Energy Storage Integration

RECOMMENDATION PAPER

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1 Executive Summary

As technology costs continue to go down, energy storage may be able to play an increasing role in enhancing the efficiency and reliability of the entire electric grid and assisting in enabling greater penetration of variable renewable energy in the supply mix. Traditionally, electricity had to be produced, delivered, and consumed instantly, creating the need to size the power generation, transmission and distribution system for the highest peak demand. Energy storage covers a wide range of technology, often with different attributes, that have the potential to provide value to the Alberta Interconnected Electric System (AIES) by allowing for the storage of energy for use at a later time.

Between September 12 and October 24, 2013, the AESO conducted four industry work group sessions to help identify and address priorities with respect to energy storage integration in Alberta. Energy storage project proponents, market participants and academics were represented in the work group sessions.

Based on stakeholder input received during the work group sessions three immediate top priorities to advance the integration of storage technologies in Alberta were identified. The three priorities developed from the storage work group sessions were:

1. Developing technical and operating requirements to connect and operate energy storage facilities
2. Determining the appropriate tariff rate to apply to energy storage facilities
3. Reviewing technical requirements for the provision of Operating Reserves considering the attributes of energy storage technologies

In May 2014, the AESO released the *Energy Storage Integration Discussion Paper*[1] (Discussion Paper) which explored key considerations regarding these top three priorities in greater detail. In July 2014, the AESO posted stakeholder comments received on the Discussion Paper.[2] Based on these comments and internal AESO examination, this paper provides recommendations and a detailed road map of the ongoing activities and timelines required to address the priorities.

Recommendations

The AESO's recommendations regarding the identified priorities are:

1. Complete the drafting of and file ISO Rules to address technical and operating requirements for battery storage facilities (Proposed Battery Facility Rules) with the Alberta Utilities Commission (AUC). The AESO recently consulted with industry on the Proposed Battery Facility Rules. Filing of the rules is targeted for Q3 2015.
2. Storage facilities operate as generating units when injecting power into the grid and operate as load when purchasing or withdrawing electricity from the transmission system. The storage facility is using the transmission system and is required to pay the just and reasonable costs of the transmission system. An economic dispatch study will be performed to develop ISO tariff treatment options for storage. The study will examine in detail the differences between storage and conventional load and generators. The target completion for the study is Q4 2015.
3. Maintain the minimum requirement of 15 MW range for regulating reserve (RR) and of 10 MW for spinning reserve (SR). The AESO conducted an off nominal frequency study that gave strong indication that reducing the size of RR and SR assets negatively impacts the ability of the AIES to respond to frequency excursions.

[1] http://www.aeso.ca/downloads/Energy_Storage_Integration_Discussion_Paper(1).pdf
[2] http://www.aeso.ca/downloads/AESO_Posting_Stakeholder_Comments_Notice.pdf

4. The AESO will revise, where appropriate, ISO Rule 205.4 *Regulating Reserve Technical Requirements and Performance Standards*, ISO Rule 205.5 *Spinning Reserve Technical Requirements and Performance Standards* and ISO Rule 205.6 *Supplemental Reserve Technical Requirements and Performance Standards* and other rules as may be incidentally impacted to reflect how energy storage technology will participate in operating reserve products (RR, SR) and Supplemental Reserve (SP). The AESO is targeting to initiate the consultation process on these revisions in 2015 and is targeting to file them in 2016.

5. Examine the performance of current RR providers and assess if changing the current technical requirements and/or introducing new technologies (such as energy storage) could reduce the required amount of RR. The AESO has entered into a partnership with the National Research Council of Canada (NRC) to perform this study and the target completion date is by end of 2015.

2 Background

In the U.S., the Federal Energy Regulatory Commission (FERC) has taken steps to enable energy storage technologies to participate in wholesale power markets and many states are already starting to deploy energy storage. The U.S. Department of Energy has identified over 200 electricity storage demonstration projects that are presently underway.[3]

In Ontario, the Ontario Minister of Energy directed the Independent Electricity System Operator (IESO) to procure 50 MW of energy storage by the end of 2014. As a result, the IESO issued a request for proposal for 35 MW of energy storage that closed in May 2014. A 2 MW flywheel facility is already operational on a pilot basis.

In Alberta, there are currently three storage projects requesting system access to the AIES:

- 150 MW Compressed Air Energy Storage (CAES) with salt cavern storage
- 14 MW battery
- A behind-the-fence battery

Storage facilities store previously generated electrical energy for release at a later time. Grid scale energy storage technologies include pumped-storage hydropower, compressed air energy storage, power to gas (electrolyzer), battery storage facilities, mechanical flywheels and several others. Each of these technologies converts electric energy into another form of energy for storage (for instance, potential, kinetic or chemical energy), which is then converted back to electric energy at the time it is released.

Storage facilities are complex from a regulatory perspective as they do not fit neatly into only one of the traditional categories of transmission, distribution or load. Depending on how they are used, storage facilities may function as one or more of generation, load, transmission, or distribution.

Storage facilities have a variety of potential applications, including:

- Energy time-shifting – Electric power produced during off-peak periods when prices are low could be stored for later use or sale when demand and prices are high.[4]

[3] http://www.energystorageexchange.org/projects
[4] http://www.puc.texas.gov/industry/electric/reports/scope/2011/2011scope_elec.pdf , page 74.

- Large-scale integration of renewable generation. As stated by the AUC in its *Alberta Smart Grid Inquiry*, issued in January 2011:

> Energy storage also has the potential to assist in addressing the challenges associated with the large-scale integration of variable generation such as wind. In many regions of North America, rapid installation of wind power has created overgeneration where high winds at night during times of low demand create more electrical energy than is needed on the system. Energy storage technologies have the potential to store and deliver this excess electrical energy when it is needed during peak demand conditions. Energy storage technologies may also be used to balance the variability of wind generation and help to avoid curtailing or limiting the amount of wind generation that is delivered onto the grid. Storage devices can typically respond very rapidly to changes in the system conditions brought about by variable generation.[5] Energy storage technologies may also be used to counter large wind ramps (up and down) on the grid and avoid curtailment or wind generation power limiting.[6]

- Ancillary services – Certain types of energy storage have the capability to respond within seconds and to provide power for short or extended periods. Energy storage could, therefore, provide energy to respond to changes in load or production from power plants, offsetting the loss of generation resources or transmission capability.[7]

- Transmission system optimization – Storage facilities could be used to manage utilization of and requirements for transmission lines by storing energy when there is more generation than transmission capacity or by discharging energy when there is more load than transmission capacity.

- Reliable power – In the event of an outage, storage could be used to meet customers' needs for the duration of the outage, facilitate an orderly shutdown process, or transfer power to on-site resources.[8] Backup power from a storage device can also give utilities the option to delay upgrades in areas prone to loss of service.

- Power quality and frequency regulation – Energy storage could quickly provide power to address voltage and frequency variations to protect customers' equipment from fluctuations in power quality.[9] Power quality applications have been described as follows:

> Power quality refers to voltage spikes, sags, momentary outages, and harmonics. Storage devices are often used at customer load sites to buffer sensitive equipment against power quality issues. Electric power systems also can experience oscillations of frequency and voltage. Unless damped, these disturbances can limit the ability of utilities to transmit power and affect the stability and reliability of the entire system. System stability requires response times of less than a second, and can be met by a variety of devices including fast-responding energy storage.[10]

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[5] Alberta Utilities Commission, *Alberta Smart Grid Inquiry*, January 31, 2011 at page 13.
[6] *Ibid*. at Appendix 6, page 2.
[7] Public Utility Commission of Texas, *supra* at page 74.
[8] *Ibid.* at page 75.
[9] Public Utility Commission of Texas, Report to the 82nd Texas Legislature, *Scope of Competition in Electric Markets in Texas*, January 2011, at page 75.
http://www.puc.texas.gov/industry/electric/reports/scope/2011/2011scope_elec.pdf
[10] Stein, Reconsidering Regulatory Uncertainty: Making a Case for Energy Storage, at 711.

Depending on their attributes, certain storage technologies may not be suited for all potential applications or markets in Alberta. For example, bulk storage such as compressed air or pumped hydro are flexible assets that are well suited for arbitrage and ancillary service. Smaller assets with shorter storage periods such as batteries or flywheels may be better suited at the provision of ancillary service products. In addition, some potential applications of storage may not be consistent with or complimentary to the current Alberta policy framework and wholesale market structure.

3 Recommendations

This section provides recommendations, analyses and a process description that the AESO will follow to address the three priorities referred to above and developed from the energy storage work group and comments received from stakeholders.[11]

3.1 Technical Requirements for Energy Storage to Connect to and Operate in the AIES

Based on the storage technologies currently in the AESO connection project queue, the AESO decided to focus first on developing the Technical and Operating Requirements to allow batteries to connect because of their unique characteristic. In contrast, compressed air or pumped hydro storage facilities are composed of conventional equipment such as electric compressor, gas turbine or hydro generators which are adequately addressed through existing technical and operating requirements.

As part of the consultation process the AESO issued the *Proposal for Battery Facility Technical and Operating Requirements*[12] on October 22, 2013. Three working sessions were held to obtain stakeholders' input. Replies to all stakeholder comments were posted on April 1, 2014.[13]

3.1.1 AESO Recommendation and Next Steps

The AESO will finalize the rule language for the Proposed Battery Facility Rules and consult with stakeholders with a view to filing them with the AUC by Q3 2015.

3.2 Treatment of Storage Facilities Under the ISO Tariff

3.2.1 Storage facilities under applicable legislation

In its *Alberta Smart Grid Inquiry*, issued in January 2011, the AUC stated:

> There would appear to be no barriers to deployment of energy storage facilities as a non-regulated generation asset that could provide energy to the power pool and ancillary services to the AESO. Legislative or policy changes may [however] be required to clarify whether energy storage technologies would be regulated as transmission or distribution assets or be left unregulated and deployed in the competitive generation market.[14]

[11] http://www.aeso.ca/downloads/AESO_Posting_Stakeholder_Comments_Notice.pdf
[12] *Proposal for Battery Facility Technical and Operating Requirements*, October 22, 2013
[13] http://www.aeso.ca/downloads/2014-04-01_Reply_Letter_(Recommendation_paper).pdf
[14] Alberta Utilities Commission, *Alberta Smart Grid Inquiry*, January 31, 2011, at page 15

Similarly, the AESO is of the view that storage facilities can function in Alberta in a manner in which they alternate between being competitive generating units and load. Where this is the case the AESO is of the view that the current legislative framework supports the conclusion that storage facilities should be treated under the tariff as generating units and load. That is, the owner of a storage facility: (i) would be charged for location-based cost of losses and other charges applicable to generators when energy is supplied to the grid; (ii) would be charged the just and reasonable costs of the transmission system when energy is withdrawn into the facility for storage; and (iii) would not be entitled to the regulated recovery of costs.

Storage facilities operate as generating units when injecting power into the grid. They are also capable of providing ancillary services. Storage also operates as load when purchasing or withdrawing electricity from the transmission system. As with other loads, the owner or operator of the storage facility is using the transmission system and is required to pay the just and reasonable costs of the transmission system.

The AESO is of the view that current legislation does not support a storage unit which provides energy or ancillary services to also be part of the rate regulated transmission system. Generating units are specifically excluded from the *Electric Utilities Act* (EUA) definition of transmission facility.[15]

It appears possible, however, for a storage facility to operate exclusively as a transmission facility to address certain specific reliability circumstances such as voltage, reactive power or power quality issues. In the AESO's view, a storage facility could operate as a "transmission facility" for purposes of the EUA and *Transmission Regulation* (T-Reg), but **only** where the facility was:

a) approved, in accordance with applicable legislative requirements (e.g. through the approval by the AUC of a needs identification document that was submitted by the AESO), as a reasonable means of meeting transmission reliability requirements; and

b) prohibited from participating in the energy market or producing ancillary services, so as to ensure that the facility was not defined as a "generating unit" for purposes of the EUA and T-Reg.

Where a storage facility functions as part of the transmission system, the owner of the facility would be entitled to cost recovery on a regulated, cost-of-service basis per the current regulatory framework, and would not be required to pay transmission system costs when withdrawing or supplying energy.

3.2.2 What is the appropriate tariff treatment of energy storage facilities?

The Discussion Paper described the existing ISO tariff and provided information on possible tariff treatments for storage. If the storage facility is not deemed a transmission facility, an appropriate tariff treatment must be developed.

The ISO tariff is a method of attributing costs of the transmission system to users of the transmission system. Other than through the mandated components of loss factors and generating unit owner's contributions, the tariff does not specifically recognize the potential avoidance of costs through location or action of market participants. In the AESO's view, these principles apply to energy storage facilities just as they do to other generators and loads.

As established earlier, energy storage is a generating unit when producing and a load when consuming and treatment of storage under the tariff should reflect this. Currently this would result in applying a combination of rate Supply Transmission Service (STS) for generation and Demand Transmission Service (DTS) and potentially, but unlikely, Demand Opportunity Service (DOS) for load. However, the terms of these rates may not be wholly appropriate for energy storage facilities. These rates may need to be modified or new rates developed to adequately reflect the characteristics of storage.

[15] EUA Section 1 (bbb)

Regarding applying only DOS to storage, DOS is a short-term temporary service provided if transmission is available and is subject to a qualification process to ensure the market participant would not otherwise increase service under Rate DTS. As Rate DOS is less expensive than Rate DTS, the qualification process ensures the consistent and reliable application of criteria to prevent cannibalization of revenues from Rate DTS. Therefore, it would not be appropriate to apply DOS for 100% of the load portion of the storage facility.

Stakeholder comments and the complexity of the tariff issue have persuaded the AESO to perform an operational and economic dispatch study. Participants who supply electricity to the transmission system are exempt from paying most transmission system costs, while participants who withdraw electricity pay in accordance with their use of the transmission system. The purpose of the study is to review the appropriateness of applying current rates to storage projects in the context of the AESO's recommendation that storage facility operators should pay the just and reasonable costs of the transmission system when utilizing that system to charge their facilities. The AESO proposes to examine whether an energy storage facility that is withdrawing electricity is using the transmission system similarly to a load that is withdrawing electricity. If the energy storage facility's withdrawal is significantly different from a load's withdrawal, then the ISO tariff may need to be amended to ensure the attribution of costs to energy storage facilities is appropriate. The following section provides further information regarding this study.

3.2.3 Operational and dispatch study next steps

Study Objectives

1. Examine how the operation and dispatch of an energy storage facility within a transmission and point-of-delivery situation will affect the electric system costs at the relevant level (bulk system, regional system and point of delivery).

2. Compare the operational and cost impacts of energy storage to similar impacts of conventional load and generation on the transmission system.

3. Develop tariff options including advantages and disadvantages to allow the AESO to recommend either:

    - that there is no basis for any changes to the existing AESO STS, DTS and/or DOS tariff to accommodate energy storage facilities; or

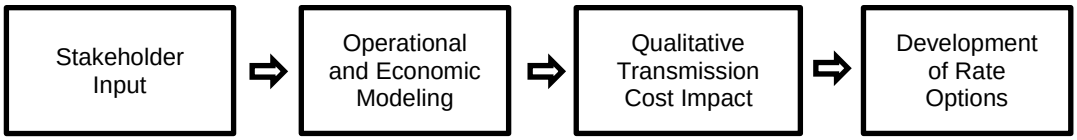
    - the application of the existing STS, DTS and/or DOS tariff to energy storage facilities with some modifications; or

    - the development of a new rate class or classes that are consistent with the existing transmission cost recovery methodology to be applied to some or all energy storage technologies.

Study Design and Work Scope

The four main steps of the operational and economic study are sequentially shown in Figure 1 below.

Figure 1: Study Components



1. Stakeholder Input

In the early study stage, specific input from energy storage project proponents and other interested stakeholders will be requested. The main objective of this engagement will be to seek feedback regarding the study methodology and confirm technical parameters for energy storage operations modelling.

The AESO will seek input from energy storage stakeholders on the operating characteristics and markets targeted by energy storage proponents. Engineering due diligence will be performed on the information received from stakeholders.

2. Energy Storage Operations and Economic Model

Modelling the operation and economic dispatch of an energy storage facility in the Alberta electricity market will investigate how the operator of an energy storage facility, seeking to maximize its operating revenue will:

- deliver energy to or withdraw energy from the transmission system in response to the hourly market price and;
- participate in all ancillary service products.

The model will compare storage with similar sized conventional loads and generators.

3. Qualitative Transmission Cost Impact

The results from the modelling in Step 2 will be compared with conventional loads and generators by the AESO transmission system planners to assess the impact of an energy storage facility on the transmission system. The study will use paragraph 30(2) of the EUA as a guiding principle to determine "…the prudent costs that are reasonably attributable to each class of system access service…"

4. Development of Rate Options

Based on the results from Step 3, options will be developed for tariff treatment. The study will include a "pros" and "cons" comparison for all rate options. All the options will align with the existing tariff components (bulk system, regional system, point of delivery, operating reserves, losses, etc.) as much as possible.

Timing

The AESO estimates that the study will be completed by Q4 2015. The implementation schedule will depend on the AESO's recommendation for energy storage tariff treatment.

3.3 Energy Storage Technical Requirements for the Provision of OR Products

In the Discussion Paper, the AESO stated that where appropriate, technical requirements for the provision of OR products should be technology neutral. The AESO also discussed the options proposed by stakeholders in the work group sessions, i.e. modifying technical requirements for the provision of products by lowering the minimum unit size requirement on units that provide OR services, reducing the continuous real power requirement to less than 60 minutes, applying "Pay-for-Performance" when compensating OR providers, and developing technical requirements so that energy storage facilities will also have an opportunity to participate in intertie restoration services.

3.3.1 Reduce Minimum Unit Size Requirements for the Provision of OR Products

The current technical requirements for OR provision set minimum sizes of OR that the asset must be capable of providing. The minimum sizes for RR, SR, and SP are 15 MW, 10 MW and 5 MW respectively.[16] These requirements were established many years ago based on the characteristics of traditional resources. In the Discussion Paper, the AESO provided a preliminary discussion of the pros and cons of lowering the minimum size requirements.

The AESO asked for stakeholder feedback as to whether the AESO should set a procurement cap on volumes that are procured from units that cannot meet the current minimum size requirements *if their inclusion beyond a certain threshold would have a negative impact on reliability.*

Minimum Capacity to provide Spinning Reserves or Regulating Reserves

The AESO currently has minimum size requirements for frequency response in the provision of Operating Reserves. The two services that have a frequency response requirement are Spinning Reserves and Regulating Reserves. The minimum size for Spinning Reserves is 10 MW and the minimum size for Regulating Reserves is 15 MW. The AESO also has requirements limiting the maximum amount of reserves provided by a resource to 80 MW.

With the emergence of load to be eligible to provide Spinning Reserves and other technologies such as batteries to provide Spinning or Regulating Reserves, the AESO re-evaluated the minimum capacities required to provide these services.

The evaluation was based on the frequency response characteristic of these resources and the frequency responsive needs in Alberta. The following describes the basis and rationale that led to the conclusion that the AESO would not permit at this time reducing the capacity to provide Spinning or Regulating Reserves and that the AESO would need to consider other characteristics or market design changes to accommodate smaller resources in the Spinning and Regulating Reserve markets.

Frequency Characteristic of Resources

The frequency response characteristic of resources is largely based on the droop characteristic of the turbine governor controls. With newer technologies such as batteries, flywheels, wind generators or loads this would be based on the droop characteristics of the control systems that change the power output based on a change in frequency. The droop setting is often described as the change in frequency (or speed) that would result with a 100% change in real-power output (or valve position). A 5% droop for example would result in a 5% change in frequency or a 3 Hz[17] change in frequency would result in a 100% change in real-power output.

For example, for a large resource such as a 400 MW capacity generator this would be the same as saying a 3Hz change would result in a 400 MW change in generation. This could be characterized as a

[16] For SP, the technical requirement allows aggregation of facilities to satisfy the minimum size.
[17] 3Hz = 60Hz*5% droop

133 MW/Hz response. For a smaller resource with 10 MW capacity, this would be the same as saying a 3 Hz change would result in a 10 MW change or 3.33 MW / Hz.

Frequency Responsive Needs of the Alberta System

When Alberta is interconnected to the Western Electricity Coordinating Council (WECC), a large generator trip in Alberta or within WECC will cause a supply – demand imbalance and frequency will decline. The arrest of the frequency decline is largely based on the ability of the frequency responsive resources within WECC to increase their real power output based on the 'droop' characteristic described above. The WECC system has many generating units that may respond and the frequency deviation is usually quite small. For example a 450 MW Alberta generator trip may cause the WECC interconnection frequency to decline by ≈ 0.05 Hz.

The Alberta system has the unique characteristic of 'islanding'. Very few jurisdictions in North America can experience this scenario. Alberta has contingencies that will result in controlled separation of the Alberta system and island it from WECC. If a controlled separation occurs during an import condition, the Alberta system will have a supply-demand imbalance and frequency will decline. The arrest of the frequency decline is largely based on ability of the frequency responsive resources in Alberta to increase their real power output based on the droop characteristic described above. Exactly how far the frequency in Alberta will decline is based on the resources providing the response. Should the frequency responsive resources have insufficient response to arrest the frequency decline and prevent tripping of customers on the under frequency load shed program, the AESO will require supplemental frequency responsive services such as Load Shed Service for Import (LSSi).

When determining the amount of LSSi required, the AESO's studies make assumptions on which resources are providing frequency responsive reserves and the total capacity of these resources. These assumptions are largely based on historical observations.

For example, if the study scenario requires 300 MW of spinning reserves an assumption will be made about the total capacity of resources providing these reserves. For example, this could be 1,500 MW. In this case, the AESO has allocated 300 MW of frequency responsive reserve on ≈ 1,500 MW of capacity. The AESO also conducts sensitivity studies on various levels of the total capacity providing frequency responsive reserves. For example "what if" the 300 MW of frequency responsive reserve was provided by only ≈ 750 MW of capacity, or "what if" the 300 MW of frequency responsive reserve was provided by ≈ 2,500 MW of capacity.

The sensitivity studies performed indicate that as the amount of capacity providing the frequency responsive reserves decreases, the overall frequency response of the Alberta system is reduced thus increasing the need for supplemental services such as LSSi. If the amount of capacity providing frequency response reserves increases, the overall frequency response of the Alberta system increases and the need for supplemental services such as LSSi is reduced. Results from the sensitivity studies where the capacity of units providing frequency responsive reserves is reduced indicate that the amount of supplemental services required can be double to quadruple the amount indicated using a historically derived base case assumption.

Conclusion on Reducing the Size Requirement to Provide Spinning or Regulating Reserve

Based on current frequency response characteristics the AESO has concluded that reducing the minimum size requirement to provide Spinning Reserve (SR) or Regulating Reserve (RR) is not the direction to pursue at this time as it has adverse impacts on the operational efficiency of the Alberta system. Reducing the size requirement for provision of RR or SR would increase the reliance on supplemental services to maintain frequency.

The AESO would have to further study other characteristics (i.e. lowering droop requirement) and their impact before implementing a reduction in size requirement. In addition, potential future Operating Reserve market product redesign or a procurement cap strategy would likely be required to accommodate smaller capacity resource participation while preserving the overall frequency response of the Alberta system. Additional discussion can be found in section 3.3.3.

Allowing Energy Storage to Participate in Operating Reserves Products

Providers of RR, SR and SP must comply with ISO Rule 205.4 R*egulating Reserve Technical Requirements and Performance Standards*, ISO Rule 205.5 *Spinning Reserve Technical Requirements and Performance Standards* and ISO Rule 205.6 *Supplemental Reserve Technical Requirements and Performance Standards*. Alberta Reliability Standard BAL-002-WECC-AB-2 has been in effect in Alberta since October 2014 with the purpose of specifying the quantity and types of contingency reserve required to ensure reliability under normal and abnormal conditions. One of the intents of BAL-002-WECC-2 is to extend participation beyond established generation technologies to other resources that can also provide energy or reduce energy consumption.[18]

The AESO has already revised several key definitions to allow storage participation in the OR products. Specifically, between October and December 2014, the definitions of governor or governor system, regulating reserve, frequency response, automatic generation control, supplemental reserve and spinning reserve were revised. For example, the definition of "governor or governor system" was modified to:

> means automatic control equipment with frequency or speed droop characteristics to control: i. the speed or electric power output of a generating unit, or both; ii. the electric power input of a load; or iii. **the electric power output or input of an energy storage facility**, or both.

Including the Load Portion of Storage in the Regulating Reserve Range

RR provides a balance between generation and load within the Alberta balancing authority area. Providers of RR must be responsive to a set-point signal between the high limit and the low limit of the regulating reserve range. The providers must be equipped with a governor system that is responsive to frequency events. Batteries, flywheels and bulk storage such as compressed air or pumped hydro are all capable of providing this service. The AESO currently intends to pursue modifications to applicable rules as appropriate to enable the charging – or load – portion of a storage facility to be included in the determination of regulating reserve range. For example, this would clarify that a 7.5 MW battery facility is able to provide 15 MW of RR range when sourcing or sinking real power.

Next Steps

The AESO will review and revise ISO Rule 205.4 *Regulating Reserve Technical Requirements and Performance Standards*, ISO Rule 205.5 *Spinning Reserve Technical Requirements and Performance Standards* and ISO Rule 205.6 *Supplemental Reserve Technical Requirements and Performance Standards* and other rules as may be incidentally impacted to allow energy storage and other technologies to participate in operating reserve products (RR, SR and SP). The AESO is expecting to initiate the consultation process in 2015 with a target to file revised rules in 2016.

[18] WECC Standard BAL-002-WECC-2

3.3.2 Shorten the Continuous Real Power Requirement

ISO Rule 205.4 *Regulating Reserve Technical Requirements and Performance Standards*[19] states that a RR resource be capable of operating continuously at either the high limit or the low limit of the regulation range for sixty (60) minutes while providing RR service.

As described in Section 5 of OPP 402[20], the current RR product has the capability to replace SR and allows the system controller to dispatch standby RR before dispatching backstop SR when the required SR volume is higher than the SR volume carried in real time. The 60-minute requirement for RR is an extension of the same requirement for contingency reserves. OPP 402 was replaced by ISO Rule 205.4 which became effective on December 23, 2014.

Analysis

The AESO has performed a statistical analysis using the full year 2013 to determine how often RR was directed at the top or bottom of their range for one hour average. Results are shown in Table 1:

Table 1 RR Directives Statistics

Percentage of Range	Time %
At 100% or 0%	0.4
Over 95 and less than 5	2.5
Over 85 and less than 15	14.1
Over 75 and less than 25	32.7
Over 65 and less than 35	56.6
Over 55 and less than 45	86.4

For a one-hour average period, the RR providers are directed between 75% and 25% of their range 67% of the time. The distribution is non-linear and the providers are very seldom directed at the top or bottom of their range (0.4%) for one hour. The only time in 2013 RR providers were directed at the top of their range at the same time as all the spinning contingency reserves were fully deployed was during the load shed event of July 2, 2013.[21] A combination of hot temperature, deration of generation and equipment failure led to load shedding during this energy emergency. Arguably, shortening or lengthening the capability requirement to provide power would not have made a difference in this scenario.

While historical data indicates that instances may be rare, the owner(s) of limited storage resources such as batteries must consider the impact of deep cycles on battery life. Historically, RR providers are seldom directed at the top or bottom of their range for one full hour but as always, future utilization may differ from past performance. In order to maintain the ability to allow for substitution between RR and SP as described above, the AESO intends to continue with the 60-minute requirement for RR service providers.

[19] ISO Rule 205.4
[20] http://www.aeso.ca/downloads/OPP_402_Supplemental_and_Spinning_Reserve_Services_-_Issued_2014-06-01.pdf
[21] http://www.aeso.ca/downloads/AESO_Load_Shed_Event_of_July_2_2013_WEB.pdf

In addition, the possibility of shortening the continuous power requirement should not be examined in a vacuum. The following section provides additional steps the AESO is conducting to explore current RR product design.

3.3.3 Further Differentiate OR Products

The current OR market consists of three different types of services procured by the AESO, RR, SR and SP. Both the Energy Storage Work Group stakeholders and the AESO noted that the design of new products or further differentiating the existing OR products should be driven by the goal of more efficiently managing system reliability based on system needs. In the Discussion Paper, the AESO discussed two ways of differentiating services, i.e., creating new types of services or differentiating existing services by paying them differently based on performance. While recognizing the merit of these concepts, the AESO also cautioned against the possibility of bifurcating the market or potentially requiring significant changes in the OR market design.

In October 2011, FERC issued Order 755.[22] The goal was to recognize additional value of fast ramping new storage technologies such as batteries and flywheels to provide regulation services. In July 2013, FERC issued Order 784[23] requiring each public utility transmission provider to take into account the speed and accuracy of regulation resources in its determination of reserve requirements for regulation and frequency response service.

The AESO is not under FERC jurisdiction but recognizes the need to investigate the potential benefits of fast responding resources such as some storage technologies to reduce RR volume requirements or improve system performance. As a first step to gain more information, the AESO has entered into an agreement with the National Research Council (NRC) to examine the potential system and regulating volume impacts of different performance or technical standard scenarios.

The project objectives are to:

- Assess the set-point tracking performance of the AESO's existing RR resources. A performance measure will be developed to describe the asset effectiveness at correcting the Area Control Error (ACE) and accurately following the Automatic Governor Control (AGC) signal.
- Provide an assessment on the possibility of reducing the required amount of regulating reserves by changing the technical requirements.
- Provide an assessment on existing or new technologies that could satisfy the new changes in the technical requirements while maintaining reliability performance.

The assessment is not meant to be a compliance exercise. The study will determine if further investigation is warranted. Potential changes to standards, products or market design would be fully consulted on before they were implemented. The target completion date for the NRC study is the end of 2015.

3.3.4 Allow Energy Storage Resources to Provide Intertie Restoration Services

Certain types of Energy Storage facilities are likely technically capable of providing services whose system effect is similar to the intertie restoration service currently provided by LSSi. In the Discussion Paper, the AESO discussed the proposal to develop technology neutral technical requirements for intertie restoration services that will not preclude energy storage facilities integrated in the grid from participating. The AESO will pursue this possibility in the long term. It was not a short-term priority due to the lack of current in-service projects and the timing of the LSSi RFP process.

[22] http://www.ferc.gov/whats-new/comm-meet/2011/102011/E-28.pdf
[23] http://www.ferc.gov/whats-new/comm-meet/2013/071813/E-22.pdf

4 Next Steps

The AESO intends to pursue the following steps in its efforts to enable the integration of energy storage facilities into the Alberta energy market and electric system.

- Finalize drafting and file with the AUC the Proposed Battery Facility Rules by Q3 2015.
- Perform an economic and operational dispatch study to inform potential ISO tariff treatment options for storage. Market participants will be consulted in the early study stage. The target completion date for the study is Q4 2015. Depending on the study results, the AESO will develop and communicate next steps to stakeholders by early 2016.
- Revise ISO Rule 205.4 *Regulating Reserve Technical Requirements and Performance Standards*, ISO Rule 205.5 *Spinning Reserve Technical Requirements and Performance Standards* and ISO Rule 205.6 *Supplemental Reserve Technical Requirements and Performance Standards* and other rules as may be incidentally impacted to reflect how energy storage technology will participate in OR products (RR, SR and SP). The AESO will initiate the rule consultation process in 2015 and target to file in 2016.
- Examine the performance of current RR providers and assess if changing the current technical requirements and/or introducing new technologies (such as storage) could reduce the required amount of RR. The target completion date for this study is end of 2015. Results from this study and energy storage considerations in general will be considered in the context of additional reviews the AESO is currently conducting regarding current technical standards, volume requirements and procurement processes for OR. Should this review indicate that changes in any of these areas may be beneficial the AESO will engage stakeholders in a fulsome consultation process before proposing changes.

5 Appendix – Stakeholder Comments

The purpose of this section is to provide additional responses to stakeholder comments from the Energy Storage Integration Discussion Paper that are not already covered in this paper. A complete listing of all stakeholder comments can be found at:

http://www.aeso.ca/downloads/AESO_Posting_Stakeholder_Comments_Notice.pdf

5.1 Technical Requirements for Energy Storage to Connect to and Operate in the AIES

Replies to all stakeholder comments were posted on April 01, 2014.[24] Because of their uniqueness, the AESO has focused initially on developing technical standards for connection and operation of batteries. This will allow projects that have submitted System Access Service Requests (SASR) to progress through the connection process. The AESO will reassess the need to develop additional standards as new storage technologies develop.

5.2 Energy Storage and OR

The AESO completed an off nominal frequency study that gave strong indication that reducing the size of RR and SR assets negatively impacts the AIES's ability to respond to frequency excursions. The AESO did not study the impact of imposing a procurement cap on smaller resources. Changing the design of OR products will require further studies. Investigating whether different product designs or changes to procurement timing are required for best use of evolving technologies to enhance the safe and reliable operation of the system is a longer-term undertaking and should be done in the context of OR market design.

5.3 Should the AESO Consider Pilot Project(s)?

The AESO does not consider a pilot project to be required at this time. Technical capabilities of different types of energy storage facilities are well documented in various documents. Therefore, there is no need for the AESO to conduct a pilot project to validate these technical capabilities. Specific questions requiring a pilot have not been identified at this stage. The AESO is monitoring lessons learned from storage pilots in other jurisdictions.

[24] http://www.aeso.ca/downloads/2014-04-01_Reply_Letter_(Recommendation_paper).pdf

Stakeholder Comment and AESO Replies Matrix

Recommendation Paper – Energy Storage Integration

June 18, 2015

The AESO is asking market participants and interested parties to participate in the AESO's consultation regarding the development of Energy Storage Integration. The AESO is seeking comments from stakeholders on the recommendations.

Date of Request for Comment: June 18, 2015	Contact: Jacques Duchesne
Period of Consultation: June 18, 2015 through July 15, 2015	Phone: 403 539-2518
Comments From: AltaLink Investment Limited Partnership (AILP)	E-mail: jacques.duchesne@aeso.ca
Date [yyyy/mm/dd]: 2015/07/15	

Complete the drafting of and file ISO Rules to address technical and operating requirements for battery storage facilities ("Proposed Battery Facility Rules") with the Alberta Utilities Commission ("AUC").		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**AESO Replies**
AILP	AILP appreciates the AESO's effort in the development of the proposed Battery Facility Rules and the consultation with stakeholders at various stages of rule development process. AILP supports the AESO's plan for next steps for implementation. Given the proposed technical and operational rules are for Battery Facilities, AILP would like to know the AESO's plan with regards to the development of rules to	

	enable other storage technologies that are not classified as batteries. It is important to have rules in place that allow all storage technologies to connect to and operate in the AIES system to ensure fair and open access and competition.	
Storage facilities operate as generating units when injecting power into the grid and operate as load when purchasing or withdrawing electricity from the transmission system. The storage facility is using the transmission system and is required to pay the just and reasonable costs of the transmission system. An economic dispatch study will be performed to develop ISO tariff treatment options for storage. The study will examine in detail the differences between storage and conventional load and generators.		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**AESO Replies**
AILP	AILP agrees with the AESO's statement in its recommendation paper that ”storage facilities are complex from a regulatory perspective as they do not fit neatly into only one of the traditional categories of transmission, distribution or load" (p.4). This statement should be at the forefront when AESO determines its policy for storage. AESO stated that in its recommendation paper that “AESO is of the view that storage facilities can function in Alberta in a manner in which they alternate between being competitive generating units and load. Where this is the case the AESO is of the view that the current legislative framework supports the conclusion that storage facilities should be treated under	

	the tariff as generating units and load." (p.7). AILP respectfully disagrees with the AESO's positions quoted above. The unique function storage facilities bring to the power system is system flexibility - the capability to adjust system balance of supply and demand at times when most needed for reliable and economic operation of the grid system. Currently, the need for flexibility in Alberta is provided primarily by generation units through the delivery of ancillary services or following energy dispatch. Storage facilities can provide the same functionality through storing and discharging of power to make the system more flexible. As such, from the view of functional equivalence perspective, the storage facilities are similar to a generator. Further, AILP wishes to highlight several key operational features of energy storage, for the AESO to consider in determining appropriate tariff treatment for storage: • When energy storage facilities are operating under "charging" mode, they do not function like a typical customer load which consumes electricity by converting electric energy into end-use services such as lighting, HVAC, pumping etc. Instead, when a storage facility is "charging", it operates to	

	balance the system by either following ISO operating signals such as frequency regulation; or absorbing energy that is “surplus” due to either physical or economic reasons. In addition, when a storage facility is armed to provide intertie restoration service similar to LSSi, it will not draw any power from the system. All these operating characteristics suggest storage facilities do not operate like a customer load. • To some extent, the functionality of charging and discharging performed by a storage facility is similar to those by interties during imports and exports. • Energy storage facilities relieve stress on the transmission system versus adding stress. • Energy storage facilities can potentially defer or remove the need for transmission facilities to be built, thus resulting in lower transmission costs. • Energy storage facilities typically do not require transmission to be built for their connection to the system (except for their local interconnection cost which will be paid by the BES	

	developer). These unique operational characteristics and benefits of energy storage facilities should be recognized by the AESO when developing its tariff and operating rules. AILP supports the AESO performing an operational and economic dispatch study to assist in the determination of appropriate tariff treatment options for storage when operating as short duration applications (e.g. frequency regulation) and when operating as long duration applications (e.g. energy shifting). However, AILP wishes to understand how this proposed Dispatching study would support this objective and any other studies/work will be required before the AESO's determination of appropriate tariff treatment for storage facilities. Finally, AILP recommends that the AESO consider information from other jurisdictions that have integrated storage into their systems with respect to the tariff treatment for storage facilities that provide both short duration and long duration services. Even though Alberta has a unique market and tariff structure, the physical operation of storage facilities should not be much different between jurisdictions.	

Maintain the minimum requirement of 15 MW range for regulating reserve ("RR") and of 10 MW for spinning reserve ("SR")		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**Replies**
AILP	AILP appreciates the AESO's efforts in identifying the relationship between system frequency response capability and the size of Regulating and Spinning Reserve. AILP wishes to point out that the AESO's studies and conclusions appear to be based on the frequency response characteristics of existing Alberta grid system. As existing coal units retire, the Alberta generation mix is expected to change significantly. With the penetration of renewable and small gas generation units, the frequency response characteristics of the future Alberta system could differ significantly from historical ones. AILP encourages the AESO to take a forward looking approach in assessing frequency response characteristics and in deciding whether or not to relax the minimum size for providing frequency and spinning reserve. If the future grid is moving towards a system characterized with less "inertia" and frequency responsiveness, then artificially limiting the capacity size of Spinning and Regulating Reserves services will not remove the need	

	for additional supplemental services to maintain frequency. In essence, the frequency response problem is due to the nature of the Alberta system and the need to run the interties. Reducing the OR size requirement itself is not the source of the problem. Rather it allows more service providers to compete in the market and therefore provide more cost effective solutions. It is also worth to note that only a portion of the RR and SR will be supplied by small size devices, or like the AESO pointed out in its paper – need to be "capped" (p. 12). Therefore the risk of losing system frequency response capability as a result of reducing the size of OR products is small. Given supplement frequency response is likely to be required in the future, reducing the size of SR and RR will allow more cost effective solutions.	
The AESO will revise, where appropriate, ISO Rule 205.4 Regulating Reserve Technical Requirements and Performance Standards, ISO Rule 205.5 Spinning Reserve Technical Requirements and Performance Standards and ISO Rule 205.6 Supplemental Reserve Technical Requirements and Performance Standards and other rules as may be incidentally impacted to reflect how energy storage technology will participate in operating reserve products (RR, SR) and Supplemental Reserve ("SP")		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**Replies**
	AILP agrees with the AESO's assessment and supports the recommended next steps	

	to modify ISO Rule 205.4, 205.5, and 205.6 to allow energy storage and other technologies to participate in operating reserve markets (RR, SR, and SP).	
Examine the performance of current RR providers and assess if changing the current technical requirements and/or introducing new technologies (such as energy storage) could reduce the required amount of RR.		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**Replies**
	AILP supports the AESO/NRC study to examine the potential system and regulating volume impact under different technical requirement scenarios. It is worthwhile to note that similar studies have been done in other jurisdictions (e.g. PJM Performance Based Regulation Year One Analysis Report, filed at FERC October 14, 2013). There are also operating data in various ISOs which implemented FERC Order 755. It would be beneficial for the study team to review these information and incorporate lessons learned where necessary.	
Other		
Stakeholder	**Stakeholder Comment**	**Replies**
	The AESO paper identified several areas for further investigation to allow storage to participate in various ancillary service markets; such as:	

	• Shortening the continuous real power requirement • Allowing energy storage to provide intertie restoration services • AS market re-design, including potentially new OR products AILP agrees these are important issues to be addressed in order to allow efficient and effective participation of storage facilities in the Alberta market. AILP suggests the AESO to also proactively look into the frequency response need arising from the forecast changing of the generation mix and frequency response characteristics in Alberta, and develop appropriate OR products to address them. As stated in our comments with regards to the minimum capacity requirement for regulating and spinning reserves, the frequency response problem is due to the nature of our system and the need to run Alberta interties. Reducing the size itself is not the source of the problem. Rather it allows more service providers to compete and provide more cost effective solutions. We encourage the AESO Take a holistic approach. For example, define functional services/product required and allow all	

	technologies, including storage facilities, to compete and provide services. With respect to shortening the time, we encourage AESO to continue to investigate and develop ways to allow efficient solutions. Based on the statistics on Page 13, currently OR assets are running less than 25% of their range (or running full range for 15 minutes duration) less than 33% of time. This suggests an opportunity for AESO to develop a portfolio of assets with short and long-time duration requirement for continuous real power. This type of product mix has the potential to take advantage of a range of different technologies and minimize the cost o of delivering OR services. AILP appreciates the opportunities to provide comments on the AESO's storage recommendation paper and look forward to continuing to work with the AESO in moving this important initiative forward.	

Stakeholder Comment and AESO Replies Matrix

Recommendation Paper – Energy Storage Integration

June 18, 2015

The AESO is asking market participants and interested parties to participate in the AESO's consultation regarding the development of Energy Storage Integration. The AESO is seeking comments from stakeholders on the recommendations.

Date of Request for Comment: June 18, 2015	Contact: Grant Berry
Period of Consultation: June 18, 2015 through July 15, 2015	Phone: 780-392-5294
Comments From: Capital Power	E-mail: gberry@capitalpower.com
Date [yyyy/mm/dd]: 2015/07/15	

Complete the drafting of and file ISO Rules to address technical and operating requirements for battery storage facilities ("Proposed Battery Facility Rules") with the Alberta Utilities Commission ("AUC").		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**AESO Replies**
Capital Power	Capital Power agrees the AESO should complete and file ISO Rules to address technical and operating requirements for battery storage facilities. The AESO should also continue to work with stakeholders to develop technical standards and operating requirements for other energy storage (ES) technologies as new connection requests arise. Capital Power expects that the	

	development of rules and standards will be executed within existing ISO Rule and AESO consultation processes, and looks forward to participating in these processes.	
Storage facilities operate as generating units when injecting power into the grid and operate as load when purchasing or withdrawing electricity from the transmission system. The storage facility is using the transmission system and is required to pay the just and reasonable costs of the transmission system. An economic dispatch study will be performed to develop ISO tariff treatment options for storage. The study will examine in detail the differences between storage and conventional load and generators.		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**AESO Replies**
Capital Power	Capital Power reiterates its previous support for the AESO's initial assessment that storage facilities operate as generating units when injecting power into the grid and operate as load when purchasing or withdrawing power from the grid. Based on that assessment it seems just and reasonable to apply STS charges to ES when it is supplying power to the grid and DTS charges to ES when it is withdrawing power from the grid. Capital Power supports efforts by the AESO to examine how the operation and dispatch of ES within a transmission and point-of-delivery situation will affect electric system costs at the relevant levels (bulk system, regional system, and POD). The tariff treatment of ES should reflect its impact on the transmission system and the principles of cost causation.	

	Capital Power looks forward to reviewing and commenting on the results of the AESO's economic dispatch study and any accompanying tariff treatment options. In Section 3.2.1, the AESO discusses its views on how ES could operate as a "transmission facility" under the current legislation. Capital Power is interested in understanding the AESO's current and future intentions for employing ES as a "transmission facility" in Alberta. In particular, Capital Power would like to know if ES options are currently being considered as a transmission solution/alternative as part of the AESO's long-term planning? If so, more information and discussion would be helpful. Please explain fully.	

Maintain the minimum requirement of 15 MW range for regulating reserve ("RR") and of 10 MW for spinning reserve ("SR")		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**Replies**
Capital Power	The AESO's assessment to maintain the current minimum size requirements seems reasonable based on the information provided in Section 3.3.1.	

The AESO will revise, where appropriate, ISO Rule 205.4 Regulating Reserve Technical Requirements and Performance Standards, ISO Rule 205.5 Spinning Reserve Technical Requirements and Performance Standards and ISO Rule 205.6 Supplemental Reserve Technical Requirements and Performance Standards and other rules as may be incidentally impacted to reflect how energy storage technology will participate in operating reserve products (RR, SR) and Supplemental Reserve ("SP")

The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**Replies**
Capital Power	Capital Power supports the AESO's review and revision of ISO Rules outlining the technical requirements and performance standards for Operating Reserve (OR) market products, provided that any potential changes to the technical requirements for the provision of OR products involve consideration of, and apply to, all generation technologies that meet the requirements. Any changes to the technical requirements and performance standards for providing OR market products must preserve a level playing field while maintaining and/or improving the safe and reliable operation of the system. Changes should not be solely driven by, or remain exclusive to, ES technologies. Capital Power looks forward to participating in any formal rule change initiatives within existing ISO Rule and formal consultation processes.	
Examine the performance of current RR providers and assess if changing the current technical requirements and/or introducing new technologies (such as energy storage) could reduce the required amount of RR.		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**Replies**
Capital Power	Capital Power supports the AESO's efforts to make the provision of OR products as technology neutral as possible without	

	sacrificing the functionality of the products. Capital Power looks forward to reviewing and commenting on the NRC performance study and subsequent next steps. Any potential Operating Reserve (OR) market redesign, new products or procurement cap strategy should be based on preserving and improving the safe, reliable, and FEOC operation of the system. ES should be treated the same as all other technologies and any changes to current OR products should include consideration of all technologies. OR market re-design discussions are broader than the current scope of the AESO's ES integration initiative. If the AESO is considering a re-design of the OR market, the AESO should establish a separate formal consultation on the matter.	
Other		
Stakeholder	**Stakeholder Comment**	**Replies**
Capital Power	Capital Power is supportive of the AESO's efforts to integrate ES technologies into the market insofar as they compete on a level playing field with other technologies. Capital Power supports Alberta's current energy-only market design. Efforts to integrate new technologies must align with FEOC principles, support the safe and reliable operation of the electric system,	

	and remain fuel and technology neutral. Capital Power does not support changes to current AESO Rules, technical standards, or tariff design that would create unfair advantages for specific technologies.	

Stakeholder Comment and AESO Replies Matrix

Recommendation Paper – Energy Storage Integration

June 18, 2015

The AESO is asking market participants and interested parties to participate in the AESO's consultation regarding the development of Energy Storage Integration. The AESO is seeking comments from stakeholders on the recommendations.

Date of Request for Comment: June 18, 2015	Contact: Jacques Duchesne
Period of Consultation: June 18, 2015 through July 15, 2015	Phone: 403 539-2518
Comments From: Horst Klinkenborg (ATCO Power)	E-mail: jacques.duchesne@aeso.ca
Date [yyyy/mm/dd]: 2015/06/26	

Complete the drafting of and file ISO Rules to address technical and operating requirements for battery storage facilities ("Proposed Battery Facility Rules") with the Alberta Utilities Commission ("AUC").		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**AESO Replies**
ATCO Power	*No comment*	

Storage facilities operate as generating units when injecting power into the grid and operate as load when purchasing or withdrawing electricity from the transmission system. The storage facility is using the transmission system and is required to pay the just and reasonable costs of the transmission system. An economic dispatch study will be performed to develop ISO tariff treatment options for storage. The study will examine in detail the differences between storage and conventional load and generators.		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**AESO Replies**
ATCO Power	*ATCO Power supports the AESO's suggestion to undertake a study to*	

	examine in detail the differences between storage and conventional load and generators. However, ATCO Power would like to suggest broadening the scope of the study. ATCO Power has previously raised the concern that there is a potential for non-conventional "generation" to decrease the reliability of the system and to threaten the sustainability of the market if it is wrongly integrated into the market. ATCO Power is looking forward to work with the AESO on developing appropriate system studies.	
Maintain the minimum requirement of 15 MW range for regulating reserve ("RR") and of 10 MW for spinning reserve ("SR")		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**Replies**
ATCO Power	*No comment*	
The AESO will revise, where appropriate, ISO Rule 205.4 Regulating Reserve Technical Requirements and Performance Standards, ISO Rule 205.5 Spinning Reserve Technical Requirements and Performance Standards and ISO Rule 205.6 Supplemental Reserve Technical Requirements and Performance Standards and other rules as may be incidentally impacted to reflect how energy storage technology will participate in operating reserve products (RR, SR) and Supplemental Reserve ("SP")		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**Replies**
ATCO Power	*ATCO Power is looking forward to participate in the upcoming consultation.*	
Examine the performance of current RR providers and assess if changing the current technical requirements and/or introducing new technologies (such as energy storage) could reduce the required amount of RR.		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**Replies**

ATCO Power	*No comment*	
Other		
Stakeholder	**Stakeholder Comment**	**Replies**
ATCO Power	*In its comments on the Discussion Paper under Next Steps, ATCO Power made statements regarding the long term implications of new technologies in general and energy storage in particular. ATCO Power had previously raised similar issues during the Wind Integration consultation. ATCO Power notes that the AESO has yet to respond and to address this concern.* *The AESO states in the Executive Summary of the Recommendation Paper that "energy storage may be able to play an increasing role in enhancing the efficiency and reliability of the entire electric grid and enabling greater penetration of variable renewable energy in the supply mix." However, ATCO Power believes that if the integration is not handled carefully the opposite might be true and the reliability of the system might decrease and the sustainability of the market might be jeopardized.* *ATCO Power therefore urges the AESO to start the broader policy discussion regarding the integration of new or non-traditional technologies. ATCO Power*	

	believes that the system studies the AESO is contemplating could be set up in a fashion that would provide valuable insights into this discussion.	

Stakeholder Comment and AESO Replies Matrix

Recommendation Paper – Energy Storage Integration

June 18, 2015

The AESO is asking market participants and interested parties to participate in the AESO's consultation regarding the development of Energy Storage Integration. The AESO is seeking comments from stakeholders on the recommendations.

Date of Request for Comment: June 18, 2015	Contact: Jacques Duchesne
Period of Consultation: June 18, 2015 through July 15, 2015	Phone: 403 539-2518
Comments From: Rocky Mountain Power (2006) Inc. ("RMP")	E-mail: jacques.duchesne@aeso.ca
Date [yyyy/mm/dd]: 2015/07/15	

Complete the drafting of and file ISO Rules to address technical and operating requirements for battery storage facilities ("Proposed Battery Facility Rules") with the Alberta Utilities Commission ("AUC").		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**AESO Replies**
RMP	No comment	

Storage facilities operate as generating units when injecting power into the grid and operate as load when purchasing or withdrawing electricity from the transmission system. The storage facility is using the transmission system and is required to pay the just and reasonable costs of the transmission system. An economic dispatch study will be performed to develop ISO tariff treatment options for storage. The study will examine in detail the differences between storage and conventional load and generators.		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**AESO Replies**
RMP	*RMP is in favor of the recommendation that an economic dispatch study be performed.*	

	However, RMP has a number of comments associated with the various sections of the recommendation paper that deal with storage facilities paying just and reasonable rates of the transmission system. *Comment 1 – refer to page 8, paragraph 1 – The AESO concludes that … "it is not appropriate to apply the DOS for 100% of the load portion of a storage facility." The AESO's rationale is … As Rate DOS is less expensive than Rate DTS, the qualification process ensures the consistent and reliable application of the criteria to prevent cannibalization of Revenues from Rate DTS. AESO's conclusion that it is not appropriate to apply the DOS for 100% of the load portion of a storage facility presupposes or eliminates one outcome of the development of tariff options referred to in the recommendation. The AESO seems to base its conclusion about not using Rate DOS on the statement that current regulations prevent the usage of the Rate DOS and that those regulations are in place to prevent the loss of revenue from Rate DTS. RMP agrees that current regulations prevent the usage of Rate DOS for extended periods of time, but we suggest that one of the alternatives that should be studied in the tariff development process is changing the regulations associated with Rate DOS. Otherwise the AESO is stating a tautology – we can't use the Rate DOS because our regulations*	

	prevent us from doing so – without assessing whether it makes sense to amend the regulations which would allow use of Rate DOS. *Comment 2 - Page 8 – paragraph 2 – 2nd last sentence – "If the energy storage facility's withdrawal is significantly different from a loads withdrawal, then the AESO's tariff may need to be amended to ensure the attribution of costs to energy storage facilities is appropriate." While RMP is generally in agreement with the sentiment expressed in this sentence, RMP would like clarification of what constitutes a "significant difference". RMP suggests that the AESO ensure that it seeks stakeholder input as to what constitutes significant differences.* *Comment 3 – Page 9 – Study Design and Work Scope. RMP welcomes the opportunity to provide input as outlined in Step 1 - Stakeholder input – of the Operational and Dispatch study. However, RMP is concerned that stakeholder input is not specifically provided for in step 3 – Qualitative Transmission Cost Impact – and step 4 – Development of Rate Options. RMP urges that stakeholder input be allowed in each step of the Operational and Dispatch study processes including cost impact assessments and rate design options.* *Comment 4 – RMP would also like to suggest that the scope of the economic dispatch study be amended to include the*	

	study of economic import and export activities. We note that there is a tendency for exports to occur when Alberta power prices are low and for imports to occur when Alberta prices are high. We would like to point out that the Rates IOS and XOS are significantly lower than both Rate DTS and Rate DOS even though the activities of imports and exports are very similar to the activities that will take place for storage facilities and that import and export transactions take place through dedicated tie lines, the costs of which, with the exception for MATL, are absorbed by all rate payers. Storage facilities located in the province would not require expensive tie-lines. While there are other benefits associated with tie-lines that may justify their costs being included in system costs, RMP suggests that the economic dispatch study consider the similarities between import and export activities and storage activities and the implications that may have for tariff design.	
Maintain the minimum requirement of 15 MW range for regulating reserve ("RR") and of 10 MW for spinning reserve ("SR")		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**Replies**
RMP	*RMP would like to suggest that the AESO may be able to reduce its minimum requirement for RR and SR if it were to change its procurement processes for the OR services. The AESOs conclusion to NOT reduce the minimum requirement*	

	stems from its analysis that lower minimum requirements may result in a degradation of the resources dedicated to respond to frequency deviations. RMP would like to suggest that the AESO consider studying a procurement process whereby a base level of RR and SR requirements is procured through a competitive process for long-term dedicated RR and SR capabilities and that these base capabilities be procured from facilities that are greater than or equal to the current minimum size requirements. For the remainder of the RR and SR requirements, the AESO could continue to procure these services on a daily basis but because a base quantity of services was assured, the AESO could reduce the minimum size requirements for the remaining level of short term RR and SR services.	
The AESO will revise, where appropriate, ISO Rule 205.4 Regulating Reserve Technical Requirements and Performance Standards, ISO Rule 205.5 Spinning Reserve Technical Requirements and Performance Standards and ISO Rule 205.6 Supplemental Reserve Technical Requirements and Performance Standards and other rules as may be incidentally impacted to reflect how energy storage technology will participate in operating reserve products (RR, SR) and Supplemental Reserve ("SP")		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**Replies**
RMP	*RMP agrees with this recommendation.*	
Examine the performance of current RR providers and assess if changing the current technical requirements and/or introducing new technologies (such as energy storage) could reduce the required amount of RR.		
The AESO is interested in stakeholder feedback on this recommendation.		

Stakeholder	Stakeholder Comment	Replies
RMP	*RMP is in agreement with this recommendation. RMP would also like to reiterate the suggestion it made regarding the AESO's OR procurement process in the previous section dealing with minimum requirements for RR and SR services.*	
Other		
Stakeholder	**Stakeholder Comment**	**Replies**
RMP	*RMP appreciates the steps AESO is taking as they are outlined in its Recommendation Paper. RMP's comments are meant to be additive to the AESO's recommendations, suggested studies and processes. RMP is heartened by the AESO's acceptance that… "Energy storage covers a wide range of technologies, often with different attributes, that have the potential to provide value to the Alberta Interconnected Electricity System (AIES) by allowing for the storage of energy for use at a later time." RMP urges the AESO to look at all aspects of the potential value that storage can bring to the AIES including, for example, the provision of OR while the storage facility is in generation mode, or storage mode, or both. Another value added service example is a storage facility's ability to provide black start services. In short, RMP believes there is much more value to energy storage than initially meets the eye and we urge the*	

	AESO to undertake a full in-depth assessment of the advantages that storage service facilities can provide to the AIES. Thank you for this opportunity to provide our comments. Jan van Egteren. President.	

Stakeholder Comment and AESO Replies Matrix

Recommendation Paper – Energy Storage Integration

June 18, 2015

The AESO is asking market participants and interested parties to participate in the AESO's consultation regarding the development of Energy Storage Integration. The AESO is seeking comments from stakeholders on the recommendations.

Date of Request for Comment: June 18, 2015	Contact: Jacques Duchesne
Period of Consultation: June 18, 2015 through July 15, 2015	Phone: 403 539-2518
Comments From: Ben Hui	E-mail: jacques.duchesne@aeso.ca
Date [yyyy/mm/dd]: 2015-07-15	

Complete the drafting of and file ISO Rules to address technical and operating requirements for battery storage facilities ("Proposed Battery Facility Rules") with the Alberta Utilities Commission ("AUC").

The AESO is interested in stakeholder feedback on this recommendation.

Stakeholder	Stakeholder Comment	AESO Replies
	Preamble In the Executive Summary, the AESO indicated that the filing of the ISO Rules associated with technical and operating requirements for battery storage facilities is targeted for Q3 2015. It was also indicated that the economic dispatch study's target completion is Q4 2015. **Comment** Would it be anticipated that the outcome of the economic dispatch study to influence the content of the ISO Rules on the technical and operating requirements for battery storage facilities? If so, would the later completion of the economic dispatch study impede on any such changes that need to be made on the ISO Rules?	

Storage facilities operate as generating units when injecting power into the grid and operate as load when purchasing or withdrawing electricity from the transmission system. The storage facility is using the transmission system and is required to pay the just and reasonable costs of the transmission system. An economic dispatch study will be performed to develop ISO tariff treatment options for storage. The study will examine in detail the differences between storage and conventional load and generators.		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**AESO Replies**
	Preamble The AESO discusses in 3.2.2 on what the appropriate tariff of energy storage facilities should be. Under the current tariff, energy storage facilities would be subjected to both STS and DTS (with a low probability of DOS in place of DTS). The AESO also indicated that an operational and economic dispatch study would be undertaken. **Comment** We would encourage the AESO, through this study, to consider the specific operational characteristics that battery energy storage brings to the transmission system. Some examples include: When storage operates as a load, it is different than other loads on the system in that the system can be frequency responsive, can provide voltage regulation (or have a specific reactive power output), can provide a fast MW response with its high ramp rates – and in some cases, converters can provide further 'grid level' services, assisting in improving power quality for example. These functions can aid the AESO in its goal to maintain high reliability of the AIES. Though the power draw and power output of the energy storage facility is similar to that of an equivalent generation and load – it is definitely controllable and thus can potentially work within the constraints of a transmission system. For example, a battery energy storage system can interact with dynamic thermal line rating systems to not exceed existing infrastructure constraints and potentially aid system congestion.	

Maintain the minimum requirement of 15 MW range for regulating reserve (“RR”) and of 10 MW for spinning reserve (“SR”)		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**Replies**
	Preamble The AESO highlighted that smaller resources, if participating in OR products, can decrease the overall frequency response of the Alberta system if the same frequency droop was applied for all participating resources. The AESO further indicated this with an example of a 400MW resource at 5% droop has a response of 133 MW/Hz while a 10 MW resource at 5% droop has a 3.33 MW/Hz response. The AESO indicated in the conclusion of this section that further study (ie. lowering droop requirement) would be required before implementing a reduction in size requirement. **Comment** From the studies that the AESO has undertaken, can the AESO please share the target response level (ie. in MW/Hz) that it would like to achieve for any size of resource in general participating in Operating Reserves product? Would it simply be 5% droop on the minimum generator size currently permitted for the specific OR product? If a smaller resource were to meet the above frequency response via a lower droop, can the AESO please share other technical concerns in permitting smaller resources from participating in the concerned OR products?	
The AESO will revise, where appropriate, ISO Rule 205.4 Regulating Reserve Technical Requirements and Performance Standards, ISO Rule 205.5 Spinning Reserve Technical Requirements and Performance Standards and ISO Rule 205.6 Supplemental Reserve Technical Requirements and Performance Standards and other rules as may be incidentally impacted to reflect how energy storage technology will participate in operating reserve products (RR, SR) and Supplemental Reserve (“SP”)		

The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**Replies**
Examine the performance of current RR providers and assess if changing the current technical requirements and/or introducing new technologies (such as energy storage) could reduce the required amount of RR.		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**Replies**
	Preamble In section 3.3.2, the AESO provided an analysis on the percentage of time that a regulating reserve dispatched at a particular range for a one hour average. The AESO concluded that it intends to continue with the 60-minute requirement for RR service providers. Further in section 3.3.3 the AESO indicated that a project with the NRC will be undertaken to further study OR products. **Comment** Because of the nature of battery energy storage, even the largest battery has a finite amount of energy capacity. Would the AESO consider the limited energy capacity of storage facility as a performance attribute rather than a non-compliance to the existing requirements?	
Other		
Stakeholder	**Stakeholder Comment**	**Replies**

Stakeholder Comment and AESO Replies Matrix

Recommendation Paper – Energy Storage Integration

June 18, 2015

The AESO is asking market participants and interested parties to participate in the AESO's consultation regarding the development of Energy Storage Integration. The AESO is seeking comments from stakeholders on the recommendations.

Date of Request for Comment: June 18, 2015	Contact: Jacques Duchesne
Period of Consultation: June 18, 2015 through July 15, 2015	Phone: 403 539-2518
Comments From: Janene Taylor, TransCanada Energy Ltd. (TCE)	E-mail: jacques.duchesne@aeso.ca
Date [yyyy/mm/dd]: 2015/07/15	

Complete the drafting of and file ISO Rules to address technical and operating requirements for battery storage facilities ("Proposed Battery Facility Rules") with the Alberta Utilities Commission ("AUC").
The AESO is interested in stakeholder feedback on this recommendation.
Stakeholder Comment TCE agrees that the technical requirements for energy storage to connect and operate are a priority. TCE supports the AESO's approach to apply similar connection requirements to battery facilities as synchronous generating units.
Storage facilities operate as generating units when injecting power into the grid and operate as load when purchasing or withdrawing electricity from the transmission system. The storage facility is using the transmission system and is required to pay the just and reasonable costs of the transmission system. An economic dispatch study will be performed to develop ISO tariff treatment options for storage. The study will examine in detail the differences between storage and conventional load and generators.
The AESO is interested in stakeholder feedback on this recommendation.
Stakeholder Comment

In principle, TCE supports tariff treatment of Energy Storage (ES) facilities that would charge location–based costs of losses and other charges applicable to generators when energy storage facilities supply energy to the grid; as well as for the just and reasonable costs of the transmission system when energy is withdrawn from the system into an ES facility. TCE further agrees that ES facilities that are participating in the energy market should be precluded from regulated recovery of costs in order to maintain a level playing field.

Although TCE supports treating ES facilities as generating units and loads under the tariff, TCE agrees the AESO should carry out an operational and dispatch study to review the appropriateness of applying the STS and DTS rates, as they are currently defined, to ES facilities. Due to the interaction of the tariff with the energy market, transmission cost causation is affected by the application of at least some of the ISO market rules (ISO Rules). Although not explicitly stated in the paper, it appears that the study objectives listed in Section 3.2.3 are defined broadly enough to consider the impact of the ISO Rules on the operation and dispatch of ES facilities and the resultant effect on the market and operation of the AIES, including electric system costs. TCE encourages the AESO to consult with industry on the assumptions being made regarding the application of the ISO Rules in the operational and dispatch study.

For example, in determining the appropriateness of applying Rate DTS to ES facilities, the AESO may want to consider how it intends to apply Rule 302.1 Transmission Constraint Management (TCM), as the TCM Rule uses the tariff rate classes to determine curtailment priority in the energy market in the presence of transmission constraints.

Likewise, in determining the appropriateness of applying Rate STS to ES facilities, the AESO should consider how the application of ISO Rules, such as the Energy Submission Rules (Must Offer, Must Comply (MOMC), T-2, and Acceptable Operational Reasons) will impact the costs that ES facilities have on the transmission system.

In its comments on the Energy Storage Integration Discussion Paper, TCE stated that ES facilities, with the ability to forecast and control energy output, should be treated similarly to conventional generation particularly with respect to the MOMC and Outage Reporting requirements. That is, ES facilities should be required to set their AC in a manner that requires them to sustain a level of production equal to their AC for an entire energy “offer interval”, which is currently one hour. If ES facilities are treated similarly to conventional generation, TCE expects that the results of the operational and dispatch study would show operational and cost impacts similar to conventional generation.

Previously, TCE provided substantive comments on the impact of the T-2 lockdown period and the use of AOR’s on ES facilities.[1] TCE does not intend to repeat all of those comments here but would simply reiterate its view that the application of the Energy Submission Rules, such as the T-2 lock-down period and the use of AORs, could impact the operational and dispatch characteristics of an ES facility, thereby affecting the Rate classification.

[1] TCE Comments AESO Energy Storage Discussion Paper http://www.aeso.ca/downloads/Energy_Storage_Discussion_Paper_TCE_Comments.pdf

In summary, TCE supports the development and application of ISO Rules that maintain fair treatment among DTS and/or STS customers. Further, an assessment of the application of certain ISO Rules is required in order for the operational and dispatch Study to accurately determine the operational and cost impacts of ES relative to conventional load and generation, the resultant effect on electric system costs and the appropriate tariff treatment relative to conventional load and generation.
Maintain the minimum requirement of 15 MW range for regulating reserve ("RR") and of 10 MW for spinning reserve ("SR")
The AESO is interested in stakeholder feedback on this recommendation.
Stakeholder Comment
TCE agrees that based on the results of the sensitivity studies performed by the AESO reducing the minimum size requirement to provide Spinning Reserve or Regulating Reserve is not appropriate.
The AESO will revise, where appropriate, ISO Rule 205.4 Regulating Reserve Technical Requirements and Performance Standards, ISO Rule 205.5 Spinning Reserve Technical Requirements and Performance Standards and ISO Rule 205.6 Supplemental Reserve Technical Requirements and Performance Standards and other rules as may be incidentally impacted to reflect how energy storage technology will participate in operating reserve products (RR, SR) and Supplemental Reserve ("SP")
The AESO is interested in stakeholder feedback on this recommendation.
Stakeholder Comment
TCE supports the development of technical requirements for existing products such that they are technologically neutral.
Examine the performance of current RR providers and assess if changing the current technical requirements and/or introducing new technologies (such as energy storage) could reduce the required amount of RR.
The AESO is interested in stakeholder feedback on this recommendation.
Stakeholder Comment
Other

Stakeholder	Stakeholder Comment	Replies

Stakeholder Comment and AESO Replies Matrix

Recommendation Paper – Energy Storage Integration

June 18, 2015

The AESO is asking market participants and interested parties to participate in the AESO's consultation regarding the development of Energy Storage Integration. The AESO is seeking comments from stakeholders on the recommendations.

Date of Request for Comment: June 18, 2015	Contact: Hameed Zaman
Period of Consultation: June 18, 2015 through July 15, 2015	Phone: 403 267-3715
Comments From: TransAlta	E-mail: Hameed_zaman@transalta.com
Date [yyyy/mm/dd]: 2015/07/15	

Complete the drafting of and file ISO Rules to address technical and operating requirements for battery storage facilities ("Proposed Battery Facility Rules") with the Alberta Utilities Commission ("AUC").		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**AESO Replies**
TransAlta	1. TransAlta supports the drafting and filing of the technical and operating requirements for battery storage facilities.	

Storage facilities operate as generating units when injecting power into the grid and operate as load when purchasing or withdrawing electricity from the transmission system. The storage facility is using the transmission system and is required to pay the just and reasonable costs of the transmission system. An economic dispatch study will be performed to develop ISO tariff treatment options for storage. The study will examine in detail the differences between storage and conventional load and generators.

The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**AESO Replies**
TransAlta	2. TransAlta supports the AESO studying the tariff treatment of energy storage facilities to the extent there aren't perverse incentives created if the AESO does pursue the implementation of alternative tariff treatments.	
Maintain the minimum requirement of 15 MW range for regulating reserve ("RR") and of 10 MW for spinning reserve ("SR")		
The AESO is interested in stakeholder feedback on this recommendation.		
Stakeholder	**Stakeholder Comment**	**Replies**
TransAlta	3. *The AESO states that it "…would not permit at this time reducing the capacity to provide spinning and regulating reserves..." and also that "…a 7.5 MW battery facility is able to provide 15 MW of RR range when sourcing or sinking real power." TransAlta requests clarification on whether or not this means that a battery of size 7.5 MW would qualify for the provision of RR?* 4. *Additionally, when a battery is providing RR, would it be allowed to specify a range around charging/discharging? For example, a 5 MW block of RR provided by either charging at 0 MW or*	

	charging at 5 MW with the average being 2.5 MW charges. Or 2.5 MW of RR provided by generating at 2.5 MW or charging at 2.5 MW, with the average being 0 MW.	

The AESO will revise, where appropriate, ISO Rule 205.4 Regulating Reserve Technical Requirements and Performance Standards, ISO Rule 205.5 Spinning Reserve Technical Requirements and Performance Standards and ISO Rule 205.6 Supplemental Reserve Technical Requirements and Performance Standards and other rules as may be incidentally impacted to reflect how energy storage technology will participate in operating reserve products (RR, SR) and Supplemental Reserve ("SP")

The AESO is interested in stakeholder feedback on this recommendation.

Stakeholder	Stakeholder Comment	Replies
TransAlta	*5. TransAlta is of the view that wholesale changes to the market design should not be implemented to accommodate any one kind of asset type. TransAlta recommends an approach similar to the one taken for the integration of wind where the unique characteristics of the new technology were accommodated in the context of the market design.*	

Examine the performance of current RR providers and assess if changing the current technical requirements and/or introducing new technologies (such as energy storage) could reduce the required amount of RR.

The AESO is interested in stakeholder feedback on this recommendation.

Stakeholder	Stakeholder Comment	Replies
TransAlta	*6. TransAlta requests that the AESO*	

	provide more information on the NRC study such as assumptions made and the scenarios being studied. Generally, TransAlta supports the goal of efficiently managing system reliability based on system needs but is unable to comment without more information on what the product structures and procurement mechanisms could look like. In recent experience, the reduction in the amount of contingency reserves the AESO procures as well as LSSi arming requirements have led to many instances where the system has had insufficient contingency reserves. TransAlta cautions against reducing RR simply as a means of reducing costs and any change should be well thought out so as to avoid unintended consequences for system reliability or the FEOC operation of the markets. TransAlta also requests that the AESO provide a ballpark timeframe for such a change, i.e. 3, 5 or 10 years.	

Other		
Stakeholder	**Stakeholder Comment**	**Replies**