Purpose of Document and Request for Feedback

This is an overview of the short-term market implementation requirements for energy storage facility participation in the energy and operating reserves (OR) markets.

In order to provide energy storage projects with clarity for participation in the markets under the existing Authoritative Documents (prior to the implementation of the longer-term changes), the AESO has assessed the current Authoritative Documents and identified areas that could benefit from further clarity, based on questions being asked by the current energy storage project developers.

The AESO intends to provide this additional clarity to stakeholders by developing or updating a series of Information Documents related to the current AESO Authoritative Documents. The AESO wishes to ensure that it has considered the perspectives of interested stakeholders prior to the finalization of the content of these Information Documents.

The AESO values stakeholder feedback and invites stakeholders to provide input to the AESO on the questions set out in the associated Stakeholder Comment Matrix on or before **April 27, 2020**.

The AESO will review and consider stakeholder feedback as well as use the conclusions and rationale set out in this overview document in the development or updating of Information Documents related to current AESO Authoritative Documents to provide clarity for energy storage participants in the short-term.

Clarity that cannot be provided within the current legislative and Authoritative Document structure will be considered as part of the long-term storage integration phase outlined in the AESO Energy Storage Roadmap[1]. It is expected that the AESO's longer term storage work will result in changes to the Authoritative Documents, both to provide specific clarity as it relates to storage and to consider the uniqueness of energy storage.

1 Background

In August 2019, the AESO published an Energy Storage Roadmap. This roadmap was developed to set out the plan to integrate energy storage facilities, given that current legislation and AESO Authoritative Documents do not fully contemplate the unique attributes and challenges associated with energy storage participation. Four market participants have submitted requests to connect their energy storage facilities to the Alberta Interconnected Electric System (AIES) with 2020-21 in-service dates (ISDs). In order to accommodate these ISDs, two deliberate phases of implementation work have been developed within the AESO Energy Storage Roadmap:

1) A short-term phase to support and enable connection projects requesting 2020-21 ISDs within the current AESO Authoritative Documents; and
2) A longer-term implementation phase specifically covering changes to AESO Authoritative Documents and longer-term AIES and market system changes.

1.1 Principles

The following principles for facilitating a fair, efficient and openly competitive market were applied when developing the additional clarity for energy storage facility participation in the markets outlined in this document:

[1] https://www.aeso.ca/assets/Uploads/Energy-Storage-Roadmap-Report.pdf

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1) New technology types are provided non-discriminatory access to the market;
2) Orderly dispatch is achieved through bids and offers that reflect least cost and up; and
3) All stakeholders are transparently provided clarity on energy storage facility participation in the energy and operating reserve markets.

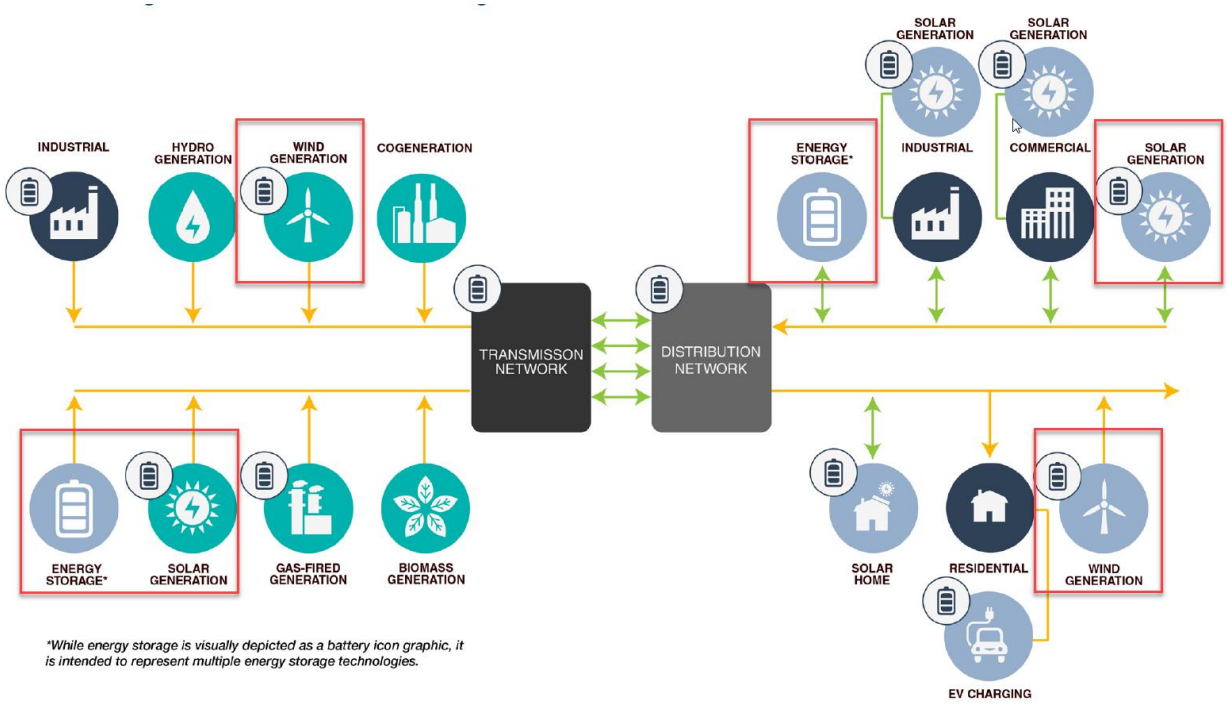
2 Short-term market implementation scope

The AESO Energy Storage Roadmap describes different applications for energy storage within the electric system. Energy storage is often thought about in the context of a stand-alone device connected to the AIES; however, energy storage technology is found in combination with other forms of generation, and can potentially be used as a transmission or distribution wires alternative. Figure 1 below shows the different ways energy storage can be applied to an electric system. Of the various energy storage applications, the scope of the short-term phase of the AESO Energy Storage Roadmap is limited to the energy storage applications the AESO has identified as the most likely to be implemented in the short-term, within the confines of the existing legislation and Authoritative Documents. These applications include stand-alone energy storage, wind/ energy storage and solar/ energy storage hybrid combinations connected to the AIES.

Note that gas/energy storage configurations have not been considered within this document. Generally, of the configurations that the AESO has seen, the gas generator would participate in the markets in accordance with the current ISO Rules, as written, and further clarity may not be required. Gas/energy storage configurations that the AESO may not have contemplated will be reviewed and information documents may be updated accordingly to reflect clarity on market participation, if required.

Other energy storage applications, not highlighted in red boxes below, will be investigated as part of the longer-term implementation phase.

Figure 1: In-scope storage applications for short-term implementation (boxed in red)



3 Energy storage configurations

Energy storage configurations can be described in two different contexts:

1) How they are configured electrically; and
2) How they are configured in the markets.

Before describing the various energy storage configurations, it is important to explain how the AESO approaches these two contexts and how the AESO uses the terms facility, asset and market participation within those contexts.

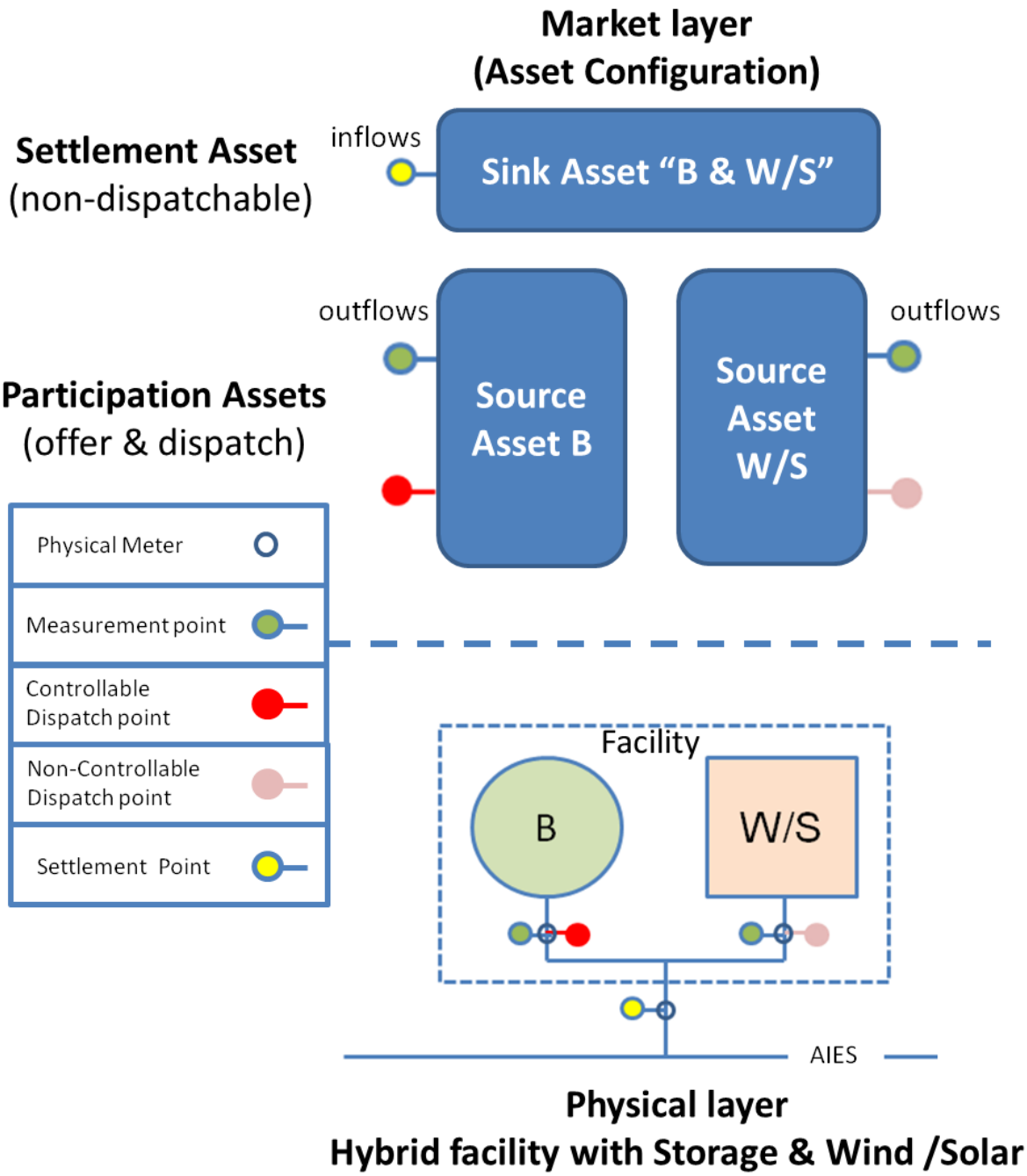
3.1 Facility, asset and market participation

In jurisdictions with vertically integrated utilities, utilities build, operate, and maintain generating units, transmission and distribution facilities and load facilities. In deregulated electric markets like Alberta the physical nature of the electric system does not change; however, a market layer is virtually placed over top of this physical reality in order to facilitate the exchange of electric energy and ancillary services within a market. Within this market layer, the market concepts of asset, offer and restatement are introduced. Transitioning between the layers requires a translation. In some cases the translation is very straight forward and in some cases the translation is a loose coupling between physical facilities and market concepts.

The industry has created general classifications for electrical sites such as transmission connected load, generation, co-generation, distributed energy resources, etc. These terms help us understand what is physically configured and how it will impact the physics of the electric system, but they do not provide context to how they will behave in the electricity market. When the electricity market was first introduced, it was built around the concept that generators produce and sell electricity; and loads purchase and consume it. This was a generalization; generators could be short generation, unable to meet commitments and be required to buy energy. Loads may have procured excess energy they can not consume and desire to sell it. Simply linking the facility to the trade of electricity did not work. As a result, markets create a virtual construct in which to trade their products, similar to stock market ticker symbols. At the AESO this construct is termed an “asset”. There are two types of assets: a seller has a source asset to provide the product; and a buyer has a sink asset to consume it. Most generating facilities will be given at least one of each type of asset. This definition went generally uncontested until the introduction of energy storage facilities, which have attributes of both source and sink assets.

In order to know how much energy was bought and sold, and whether the product was actually delivered requires a mapping between the asset used in the trade and the physical facilities involved in the trade. In the simplest case the mapping is very straight forward. One generating unit is linked to one source asset. But physical facilities are often more complex than just a simple generating unit. Combined cycle generation, co-generation sites and distributed energy resources with on-site load are some examples. In each of these examples, participation in the market may be different. To facilitate their market participation, facilities are associated with combinations of source and sink assets, termed “asset configurations”. To illustrate the complexity found in some configurations see Figure 2 below. A facility with storage (B) combined with a wind (W) or solar (S) facility on the same site could have their market assets configured such that the two technologies could be dispatched independently but share a common connection to the AIES.

Figure 2: Mapping between the physical facility and the market assets



3.2 Stand-alone and hybrid facilities

Currently two high-level energy storage facility implementations appear in the recent connection requests:

1) Stand-alone energy storage facilities connected to the AIES; or

2) Hybrid facilities based on combinations of different generation and energy storage technologies built on the same site.

As explained in the scope section and for the purposes of this document, an energy storage "hybrid facility" is limited to facilities with energy storage technology and a wind or solar aggregated generating facility (AGF) on the same site.

3.3 Asset configurations for financial settlement and market participation

Assets are used in two ways in the electricity markets:

1) Financial Settlement: An asset that is used in financial settlement must have an association with a measurement point. A measurement point is the point at which official measurement of volume is transacted. Facilities can have energy flows in both directions, into the site and out of the site. Therefore, the AESO assigns a source asset to the outflows, and a sink asset for the inflows associated with the appropriate measurement point that captures the metered volume.
2) Market participation: The ISO rules regarding market participation generally only apply to source assets with a maximum capability greater than or equal to 5 MW. The AESO will provide a source asset to the pool participant to which the dispatch instruction or directive will apply. The pool participant must offer the entire capability of the asset, manage the available capability of the asset, and comply to a dispatch instruction or directive issued by the AESO. In the Alberta electricity market all source assets, of any technology, with maximum capability over 5 MW are considered dispatchable, including wind, solar and energy storage facilities.

In most cases, the AESO will use the same source asset for settlement and dispatch, however, there are cases in which financial settlement metering may not necessarily correspond to how an asset participates and is dispatched in the energy market. This flexibility allows the AESO to configure the facility's participation in the market appropriately based on its capability. Extending this flexibility for stand-alone energy storage facilities and energy storage hybrid facilities is critical to ensuring the AESO and facility owner are able to leverage all the capabilities of the facility in the market.

The AESO's existing practices and standards for metering and asset configuration will guide the short-term integration of energy storage facilities.

3.4 Stand-alone energy storage facility

The AESO will configure stand-alone energy storage facilities as a generator application. The metering will be set-up and measured at the point of connection to the AIES. For stand-alone energy storage facilities, the AESO would likely assign two market assets: a source asset used for dispatch, and market and tariff settlement for any energy injections from the site to the AIES; and a sink asset for market and tariff settlement for any energy withdrawals from the AIES.

3.5 Energy storage hybrid facility

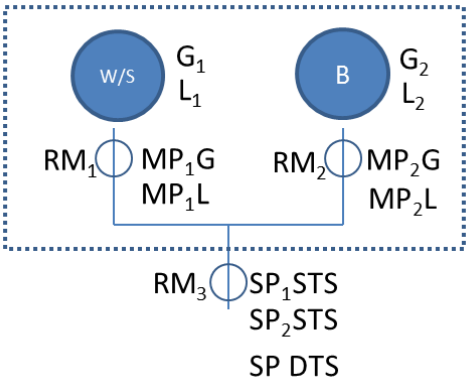
For energy storage hybrid facilities, the AESO will measure all energy flows to and from each technology, where possible. This may be limited by the physical configuration of the site; for example, sites where the generation and storage technologies are behind the same inverter. The asset configurations of these sites are dependent on where the connection(s) to the AIES are and the way the pool participant wants to participate in the energy and ancillary services markets. For the purpose of dispatch in the electricity markets, a pool participant with an energy storage hybrid facility may choose to aggregate the technologies on site to a single pool asset or keep the technologies as separate assets.

If the pool participant chooses to combine the energy storage resource and the wind or solar AGF to a single source asset, that asset will be "hybrid dispatched" from a single dispatch point.

A pool participant that chooses to uncouple the on-site technologies will be configured in the electricity markets as two independent source assets, one source asset representing the energy storage facility, and another source asset for the wind or solar AGF.

Energy storage hybrid facilities with uncoupled market assets require additional metering and measurement points to reflect their multiple points of supply. As illustrated in the Figure 3 below, the real meters (RMx) are installed on the high voltage side of the transformer of the site as well as at the terminus of the storage (B) and the wind/solar facility (W/S). Measurement points are calculated for the outflows (MPxG) and the inflows (MPxL) from all resources at the facility. Settlement points (SPxSTS and SP DTS) are based on revenue-level metering and used for energy and tariff settlement.

Figure 3: Energy measurements for a hybrid facility where the resources are dispatched independently



A pool participant will choose the asset configuration that makes the most sense for their operation and how the pool participant intends on participating in the markets. Asset configurations will be limited by boundaries defined in the AESO Authoritative Documents and applicable Alberta Utilities Commission (AUC) approval(s).

4 Market participation

This section provides further information on how energy storage participants will provide energy and operating reserve (OR) market submissions, and the requirements for dispatch.

The current ISO rules require source assets with a maximum capability of 5 MW or more to “participate” in the energy market. Source assets with a maximum capability less than 5 MW do not currently have this “must offer, must comply” obligation; however, these assets are still accounted for in market settlement (see Section 5 below).

4.1 Energy market

4.1.1 Bids and offers

Through the AESO’s Energy Storage Roadmap and the Connection Process, the AESO will be reviewing how it may be possible to enable an energy storage facility to offer its full operational range across charging and discharging states into both the energy and OR markets in the long-term market implementation phase. It has been determined that enabling full range energy storage participation within the energy markets would require Authoritative Document changes and could not be reasonably implemented in time for the ISDs of pending connections. A review of the current ISO rules revealed that the definitions of “offer” and “maximum capability” limit full range participation in the energy market. Specifically:

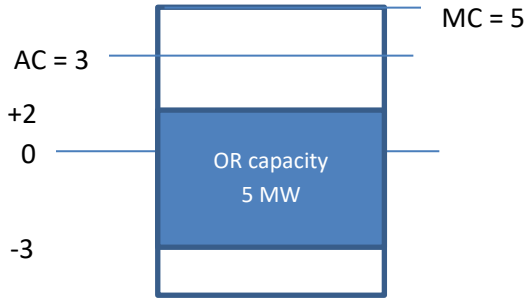
- The AESO *Consolidated Authoritative Document Glossary* "offer" definition review indicated that, an energy storage facility cannot "offer" its consumption/charge, because consumption/charge is not a submission to sell electric energy, rather it would be a submission not to consume; and
- "maximum capability" (MC) is currently defined within the AESO *Consolidated Authoritative Document Glossary* as the "maximum MW that [a generating unit/aggregated generating facility (AGF)] is physically capable of providing under optimal operating conditions ...". This definition does not support an MC value that includes the charging capability.

For the short-term market implementation, energy storage participation will be such that an energy storage asset's energy market offer will only include the discharge capability, provided that capability is over 5 MW (i.e. that MC is 5 MW or larger). Pool participants will submit offers in the energy market for the energy storage asset's energy production (typically half of its operational range), provided the energy storage asset is capable of producing at least 5 MW of discharge energy. This half range energy offer scenario can be implemented within a timeline that enables the AESO to support the 2020-21 ISDs while still being compliant within the current AESO Authoritative Documents.

The AESO's current Authoritative Documents enable an energy storage asset to operate within the full range of capability in the OR market. Having different ranges across these different markets is manageable because the attributes associated with the energy storage asset are market dependent.

If qualified, a pool participant will be permitted to use the full range of its operation for the provision of operating reserves. For example, as shown in Figure 4, an energy storage asset with an energy market MC of 5 MW could have a qualified OR capacity of 5 MW and be permitted to operate from -5 to +5 MW, assuming the resource meets the technical requirements, as defined in Section 205.4 of the ISO rules, Regulating Reserve Technical Requirements and Performance Standards, Section 205.5 of the ISO rules, Spinning Reserve Technical Requirements and Performance Standards and Section 205.6 of the ISO rules, Supplemental Reserve Technical Requirements and Performance Standards for the reserve product in this mode of operation.

Figure 4: OR operation for storage resources.



4.1.2 Restatements

Energy storage assets are energy limited. In other words, when the energy storage technology is completely discharged, it is not capable of discharging electrical energy and when the energy storage technology is completely charged, it is not able to consume electric energy. State of charge (SoC) is the term used to describe the level of charge of an electric storage asset relative to its capacity. For simplicity, this document will refer to state of charge in relative percentage terms. One hundred per cent is fully charged and 0 per cent is fully discharged and this range reflects the normal operating limits of the device and not the absolute state of charge.

Available capability (AC) reflects the physical capability of the energy storage asset. Pool participants will not be permitted to restate the AC of their energy storage asset in order to restore their state of charge

except under limited conditions. State of charge will only be considered a physical limitation at relative zero and relative 100 per cent charge. Pool participants will be expected to manage their state of charge through their offers and manage their offers with price restatements two hours in advance of the settlement interval as per the ISO rules found in Division 203.

In the event an energy storage asset cannot physically comply with a dispatch instruction, the existing "acceptable operational reason" (AOR) definition applies[2]. In particular, section (iii) of the definition stating "re-positioning a generating source asset within the energy market to manage physical or operational constraints associated with the source asset". In other words, when the state of charge of the energy storage asset reaches relative zero or 100 per cent, the pool participant may perform a MW restatement at that time as per subsection 4(3) of Section 203.3 of the ISO rules, Energy Restatements, and declare state of charge as the AOR. The AESO will require visibility of the energy storage asset's state of charge to confirm the legitimacy of the energy market restatement and the associated AOR.

State of charge will be included as a requirement in the functional specification, and will be provided through SCADA, for all energy storage projects.

4.1.3 Dispatch and dispatch compliance

The ISO rules regarding dispatch are agnostic to technology types. A hybrid dispatched energy storage asset that informs the AESO it will be operating as a "firm" asset will be subject to the requirements of Section 203.4 of the ISO rules, Delivery Requirements for Energy. If the hybrid dispatched energy storage asset informs the AESO it will be operating as "non-firm" the hybrid asset will be considered a wind and solar aggregated generating facility and be subject to Section 304.3 of the ISO rules, Wind Power Ramp Up Management and Section 304.9 of the ISO rules, Wind and Solar Aggregated Generating Facility Forecasting. Choosing to operate as a firm or non-firm energy storage asset may affect the ability to qualify for the provision of various ancillary services.

4.1.4 Outage reporting

As an energy storage facility can be applied or considered as generation and a load, in its treatment within the ISO rules, both the load and generator outage reporting requirements may apply. If an energy storage facility's charging energy is 40 MW or greater, Section 306.3 of the ISO rules, Load Planned Outage Reporting (Section 306.3) applies. The outage would be declared against the sink energy asset for the energy storage facility. Additionally, if the MC of the source asset is 5 MW or greater, Section 306.5 of the ISO rules, Generation Outage Reporting and Coordination (Section 306.5) applies. To align with the current ISO rules, should the market participant derate or take the entire 40+ MW storage facility down on an outage, the market participant will be required to report both the generation and load side of the facility separately, for a single outage, until such time as Section 306.3 and Section 306.5 of the ISO rules are changed to consider energy storage facility outages.

4.2 OR market

Energy storage resources may participate in the OR market with their qualified volumes using the full range of operation. In the energy market the energy storage asset "must offer" their discharge capability only. As a result, the energy market source and sink assets may be a different size (MW) than the asset set up for the OR market for the same site. Regardless of the differing asset configurations for the two markets, subsection 7(2) of Section 203.4 of the ISO rules, Delivery Requirements for Energy states:

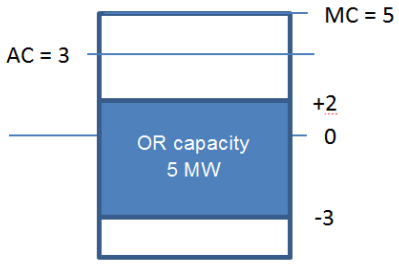
> "**(2)** The **ISO** must, when assessing a **pool participant's** compliance with subsections 4(3) through 4(6) of section 205.2 of the **ISO rules**, *Issuing Dispatches and Directives for Operating Reserve* in a situation where there are concurrent energy and **spinning reserve** requirements or

[2] https://www.aeso.ca/rules-standards-and-tariff/consolidated-authoritative-document-glossary/

energy and **supplemental reserve** requirements, consider the MW quantity to be the energy **dispatch** quantity plus the **spinning reserve** or **supplemental reserve** quantity while the **directive** remains in effect"

Considering the ISO rule and the facilitation of full range OR participation, if an energy storage asset is dispatched to zero MW in the energy market as a result of an OR dispatch, when the energy storage asset is directed to provide its OR capacity as energy, it will be expected to "move" from its current operating level to a new level equal to the current operating level plus the spinning reserve or supplemental reserve quantity. For example, using the illustration in Figure 5 below, the resource was dispatched to provide 5 MW of operating reserves. In the event the AESO directs the operating reserve capacity, the resource will move from its current position of consuming 3 MW to an output level producing 2 MW.

Figure 5: OR capacity



4.2.1 Supplemental reserves

Currently, the AESO's internal systems separates supplemental reserves into two products, based on the resource type. SUPG is provided by generation, SUPL is provided by loads. Energy storage resources that meet the technical requirements for supplemental reserve will be procured by the AESO as a SUPG product. Simplifying the procurement in this way will allow energy storage to sell supplemental reserves without ISO rule or IT system changes.

6 Storage settlement

Settlement of energy storage assets will be consistent with the settlement of other pool participant assets. As mentioned in the configuration section of this document, source and sink energy market assets will be created depending on the configuration of the energy storage facility. At a minimum, one source and one sink asset will be associated with a settlement point. Settlement is calculated for the measurement point based on the flows from real meters located on the site and is defined within an AESO connection document called the Measurement Point Definition Record (MPDR). Each measurement point is assigned a unique identifier (measurement point ID or MPID) to be used by the AESO for billing purposes. There may be multiple MPIDs associated with an energy storage facility.

Should the site inject energy onto the AIES, the pool participant will be paid pool price multiplied by the metered volume of the injection for the settlement interval the energy was injected. A trading charge will be applied to the transaction. Should the site withdraw energy from the AIES, the pool participant will pay the pool price multiplied by the metered volume of the withdrawal for the settlement interval the energy was withdrawn. The trading charge will be applied to this transaction as well.

7 Tariff treatment

7.1 Rate DTS

Under the current tariff,[3] energy storage facilities will be treated similar to all other facilities. Energy withdrawals from the AIES will be assessed rate DTS. A wind or solar facility located on the same site charging the energy storage facility will not incur DTS charges provided the energy flows are not withdrawn from the AIES.

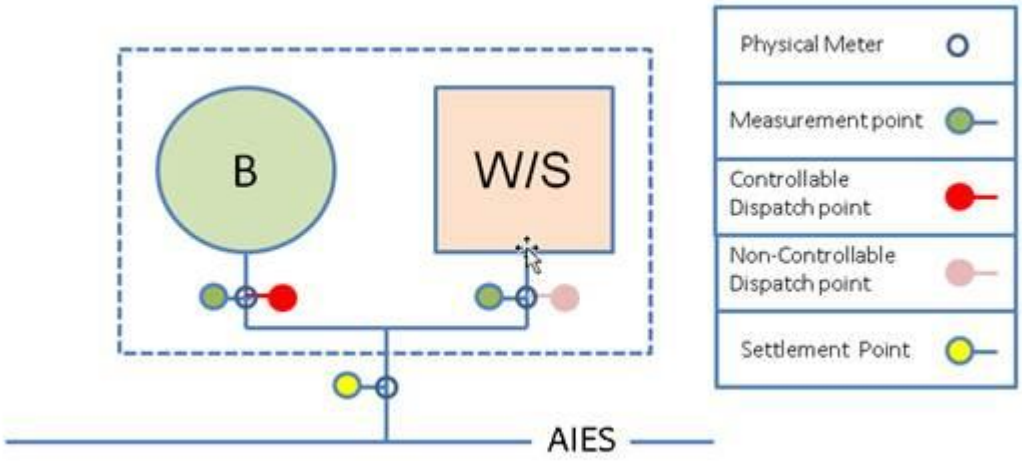
On Jan. 31, 2020, the AESO advised the AUC in its 2018 ISO tariff compliance filing and 2020 rates update application that the AESO intends to address energy storage tariff treatment within the scope of the Bulk and Regional Tariff Design. Stakeholder sessions will be held to develop the tariff design options related to energy storage treatment.

7.2 Losses

Energy storage facilities will be considered generating source assets or AGFs for the determination of losses. If the market participant has requested or is receiving system access service under Rate STS, Supply Transmission Service or Rate DOS, Demand Opportunity Service, the source assets associated with the facility would be subject to Section 501.10 of the ISO rules, Transmission Loss Factors (Section 501.10).

If a pool participant chooses to offer the energy from an energy storage facility separate from the other technology on the site and that site is connected directly to the transmission system, Section 501.10 requires that a loss factor is assigned to each location at which electricity is transferred to the transmission system; and at which pool participants are dispatched from in the energy market for each source asset (i.e. each energy market source asset requires a unique MPID). For example, as shown in Figure 6 below, if a transmission connected facility is capable of measuring the battery (B) energy separately from the on-site wind or storage facility (W/S) energy, the pool participant can offer each technology as separate assets and each asset will be dispatched from distinct dispatch points.

Figure 6: Configuration for hybrid facilities connected to the transmission system with two source assets



[3] 2020 ISO Tariff, Effective 2020-04-01

7.3 Generator unit owner's contribution

Generating unit owners contribution (GUOC) is applied to new and incremental generation connecting to the transmission system in accordance with the applicable provisions of the applicable ISO tariff.

8 Other ISO rules

Energy storage assets are eligible to participate in the Dispatch Down Service market, subject to the requirements outlined in the ISO rules within Division 204 - Dispatch Down Service Market.

Energy storage assets will also participate in Transmission Constraints Management procedures under Section 302.1 of the ISO rules, Real Time Transmission Constraint Management.

The energy storage facilities will be subject to all ISO rules as applicable. Clarity will be included on the participation of the energy storage facilities within Information Documents.

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