIES, except when the cost of electricity exceeds the price the consumer is willing to pay to consume it.

Stand-alone storage facilities do not have an off-grid purpose for the energy they withdraw from the AIES. The energy is taken off the grid, stored for a period of time, and then delivered back to the grid. However, energy storage can serve a number of on-grid purposes, such as energy price arbitrage, congestion relief and provision of ancillary services. In order to best facilitate these on-grid services, and to have these services be provided when the system needs them, there is benefit to have both the charge and discharge capabilities of the storage facility to be controllable by the system operator in much the same fashion as a typical generating unit is controllable. In other words, if the facility can make available its full-range of capacity for dispatch or directive and comply with the System Controller instruction, the range of reliable services storage can provide widens. The AESO's approach to addressing this issue is to first discuss the merits and drawbacks of full-range participation, and second, discuss possible implementation strategies should full-range participation be implemented.

Figure 4 - Energy market participation decision tree



In section 2 of this document, the AESO discusses the advantages and disadvantages of the two participation models (full-range and half-range).

3) State of charge

For the short term implementation, the AESO stated in the Information document ID #2012-009R for Section 203.3 of the ISO rules - Energy Restatements, that state of charge could be used as an AOR for restatement only if the state of charge is at 0% or 100%. It is at these levels the storage device can no longer discharge or charge. Percent state of charge is a relative term and the AESO currently provides no guidance to the participant to how zero and one hundred percent are determined nor does the AESO provide a definition as to what state of charge means with respect to compliance with the ISO rules. Section 4 of this paper explores the need for and possible rule approaches for state of charge.

4) Commissioning requirements for storage

In order for storage assets to complete commissioning they must test both the charging and discharging capabilities of the site. The current ISO rules regarding commissioning are designed for generating units and aggregated generating facilities. Subsection 4 of Section 203.1 of the ISO rules, *Offers and Bids for Energy* requires all offers to be submitted at $0 and therefore doesn't permit multiple offer or bid blocks while commissioning. The rule requires pool participants to offer the source asset using a single block and use an Available Capability restatement to move the energy in and out of the merit order while testing the operation of the facility. This requirement of the ISO rules was designed with generators in mind and did not consider the need for charging the device. The AESO discusses the possible rule options and assesses the advantages and disadvantages of each in section 5 of this paper.

Section 1 - Solar/Wind & Storage hybrid participation

This section explores the merits and drawbacks of VER and storage hybrid participation and outlines possible implementation mechanisms should these types of hybrids be permitted.

Some storage applications may be better suited to a hybrid participation configuration. This configuration results in a single dispatch and a single settlement for the combined technologies. The onus is on the pool participant to manage operation of the combined asset through its offers in order to comply with instructions issued by the system controller. Combining technologies into a single dispatch works well when the combination, as a whole, is capable of responding to the dispatch instruction and remains within the dispatch tolerances specified in the ISO rules. However, an energy market asset made up of energy storage in combination with a variable energy resource such as solar or wind aggregated generating facility presents some dispatch challenges. The AESO developed a separate methodology for determining dispatch instruction compliance of Wind or Solar AGFs to deal with the uncontrollable nature of wind and solar. "Allowable dispatch variance" is currently defined in the AESO's Consolidated Authoritative Document Glossary as:

(i) for each generating source asset, other than a wind or solar aggregated generating facility, as measured from the dispatch quantity:

- (a) plus or minus five (5) MW for a generating source asset with a maximum capability of two hundred (200) MW or less; or
- (b) plus or minus ten (10) MW for a generating source asset with a maximum capability of greater than two hundred (200) MW;

(ii) for each wind or solar aggregated generating facility with a maximum capability of two hundred (200) MW or less:

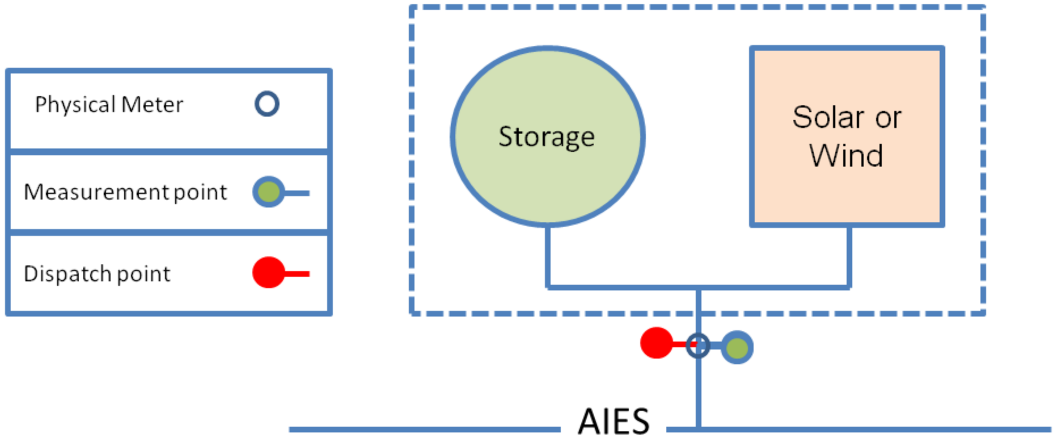
- (a) five (5) MW greater than the dispatch quantity and five (5) MW less than the potential real power capability, if the potential real power capability is less than the dispatch quantity; or
- (b) plus or minus five (5) MW from the dispatch quantity, if the potential real power capability is greater than or equal to the dispatch quantity; and

(iii) for each wind or solar aggregated generating facility with a maximum capability of greater than two hundred (200) MW:

- (a) ten (10) MW greater than the dispatch quantity and ten (10) MW less than the potential real power capability, if the potential real power capability is less than the dispatch quantity; or
- (b) plus or minus ten (10) MW from the dispatch quantity, if the potential real power capability is greater than or equal to the dispatch quantity.

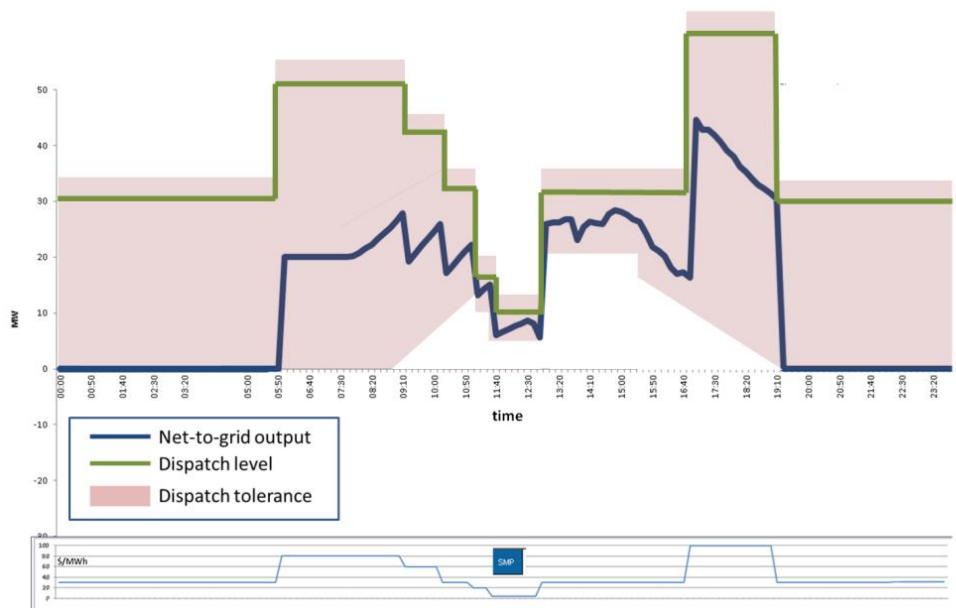
Wind or solar aggregated generating facility with storage (hybrid configuration) is not considered in the current definition of "allowable dispatch variance". Figure 5 provides an illustration of a hybrid configuration.

Figure 5- Solar or wind with storage hybrid application with hybrid dispatch



The hybrid configuration results in a single point of connection that acts as both the bi-directional measurement point and the dispatch point. An example may be the best way to illustrate the challenges this configuration causes. Assume a battery and solar farm each 30 MW in size are installed on the same site and have chosen to be configured as a hybrid asset. Assume this asset has a maximum capability and a must-offer/must comply requirement of 60 MW. As shown in figure 6 below, the participant submits a 6 block offer for the entire 24 hour period. As a result, the asset is dispatch up and down as the system marginal prices changes throughout the day. The green line on figure 6 represents the dispatch level and the blue line represents the net to grid MW output from the site. Short of a few hours in the afternoon there is a wide variance between the dispatch level and the actual output over the course of the day.

Figure 6- VER and storage hybrid dispatch



This wide allowable dispatch variance (shown as the pink area in figure 6) is permitted under the current ISO rules because the aggregate asset chose to participate as a wind and solar AGF rather than as a generating unit. With this wide allowable dispatch variance it is very difficult to reconcile the dispatch instruction with the expected output. It is not until the underlying component generation output is assessed, shown in figure 7, does the relationship between the output and offer become clear.

Figure 7- Hybrid dispatch underlying components

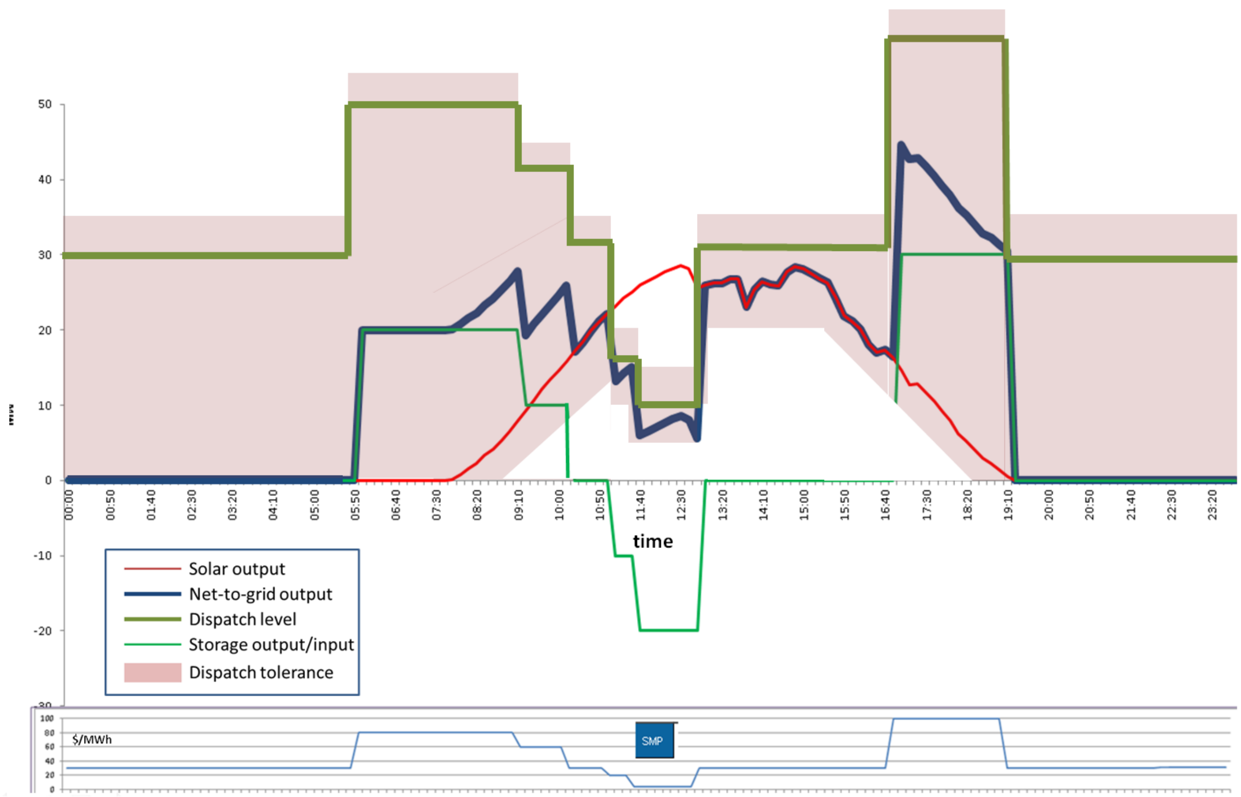
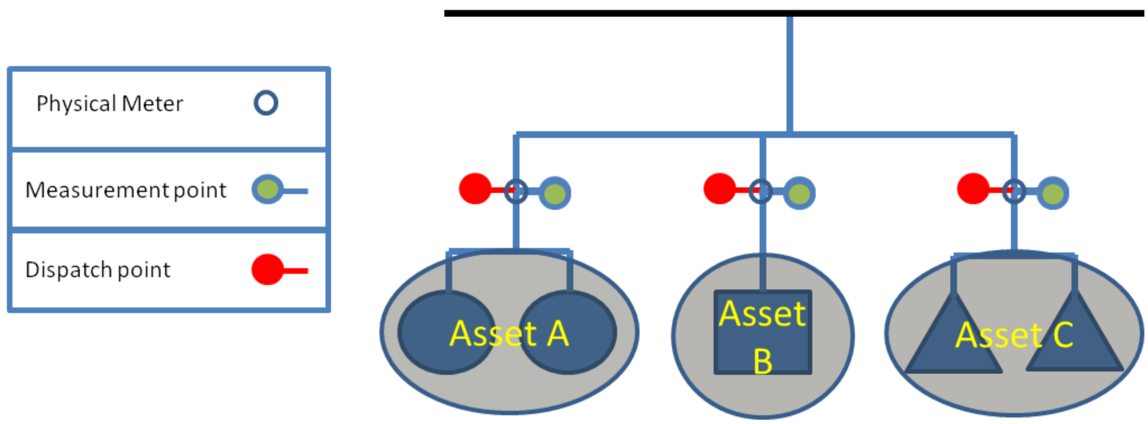


Figure 7 shows the same dispatch level (thick green line) and the net to grid output (dark blue) as in figure 6 but includes solar output shown by the red line and the storage charging and discharging levels shown by the thin green line. Now it is easier to assess why the net to grid output varied so far from the dispatch level. The pink areas on the graph show the allowable dispatch variance ranges given the solar potential[2]. These ranges are calculated as plus or minus 5 MW of the lesser of the solar potential MW plus storage output, or the dispatch level. Given the large allowable dispatch variance which incorporates the wind or solar potential and dispatch level, the System Controller is unable to predict the expected output of the asset within an appropriate tolerance as compared to the dispatch instruction.

[2] For simplicity this graphic does not show the ramp power management limits.

One possible solution is to not permit multiple technologies to aggregate and require separate offers and bids for each on-site technology. If a site were to have multiple technologies installed then each technology would be required to participate and be dispatched independently. For example, as shown in figure 8, if a participant had 3 different technologies on the same site, the AESO would assign assets for each. If implemented, this design would also need to be applied to cross-site aggregation rules, if such rules were to be developed in the future.[3]

Figure 8 - No hybrid option



There are a number of advantages to prohibiting hybrid assets. They are less complex to implement as the current ISO rules would suffice. The broad ADV would only apply to Variable Energy Resource assets and not to the storage or other generating units on-site. The wind and solar ramp power management and forecasting rules would not have to change. Enabling hybrids would require ISO rule changes as the current rule prohibits discharge beyond weather (MET) derived ramp limits. Also, prevention of hybrids would avoid the complexity in attempting to classify hybrid asset configurations for the purposes of outage reporting. Additionally this option provides visibility to the System Controller and market participants as to what is behind the fence.

However, disallowing VER & Storage hybrids presents disadvantages as well. Firstly, the no hybrid option limits participant flexibility. There are potential storage applications that may be difficult to operate as independent assets. For example, sites that place a separate storage device under each solar panel on the same DC circuit opposed to sites that build an independent storage facility on the same site as the VER. Revenue metering of these “DC coupled” installations would be prohibitively expensive if the hybrid configuration was not permitted. Additionally, this option requires more metering as each asset would need to be financially settled independently.

Disallowing hybrid assets limits active participation in Energy and AS markets. Aggregation for the purpose of meeting AS and Energy participation thresholds would not be possible if hybrid assets were

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[3] Cross site aggregation is being considered as part of the DER roadmap implementation.

prohibited. For example, a site with 3 MW of solar and 3 MW of storage would not meet the 5 MW participation threshold alone, but would in aggregate. More volume in the energy market merit order results in better price fidelity and more volume in the OR market increases competition.

If hybrid assets are not permitted, there may be an over estimation of the maximum capability of a site if the facility was limited by the inverter or the transformer. For example a 10 MW battery and a 10 MW solar farm are limited by a 10 MW inverter, the no hybrid option would require each independent asset to have a maximum capability of 10 MW even though the combined site could never be dispatched over 10 MW.

The no hybrid option also deviates from the AESOs design consideration of making the rules as technology agonistic as possible and has bigger implications for aggregation in general. The AESO will need to define which technologies are similar enough to aggregate and which ones are not. As new technologies are made available, the ISO rules would need to be revised.

Hybrid participation summary

When assessing the inclusion of hybrids against the market design principles we find that enabling hybrids would improve participation, give the market participants more flexibility, would not impact reliability, tests well against all storage applications and would not require grandfathering. However, the option adds complexity to the market and does not improve dispatch-ability, or allow the participation rules (part 200 of the ISO rules) to be technology agnostic.

Table 3 - Options summary

Design Principles	Allow VER &S Hybrids	Disallow VER &S Hybrids
Technology Agnostic	NO/YES	NO/YES
Minimizes Complexity	NO	YES
Maximizes Participation	YES	NO
Participation Flexibility	YES	NO
Dispatch-ability	NO	YES
Reliability	YES	YES
Grandfathering required	NO	Potentially

The *scope* of this section of the paper is to lay out the pro and cons of allowing VER and Storage hybrid assets to participate in the market. Without drawing a recommendation, the AESO went a step further and discussed what the market implementation might look like to address the dispatch-ability issue if hybrids were permitted. Doing so provided some context into how the market might need to change should the recommendation be to include hybrids as part of the long-term solution.

Participation methodologies for improved hybrid dispatch

If the AESO is to include hybrid assets in the market, it must be implemented such that the concerns caused by this type of configuration are appropriately addressed. It will be very difficult to keep the rules technology agnostic and these options will add complexity to the rules; however, it is possible improve on the dispatch-ability of this asset type while giving participants more flexibility in their asset configurations. The AESO design team developed three mechanisms to improve wind and solar hybrid storage participation:

1. VER block volume - Add additional information within the offer indicating the volume of Variable Energy Resource energy within each block MW of the offer;

2. Controllable-only Participation – Offers are only submitted for the storage component of the hybrid asset. Wind and solar output is assumed to be at the offer price floor ($0/MWh);

   and

3. Status Quo – Allow the participant to choose whether the hybrid asset is to be considered a Generating Unit or a Wind or Solar Aggregated Generating Facility that continues to permit a large dispatch variance.

Each mechanism is described in detail below along with an assessment of the advantages and disadvantages of each mechanism. Later in this section an assessment of the mechanisms against the market design principles is provided.

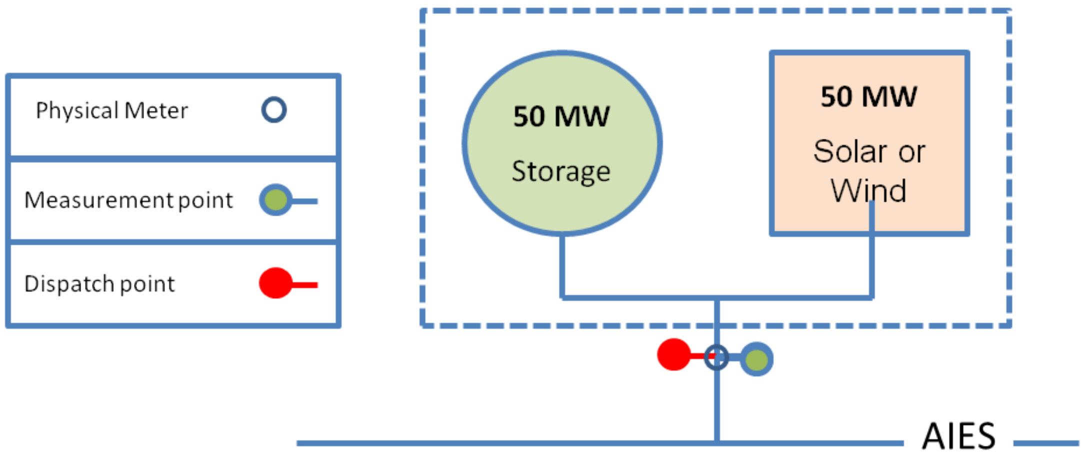
Hybrid Mechanism 1 - Variable block volume

This mechanism changes the bid/offer proforma to include an additional data point that indicates to the AESO which blocks of the submission contain variable energy from wind or solar and how much. This mechanism allows the AESO to determine the possible range of output when each block is dispatched and allows the System Controller to forecast dispatch requirements when this data is used in combination with meteorological (MET) data. For example, as shown in figure 9 below, a participant has a 100 MW asset made up of 50 MW of wind or solar and another 50 MW of discharge capability from on-site storage[4]. The participant has chosen to offer all of the variable solar or wind output at zero dollars, which is typical of VERs on the system today; however, the participant can choose to offer the variable energy resource in any or all blocks. By indicating where the variable energy is in the offer, the System

[4] This example will use the half-range submission option rather than one of the full-range options described in appendix 2.

Controller can determine the range of volume expected for each dispatch. Due to the fact that this asset is still considered a wind or solar aggregated generating facility and considered a non-controllable resource, there is still potentially a large variance in the expected output of each dispatch that is dependant on the future potential MW of the variable energy resource and the AESO ability to forecast it. For example, if the system marginal price was $38, 3 blocks of the offer would be “in merit” and dispatched. Depending on the solar or wind potential, the expected net-to-grid output from the site will be between 15 and 65 MW, when dispatched.

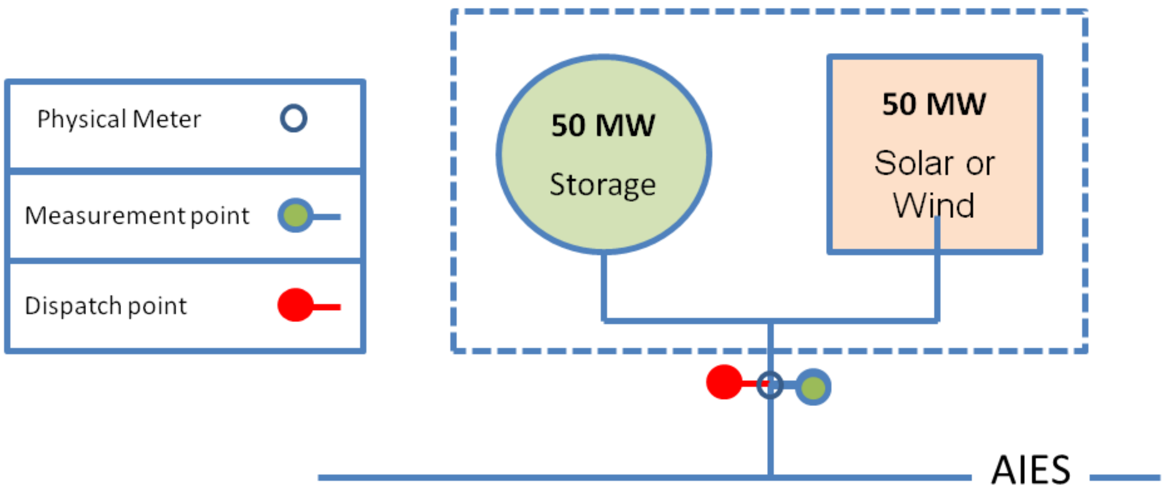
Figure 9- Variable block volume mechanism for wind or solar & storage hybrids



Price ($/MWh)	Offer (MW)	Block Size (MW)	Variable (MW)	Input (-) Output (+)
220	100	20		+50 to +100
45	80	15		+30 to +80
36	65	5		+15 to +65
25	60	10		+10 to +60
0	50	50	50	-50 to 0

The drawback to this mechanism is that the determination of the allowable dispatch variance is more complex and not intuitive, and less so when the participant chooses to price its VERs output at anything above zero. The following example shows the permissible dispatch variance when the variable energy is split between block zero and block 3. If the asset is dispatched to 65 MW, at block 2, the asset is expected to operate between 40 MW if the VER output is zero, and 65 MW if the VER output is at 25 MW.

Figure 10 - Priced variable block volume mechanism for wind or solar & storage hybrids

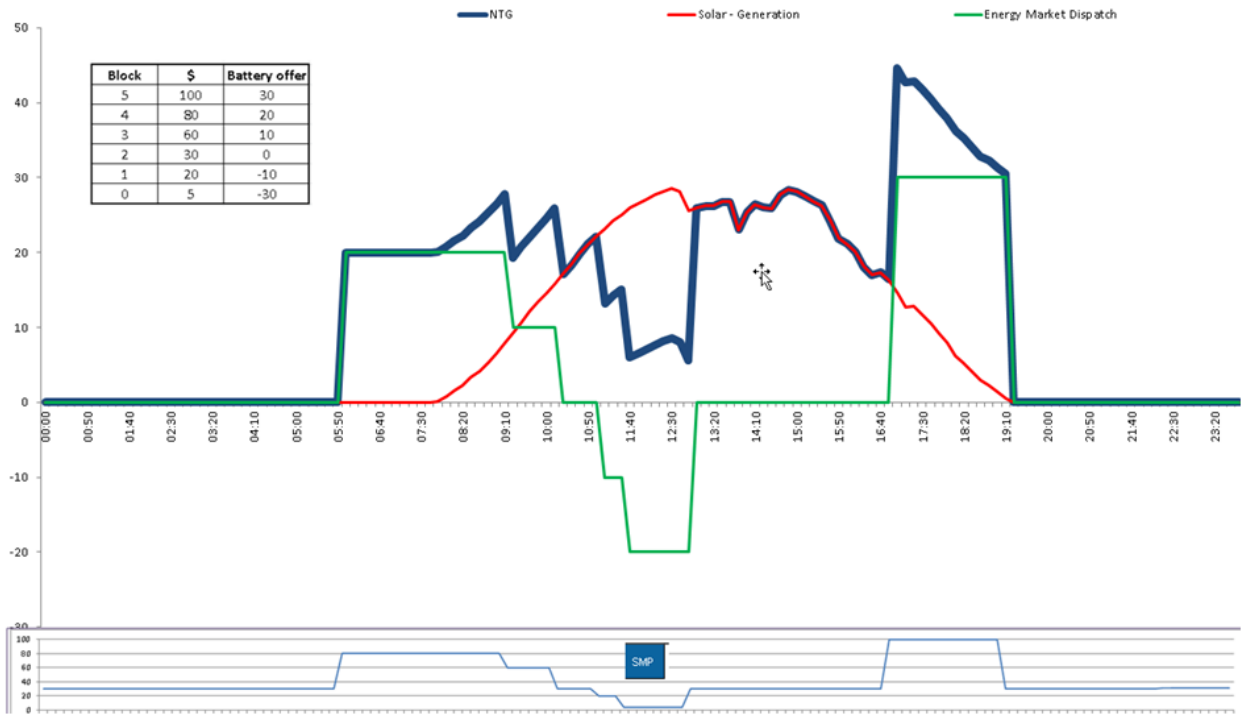


Price ($/MWh)	Offer (MW)	Block Size (MW)	Variable (MW)	Input (-) Output (+)
220	100	20		+50 to +100
45	80	15	25	+30 to +80
36	65	5		+40 to +65
25	60	10		+35 to +60
0	50	50	25	-50 to -25

Hybrid Mechanism 2 - Storage-only participation

This mechanism is a simplification of the previous hybrid mechanism. The variable energy component of the asset does not submit an offer (whether at $0 or above). This option was developed in observation that VERs do not submit non-zero priced offers into the market today, even though they have an ability to. In this option, the market submission will only include the controllable storage component. In the example, shown in figure 10, the entire range of the storage asset is priced. This participation mechanism is introduced in section 2 but included here to demonstrate how charging energy could be dispatched. In this example, the solar resource is assumed to be generating at or near its potential MW. Based on this information, the System Controller can derive the expected energy change when a block is dispatched and is able to forecast short-term adequacy requirements and dispatch levels to proactively maintain supply - demand balance.

Figure 11- Storage-only participation



The drawbacks to this option are that by removing the must-offer requirement from the VER resource, the participant loses the ability to respond to and set price with a component of the asset. This is inconsistent with the treatment of other assets over 5 MW in size that have a must offer - must comply and offer control reporting requirement. If the VER component has derates or outages, there will still be a requirement to make that information available to the AESO, so there would be no reduction in administrative effort.

Regardless, if the recommendation is to maintain the current state or implement one of the alternative mechanisms, there will be rule implications for allowing hybrid participation. The AESO must develop; 1) clear and obtainable dispatch compliance rules for hybrids; 2) classifications for hybrid assets to ensure transparency; and, 3) develop appropriate power ramp management and forecasting rules for these types of assets.

The table below assesses the hybrid participation of VERs with storage options against the market design principles. As shown in table 3 below, the options trade off technology agnostic treatment and dispatch-ability.

Table 4 - Summary of hybrid mechanisms and their alignment with the design principles

Design Requirements	Status quo	Variable block	Storage only
Technology Agnostic	3	2	2
Minimizes Complexity	4	3	4
Maximizes Participation	5	5	5
Participation Flexibility	5	5	4
Dispatch-ability	2	4	5
No Grandfathering required	5	5	4

This summary is based on a subjective assessment on a scale from 1 to 5 where the higher value indicates how well the option meets the requirement.

Section 2 – Half-range versus full-range energy market participation

This section outlines the differences between the current implementation of half-range energy market offers and potential enablement of full-range energy market offers. This section also outlines the pros and cons with either option, assesses the options against the design criteria, and then describes three additional participation mechanisms, should the recommendation be to pursue the full-range participation option for storage resources.

In the half-range option only the discharge capability participates in the energy market. The current ISO rules require an asset of at least 5 MW maximum capability to offer the discharge into the energy market and allow the asset to use state of charge as an AOR when the state of charge is at 0 or 100%. Enabling full-range participation would require both the charge and discharge capability to participate in the energy market.

Half-range participation

Half-range participation is the current state and is described fully in the AESO's Energy Storage Guide[5] and the related information documents but can be summarized in the following points:

- One asset for energy offers that only apply to energy production.
- Full-range Operating Reserve (OR) operation; however, the actual max reserve volumes allowed are expected to be lower than the full-range capability due to OR Technical requirements.
- The Available Capability (AC) and MW restatement can be used to manage state of charge under certain conditions.
- No participation requirements for charging which means no must bid requirement in the energy market.
- This implementation required no rule changes, and minimal system changes.

The advantages of this option are 1) it is the simplest option to implement, leveraging the existing rules, processes and software and 2) allows full-range OR participation. One of the primary concerns for the AESO with half-range participation is the large unpredictable dispatch variances that can occur. The System Controller has no control over charging levels of a fully dispatchable device which results in unpredictable deltas when dispatched. For example, if the battery were charging at a level of -10 MW and receives a dispatch to provide 5 MW, the asset must comply with the instruction and deliver 5 MW to the grid. However, the System Controller actually receives the 5 MW of energy injection plus a 10 MW load reduction as the device switches from charging to discharging. As a result, the dispatched energy combined with the load reduction is more than what is required and the asset is dispatched off again. The cycle is repeated if the asset chooses to start charging again. Requiring the asset to price the charging energy would allow the System Controller to know exactly what level to dispatch the asset to, resulting in a much more stable system marginal price for participants. Without full-range participation the ability to forecast system marginal price and determine short-term adequacy requirements becomes difficult. There is no ability for the System Controller to specify the ramp of load reduction which could raise reliability issues, and may require the AESO to carry more regulating reserve to compensate for the charge to discharge

[5] https://www.aeso.ca/assets/Information-Documents/2020-013-Energy-Storage-Guidance-2020-06-19.pdf

transition of a storage dispatch. This is also true for highly variable loads that do not bid in the system today, but increased storage integration without full-range participation further exacerbates the net demand variability issues faced by the system controllers.

Another issue with half-range participation occurs when the storage device is at 0% state of charge. Under the current rules the asset is permitted to restate the available capability to zero and remain at the state for as long as the asset chooses, provided the asset does not attempt to recharge the storage.[6] Restating Available Capability is intended to provide pool participants a tool to remove de-rated or outage MW from the energy market merit order in the event there was a physical problem with the facility. Sitting at a zero state of charge (0 MW output or charge) is not reflective of a physical problem and it becomes difficult to determine if the asset is purposely and physically withholding energy from the market, which is not permitted within the current rules, or simply waiting for the energy price to drop to an acceptable level in which to recharge the device.

If the recommendation is to continue with the half-range option the AESO would consider additional rule changes specific to storage in an attempt to address the issues described above. One consideration would be to determine a way for the participant to indicate to the AESO when they intend to charge versus wait for a zero state of charge (SOC) in order to improve the system controller's look-ahead capabilities and to improve the supply adequacy assessments. The AESO will also consider modifying subsection 203.4 pertaining to Allowable Dispatch Variance to prevent an asset dispatched to a value less than 5 MW discharge from charging the resource. For example, if a storage asset is dispatched to 3 MW, the rules permit the resource to discharge as much as 8 MW or fully charge the asset because the allowable dispatch variance was designed for source assets and assumes an asset never drops below zero. The AESO would have to consider the impact to current exporting self-suppliers if these rules change. Additionally, the Consolidated Authoritative Document Glossary (CADG) should be updated to outline what is an AOR for storage restatements, as the current 0% and 100% state of charge reason is not authoritative. In addition, the rules pertaining to bids are not explicit enough, and would have to be rewritten in consideration for storage devices. This may also include the need to include an available capability for the bid.

Full-range participation

Full-range participation in the energy market is the inclusion of the charging component within the energy market submission to allow the System Controller to dispatch across the full-range. The ability to offer and bid already exists within the rules but the bidding rules were designed for pure loads and exports. A key component of the full-range participation option for storage would include a must bid must comply (in addition to the Must Offer Must Comply (MOMC)) component to the energy submission in order to address the dispatch variance and net demand variability issues presented with the half- range option.

Like with any design there are pros and cons. It will be the assessment of these pros and cons by the stakeholder community as a whole that will help the AESO develop a recommendation for rule changes to better integrate storage into the market. The AESO's Market participation working team have identified the following advantages and disadvantages with implementing full-range participation for storage resources.

[6] The short-term implementation paper describes the rationale for this restatement requirement. Please refer to the information document 2012- 009R Restatements for more detail (https://www.aeso.ca/assets/Information-Documents/2012-009R-Restatements-2020-06-19.pdf)

Full-range option advantages

In addition to providing a solution to the reliability concerns caused by half-range participation, full-range participation provides the following advantages:

- Able to distinguish physical withholding with economic bidding
- Allows better price forecasting, better look ahead capability
- Reduces net demand variability
- Dispatch of charging levels instead of participant monitoring SMP

Full-range option disadvantages

- Full-range participation reduces participant charging flexibility by placing a "Must Participate" requirement across the full-range. Will storage participants want their "ability to charge" to be dispatched by the SC?
- Added complexity when considering VER and Storage hybrid assets. Hybrid assets may never need to bid as they will only charge from the onsite generator and never take energy from the grid. If they do participate while charging that charging volume may change as a result of changes to wind or solar potential, so the complexity that exists for VER hybrid offers also applies to the hybrid bid.

Half vs. Full-range option summary

A stand-alone storage configuration was used to assess the participation options against the market design principles so not to complicate the results by including hybrids in the assessment. As shown in table 4 below, full-range energy submissions option improves participation, dispatch-ability, reliability and price fidelity. However, the option adds complexity to the market, makes the rules less technology agnostic, and increases the risk that grandfathering existing assets may be required.

Table 5 - Options summary for stand-alone storage

Design Principles	Half-range only	Full-range
Technology Agnostic	5	4
Minimizes Complexity	5	4
Maximizes Participation	3	5
Participation Flexibility	5	4
Dispatch-ability	2	5
No grandfathering required	5	4

This summary is based on a subjective assessment on a scale from 1 to 5 where the higher value indicates how well the option meets the requirement.

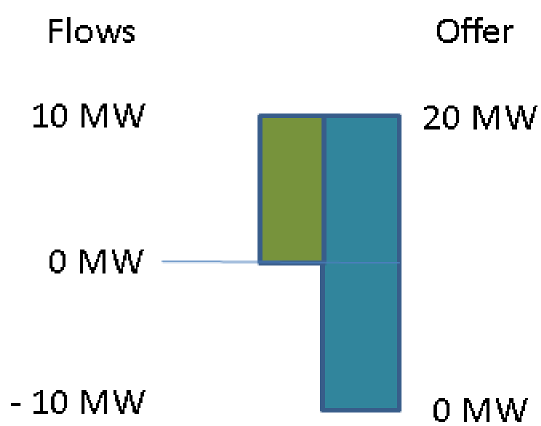
Full-range participation can take a few different forms. The following section describes three full-range mechanical options explored by the AESO. The differences in the options lie in their complexity to implement in rules and IT systems versus their simplicity for pool participants with storage to participate in the market.

Full-range mechanical options for participation in dispatch

Participation Option 1 – Absolute Zero

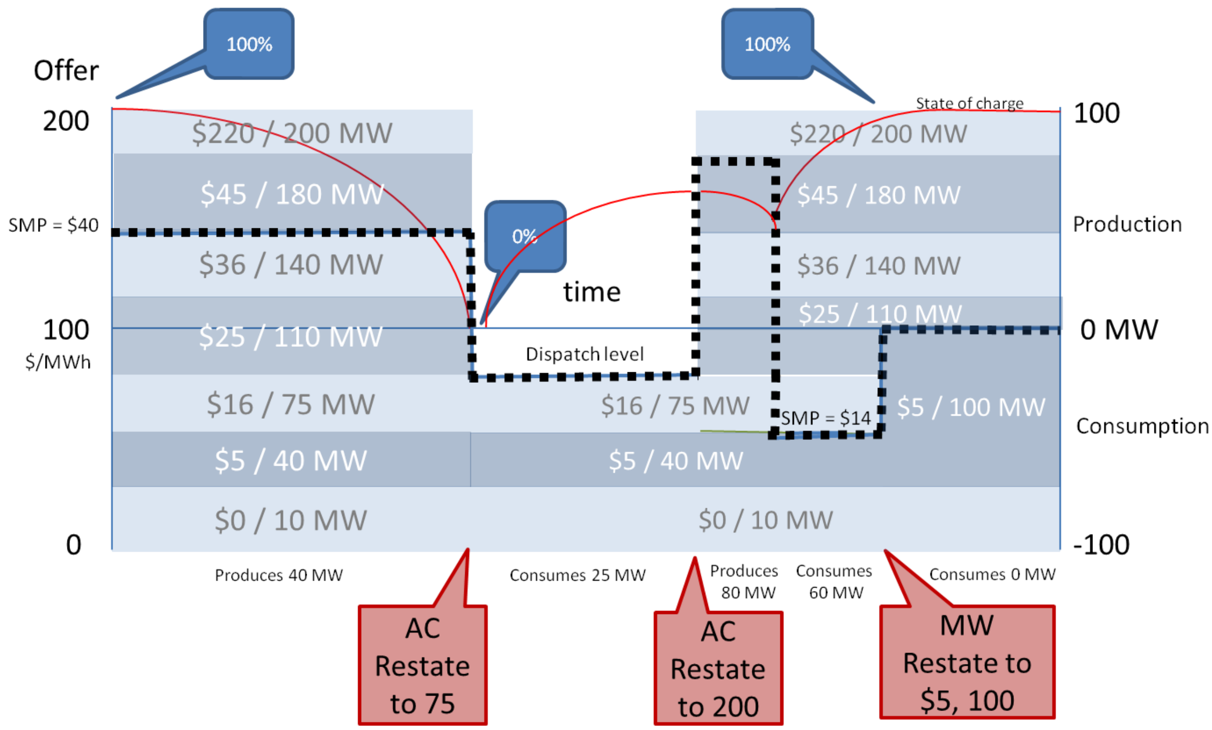
This submission structure is simply to convert the entire range of operation to a positive value offer. One way to think of it is re-adjusting the starting point from which storage is dispatched from. For example, as shown in figure 11 below, a half-range asset, only the 10 MW discharge capability is offered. In the Absolute zero mechanism the offer includes both the charge and discharge capability of the asset, doubling the size of the asset in the market. When the asset is dispatched to zero it will be charging at -10 MW, when the asset is dispatched to 10 MW it will be operating at zero state, and when dispatched to 20 MW it will be fully discharging its capacity.

Figure 12 - Absolute zero full-range mechanical option



Full-range participation still requires the asset to restate when state of charge is at 0% of 100% but the difference is the asset does not have to restate to zero MW but rather to the level the participant wants to charge at. A more elaborate multi-block example below shows the asset restating from 200 MW to 75 MW when the state of charge reaches zero percent. As a result, the asset is dispatched to 75 MW which permits it to recharge its capacity at about 25% of its charging capability. This full-range mechanism requires very little change to the ISO rules and existing processes but compared to the the other alternatives this option is not as intuitive. The charging capability is considered negative generation and the entire asset submitted into the energy market as a single offer.

Figure 13 - Absolute zero full-range mechanical option example

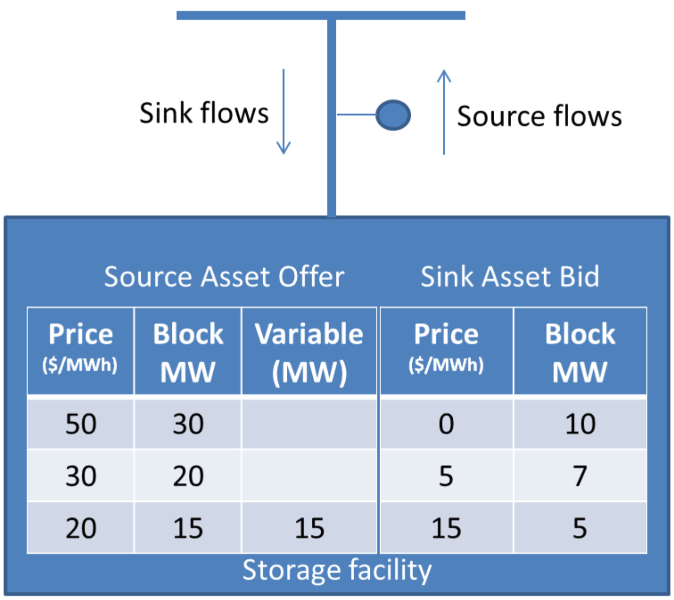


Participation Option 2 – Linked assets

This implementation option leverages the current source and sink asset model to integrate storage. A source asset is created to offer energy exports from the storage asset to the grid and a sink asset is used to bid any energy imports to the storage asset due to charging. Unlike current sources and sinks in the energy market these linked assets are not independent and when the bids and offers are submitted they are validated as a pair. Doing so ensures the participant cannot submit a combined bid and offer that results in infeasible or contradicting dispatches. In other words, the submission software within the Energy Trading System (ETS) ensures the bids are priced below the offers for a storage facility. The linked assets mechanism is fairly straight-forward. As part of the design evaluation process the AESO tested each mechanism against all the long-term considerations. In other words any proposed design for full-range participation must work with and without VER&S hybrid assets. For example, as shown in figure 13, a site is constructed with a 15 MW wind farm and a 15 MW storage facility. The participant chooses to configure the site as a hybrid, in which the storage and wind export are submitted as a single offer from a 30 MW source asset, and the grid charging requirement is reflected in the sink bid from a 15 MW sink asset. The participant can choose the size of the sink asset based on how much energy the participant will need to consume from the grid in order to maintain state of charge. In many cases these hybrid configurations will not require a sink asset as they will rely on the on-site generation to restore state of charge; however, in the event the resource decides to provide ancillary services it may be necessary to rely on grid energy while dispatched for an ancillary service.

With the linked assets approach, the participant declares the source and sink asset to be linked and submits an offer for the source asset and a bid for the sink asset. Doing so, applies additional submission validation such that if the block prices of the sink asset are higher than the lowest offer price, the bid would be rejected. Without this validation the storage facility could receive dispatches to export and as market prices increase also receive a dispatch to import energy. One caveat of this submission mechanism is the sink asset has a must bid requirement and therefore the lowest price possible for the linked offer is 1 cent above the offer floor (the current offer floor is $0.00/MWh). This submission mechanism prohibits $0 offers because there must be at least one bid block. With this structure the facility can remain at the neutral state, neither charging from the grid nor discharging to the grid, at any price at or above the highest bid price and less than the lowest offer price. Another caveat with this option is when the system marginal price is at the price floor and the state of charge is 100%, the asset will need to restate the bid to zero as it will not be able to charge any longer. This is similar to the restatement provision for offers at the offer cap when state of charge is at 0%.

Figure 14 - Linked assets for a hybrid configuration



Price ($/MWh)	Block MW	Variable (MW)	Price ($/MWh)	Block MW
50	30		0	10
30	20		5	7
20	15	15	15	5

- 15 MW wind farm with a 15 MW storage
- Participant chooses the hybrid asset configuration
    - One source asset representing the combined wind/storage export (30 MW), and;
    - one sink asset representing the grid charging requirement (10 MW)

For hybrid sites, the participant will need to manage the offers and state of charge carefully such that the dispatch does not result in an unintended operation. Using figure 13 as an example, if the SMP drops to $18.00 and the wind is blowing, the participant is expected to use the wind energy to charge the storage facility and not export any volume to the grid. If the state of charge reaches 100%, price remains below $20.00, and the wind continues to blow, the participant will need to restate the sink bid to zero and change the block zero price of the source offer to $0 in order to stay in compliance with the dispatch instruction.

Advantages of the linked asset participation mechanism are as follows:

1. Represent the Available Capability on the bid – The pool participant can restate the charging and discharging capabilities independently should the site have a physical limitation of either its charging or discharging capability

2. Bids are already considered within the market design – The ability to bid has been a long standing yet under utilized component of the market. Should the linked assets mechanism be selected for full-range participation, the rules would need to be enhanced such that bids have similar features as offers.

3. Simpler to understand compared to other options – There would be no need to convert the dispatch instruction in order to determine the output level as in the case with the absolute zero option.

4. Better aligns with outage reporting requirements – While this option would require 2 separate submissions to remove all or part of the facility from service, this mechanism allows the participant to independently derate the source and sink asset to align with the nature of the derate or outage, in particular for hybrid facilities.

Disadvantages of the linked asset participation mechanism compared to other full-range mechanisms are as follows:

1. Blocks – the site will be given 14 blocks in total to participate in the market compared with other resources such as generating units. The AESO could consider limiting the site to 7 blocks in total across the bid and offer; however, this consideration adds additional complexity and cost to the IT implementation.

2. Multiple submissions – while this option provides greater flexibility and less complexity, the participant will need to manage both the bid and offer for a single facility.

3. AS complicated by the fact that the participant will be given 1 asset to submit their AS offers and different source and sink assets for the energy market. AESO software will need to link all these assets together for dispatch and directives by the system controller. This complexity will increase the implementation costs of this mechanism.

Rule considerations for implementing the Linked Assets mechanism:

1. ACs and formal MC for the sink assets associated with each site

2. Must Bid Must Comply rules will be placed on the storage sink asset

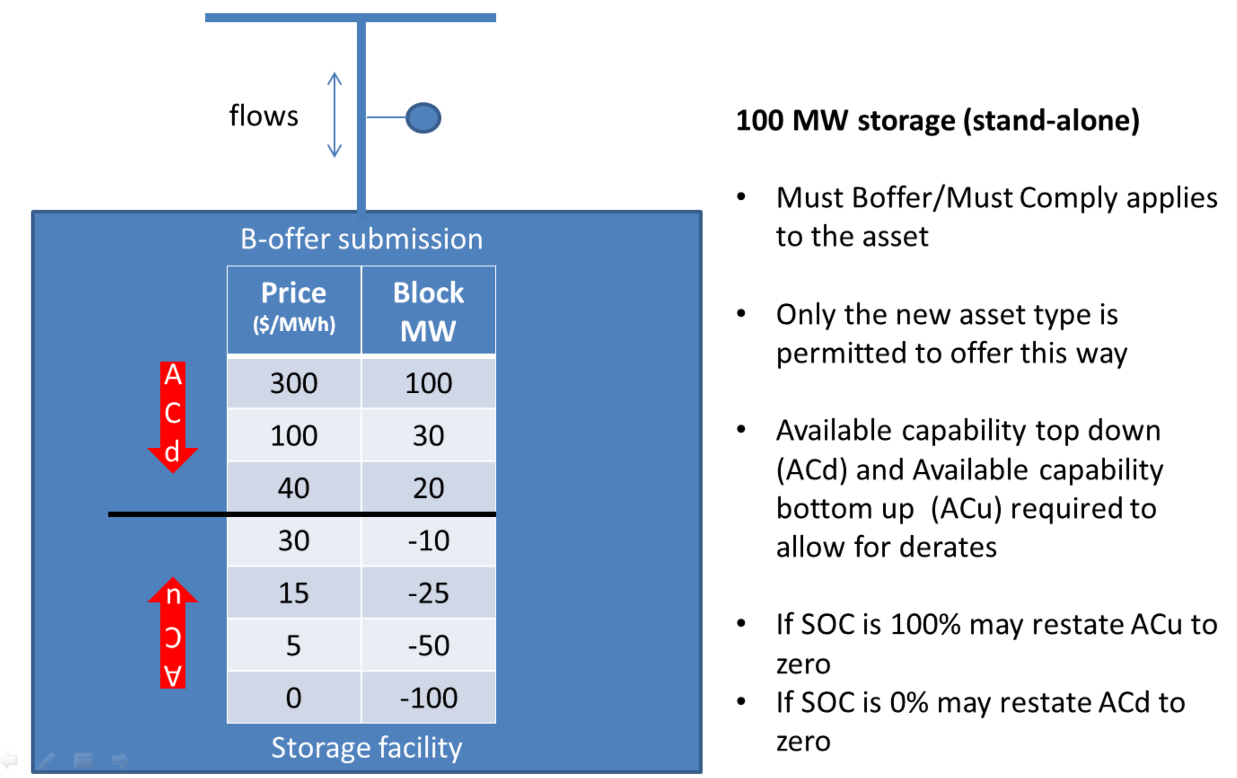
3. Allowable Dispatch Variance will apply to sink dispatches. The current rules only pertain to source asset dispatch.

Participation Option 3 – B-OFFER

The B-OFFER is the submission of a combined bid/offer (B-OFFER) and is a cross between the absolute zero and linked asset participation options. Like the Absolute zero option the B-OFFER is a single submission of the entire range of the facility represented as a single asset but does not require the conversion factor when translating between the submission and the expected net-to-grid output. This mechanism recognizes storage as a unique entity and requires a new asset type be defined in the market with characteristics of both a source and sink. The B-OFFER mechanism was designed with storage in mind; however, the AESO would have to evaluate whether this asset type should be applied to any instance where dispatchable grid injections and withdrawals could occur, such as intertie assets and self-supply that exports. Because this new asset type has the characteristics of sources and sinks, bids and offers, its implementation may result in unique rule treatment.

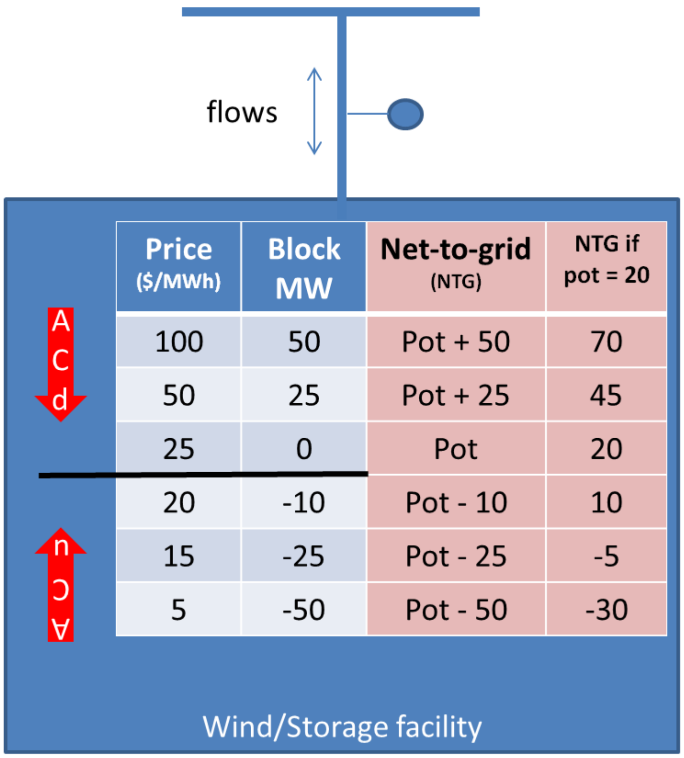
Unlike the linked assets mechanism, the B-OFFER submission is for a single asset that permits up to seven price-quantity pairs. Included in the submission of each block is the block price and block volume. The block volume is assigned a positive or negative sign to indicate the direction of flow. A positive value represents export from the site to the grid and a negative value indicates import from the grid. Figure 14 represents a 100 MW storage facility B-OFFER. This asset will charge at various charging levels when prices are below $30, Remain in a neutral state between $30 and $40, and discharge at various levels when prices reach or exceed $40.

Figure 15 - Simple B-OFFER example



These B-OFFER submissions become more complex with storage hybrids. This mechanism assumes the on-site variable energy resource will always generate to its potential and will always rely on the on-site generation to charge the storage before taking energy from the grid. This is a reasonable assumption, but this mechanism does limit the assets ability to price the variable energy resource directly. The dispatch level will differ from the net-to-grid (NTG) output because of the wind component of the asset. Suppose a site with a 50 MW windfarm and a 50 MW storage facility chooses to submit into the energy market as a hybrid. The B-OFFER shown in Figure 15 illustrates what the net-to-grid output is expected to be with each block of this example. If the wind potential is 20 MW and the system marginal price is $20 then according to the B-OFFER submission the asset is expected to produce 20 MW of wind power but use 10 MW of it to charge the storage leaving 10 MW for delivery to the grid. Assuming no change to the current ADV rules, the allowable dispatch variance for this example dispatch will be between 15 and 5 MW. If energy prices jump to over $100 then all blocks will be dispatched, and the asset will be expected to deliver all variable energy up to its potential and fully discharge the storage. In the example in figure 15, the net-to-grid output is expected to be 70 MW if the wind potential is at 20 MW. Should the state of charge drop to 0%, then the asset would have an acceptable operating reason to restate its available capability down (ACd) to zero until prices drop to $20 or below. Conversely, if the state of charge was 100% then the asset would restate its available capability up (ACu) from -50 MW to zero.

Figure 16 - Hybrid B-OFFER example



Price ($/MWh)	Block MW	Net-to-grid (NTG)	NTG if pot = 20
100	50	Pot + 50	70
50	25	Pot + 25	45
25	0	Pot	20
20	-10	Pot - 10	10
15	-25	Pot - 25	-5
5	-50	Pot - 50	-30

- 50 MW Wind and 50 MW storage Hybrid
- Assumes VER generates to its potential (pot) regardless of price
- Assumes storage will first rely on on-site generation to charge before taking from the grid

Advantages of the B-OFFER participation mechanism are as follows:

1. Single submission for a single asset that should be intuitive for the participant in either a stand-alone or hybrid dispatch configuration.
2. Ensures 7 blocks across the entire range of participation like generating assets (fairness)
3. Dispatch is only for the controllable component of a hybrid asset.

Disadvantages of the B-OFFER participation mechanism are as follows:

1. Selecting this mechanism restricts the options for hybrid participation. This mechanism presumes the variable resource component of the asset doesn't have a role in setting the energy price

2. Maximum Capability (MC) of the asset is less than its maximum net to grid output for hybrids. This confuses rules that rely on MC like loss factors and GUOC.

3. Additional rule complexity by creating this new asset type. We will now have source assets which include generating unit and AGF, Sink assets for load, and these new bidirectional assets for storage. Rules that declare an asset type will have to consider this new type now in the applicability.

4. More complex IT implementation – this mechanism introduces a brand new submission format with unique validation rules. Additionally the submission will need to be converted to support the structure of the energy merit order and dispatch used by the System Controller.

Rule considerations for implementing B-OFFER mechanism:

1. Rule impact could be quite large with the addition of a new asset type. Unfortunately, the current rules reference technology types to the applicability of the rule. Every mention of generating unit or aggregated generating facility will need to consider whether this new asset type should be included.

2. Any reference to offer or bid will also have to consider the b-offer. Rather than including the term "B-OFFER" in the rules it may be necessary to drop the terms bid and offer for the term energy market "submission", which could be a bid, an offer, or a b-offer, though b-offer is a design term that would need to be replaced by a more refined term.

3. The term maximum capability is used in many places throughout the rules. If the decision is to implement b-offers combined with VER and storage hybrids it changes the meaning of maximum capability when used in the context of total output and maximum allowable real power. The AESO will need to ensure the use of maximum capability in the rules still makes sense considering hybrid b-offers.

The table below assesses the full-range participation options against the market design principles. As shown in table 5 below, the options trade off technology agnostic treatment and complexity against participation flexibility.

Table 6 - Summary of full-range mechanisms and their alignment with the design principles

Design Requirements	Absolute Zero	Linked assets	B-OFFER
Technology Agnostic	3	4	2
Minimizes Complexity	3	4	2
Maximizes Participation	5	5	5
Participation Flexibility	3	4	5

Design Requirements	Absolute Zero	Linked assets	B-OFFER
Dispatch-ability	3	3	3
No Grandfathering required	3	3	3

This summary is based on a subjective assessment on a scale from 1 to 5 where the higher value indicates how well the option meets the requirement.

Section 3 - State of charge definition

The introduction of storage into the Alberta market also introduces new terminology related to storage devices. State of charge is one such term. This term will likely show up in ISO market rules with respect to restatements and will need to be formally defined. In looking at other jurisdictions the following definitions for state of charge were developed.

FERC order 841 and State of Charge:

> Order No. 841 provides that State of Charge represents the amount of energy stored by an electric storage resource in proportion to the limit on the amount of energy that it can store, typically expressed as a percentage. The State of Charge as a bidding parameter is the level of energy that an electric storage resource is anticipated to have available at the start of the market interval rather than the end. Order No. 841 provides each RTO/ISO the flexibility to propose telemetry requirements for such resources in its compliance filing and allows the RTOs/ISOs to implement the requirements of Order No. 841 consistent with the telemetry requirements for different services and other market participants in each RTO/ISO.
>
> Maximum State of Charge and Minimum State of Charge:
>
> Maximum State of Charge represents the State of Charge that should not be exceeded (i.e., gone above) when the electric storage resource is receiving electric energy from the grid. This value may either be a static value based on manufacturer specifications or a dynamic value depending on the operational characteristics of the resource (e.g., if it is providing multiple services and needs to reserve part of its State of Charge for another service).
>
> Minimum State of Charge represents the State of Charge that should not be exceeded (i.e., gone below) when an electric storage resource is injecting electric energy onto the grid. This value may be either a static value based on manufacturer specifications or a dynamic value depending on the operational characteristics of the resource (e.g., if it is providing multiple services and needs to reserve part of its State of Charge for another service).

PJM defines State of Charge as:

> “State of Charge” shall mean the operating parameter that represents the quantity of physical energy stored (measured in units of megawatt-hours) in an Energy Storage Resource Model Participant in proportion to its maximum State of Charge capability. State of Charge is quantified as defined in the PJM Manuals.

Alberta considerations for state of charge

Alberta operates a real-time energy only market. The AESO does not see the need to include State of Charge as a bidding parameter in the energy market submission or within restatements. However, the AESO will likely require State of Charge to be a telemetry requirement as it is needed for real-time dispatch and energy market dispatch compliance.

As described above in the FERC ruling on the definition of state of charge, it represents the amount of energy stored by an electric storage resource in proportion to the limit on the amount of energy that it can store, typically expressed as a percentage. This percentage determination is complex and is dependant on the type and nature of storage technology.

To that end, there are 2 options for the provision of state of charge to the AESO: 1) the participant derive the percent state of charge based on the real-time state in relation to the max and min and provide it as telemetry data or 2) provide the three input parameters to the AESO and have the AESO derive the percentage state of charge from the telemetry data.

Option 2 is only suggested if there is a concern participants could game the state of charge calculation in an effort to manipulate market outcomes. Even still the dynamic min and max State of Charge levels are dependant on so many variables it would be difficult to audit the authenticity of those values.

The AESO will consider stakeholder feedback as to whether participant determination of state of charge percentage could be a potential FEOC concern.

Section 4 - Commissioning requirements for storage

ISO rules section 203.6 sub-section 5 does not permit multiple offer or bid blocks while storage facilities are commissioning. The rule requires generating units and AGFs to offer a single block and use an Available Capability restatement to move the energy in and out of the merit order while testing the operation of the facility. The commissioning rule was designed with generators in mind and did not consider the need for charging the device while commissioning. Storage assets need to use prices and economic withholding in order to charge under the current short-term implementation. These rules will need to be revised based on which option is chosen for participation. If the half-range option is chosen as the participation method, then the rules will need to change to permit economic withholding while charging during commissioning. In order to do that, a participant will need at least two offer blocks- one at zero dollars and another at the price cap. Offering in this manner, while commissioning, will allow the asset to charge and discharge as required for testing and stay within the bounds of ISO rules. In the event the full-range option is selected, then the commissioning rule will still need to change depending on which mechanical implementation mechanism is chosen for storage.

Next Steps

The AESO is requesting stakeholder input on this paper. The AESO will consider this feedback in the development of a draft recommendation for long-term energy storage market participation. Following stakeholder feedback on the draft recommendation, the AESO will develop a final recommendation and initiate the Rule 017 process to begin drafting rules for implementation, consulting on the draft rules and then file those rules for disposition with the Alberta Utilities Commission. The following table outlines the proposed timeline for the remaining process.

Table 7 - Market participation implementation process timeline

Timeline	Step
Oct. 14, 2020	• Stakeholder session on Long-term energy storage market participation issues and options. Stakeholders have the opportunity to ask clarifying questions on the options paper prior to submitting written comments.
Oct. 30, 2020	• Stakeholder comments on options paper due
Nov/Dec 2020	• AESO consider written feedback • Host further engagements as necessary • Develop draft recommendation
Jan. 2021	• Release long term energy storage market participation draft recommendation • Stakeholder session on Long term energy storage market participation draft recommendation • Stakeholders have the opportunity to ask clarifying questions on the draft Recommendation prior to submitting written comments • Stakeholders to provide written comments • AESO to consider stakeholder feedback to finalize recommendations
Q1 2021	• Initiate development of draft rules (if recommended) in coordination with the Energy Storage Roadmap

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