



AESO Energy Storage Roadmap

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Executive summary

The AESO Energy Storage Roadmap sets out a plan to facilitate the integration of energy storage in Alberta.

The Alberta Electric System Operator (AESO) is mandated to promote the fair, efficient and openly competitive exchange of electric energy. The current regulatory framework (regulation, legislation and policy) supports a traditional model, where electricity is produced by generators and transported through transmission and distribution systems to customers who purchase the electricity.

Legislation, regulations and AESO Authoritative Documents do not currently contemplate the integration of energy storage technologies to the Alberta Interconnected Electric System (AIES).

MOTIVATION FOR CHANGE

Level playing field

- Alberta policy, legislation and regulations lack clarity and specificity with regard to energy storage
- The unique attributes of energy storage facilities are not the same as loads or generators, as currently contemplated in the AESO Authoritative Documents, resulting in a lack of clarity in the application of those documents
- Energy storage does not currently enjoy the same ease of connection as other assets

Value and benefits

- Energy storage can optimize intermittent generation
- Energy storage could reduce costs to AIES infrastructure through transmission and distribution deferral, resulting in potential cost benefits to customers
- Fast frequency response from energy storage can enable reductions in required volumes of certain ancillary services, resulting in potential cost benefits to customers

Other jurisdictions

- Other jurisdictions have developed (or are developing) processes and rules to incorporate energy storage technologies and services into their regulatory and market frameworks

In March 2019, seven market participants received funding from Emissions Reduction Alberta (ERA) for their proposed energy storage facility projects. Four market participants have submitted requests to connect their energy storage facilities to the AIES with 2020-21 in-service dates (ISDs). There are currently no energy storage facilities participating in the energy or ancillary services markets.

The *Energy Storage Roadmap* sets out the AESO's plan to facilitate the integration of energy storage technologies into AESO Authoritative Documents and the AESO grid & market systems. This will improve the clarity required for market qualification and participation, and enable efficient, effective connection, monitoring and control of energy storage facilities when connected.

The *Energy Storage Roadmap* content has been built off a strong foundation of pre-existing work led by the AESO, dating back to 2012, with insights from a range of stakeholders including storage proponents, and owners of generating facilities, transmission facilities and electric distribution systems.

The successful implementation of the *Energy Storage Roadmap* is led at the Vice President (VP) level within the AESO, ensuring cross-functional enablement and coordination.

The *Energy Storage Roadmap* includes the internal collaboration required to provide clarity for the active connection projects within the framework of the existing legislation and AESO Authoritative Documents, to meet in-service dates starting in mid-2020. The long-term integration of energy storage forms a key part of the *Energy Storage Roadmap*. This specifically covers the development of all supporting documentation for recommended changes to AESO Authoritative Documents, considers the stakeholder engagements and Alberta Utilities Commission (AUC) proceeding timelines required to achieve AUC approvals and longer-term AESO grid & market system changes.

The AESO energy storage team has completed an important step in enabling energy storage in Alberta by assessing the current state; looking to a potential future state, and starting to determine the work needed to bridge the gap. The *Energy Storage Roadmap* sets the stage to facilitate integration of energy storage in Alberta.



- **Authoritative Documents** is the general name given by the AESO to categories of documents made by the AESO under the authority of the *Electric Utilities Act* and regulations, and that contain binding legal requirements for either market participants or the AESO, or both. AESO Authoritative Documents include: the ISO rules, the Alberta reliability Standards, and the ISO tariff.

Introduction

Energy storage is becoming more prevalent in the electricity industry as renewable penetration continues to increase and technology cost curves continue to decline.

The AESO's *Dispatchable Renewables and Energy Storage (DR&S)* report, published in September 2018, included a recommendation that the AESO develop an energy storage roadmap.

A set of principles for energy storage have been developed to guide the development of this *Energy Storage Roadmap*. The primary principles are:

- The AESO will facilitate integration of energy storage
- Energy storage will be approached as a unique asset type; it is neither a load nor a generator
- The AESO will be impartial to energy storage technology, configuration and point of connection

Subsequent to the publication of the *DR&S* report, seven projects received funding from ERA in March 2019 for energy storage installation proposals. System Access Service Requests (SASRs) have been submitted for four projects, which have requested 2020-21 ISDs.

The AESO's current operating parameters and ISO rules do not fully contemplate energy storage and, as a result, moving these projects through the AESO's Connection Process is difficult and time consuming for all parties.

The *Energy Storage Roadmap* sets out a plan to facilitate the integration of energy storage technologies into AESO Authoritative Documents. This will improve the clarity required for:

- Market qualification
- Market participation
- Efficient, effective connection, monitoring and control of these assets

➤ “The U.S. energy storage industry delivered record deployments in 2018, driven by a strong fourth quarter for utility-scale projects... an expected doubling in 2019, followed by a tripling in 2020.”

Wood Mackenzie U.S. Energy Storage Monitor Q2 2019

BACKGROUND

In February 2018, the Federal Energy Regulatory Commission (FERC) released Order 841 that states:

“The FERC is amending its regulations under the *Federal Power Act* (FPA) to remove barriers to the participation of electric storage resources in the capacity, energy, and ancillary service markets operated by Regional Transmission Organizations (RTO) and Independent System Operator (ISO) (RTO/ISO markets). Specifically, we require each RTO and ISO to revise its tariff to establish a participation model consisting of market rules that, recognizing the physical and operational characteristics of electric storage resources, facilitates their participation in the RTO/ISO markets.

The participation model must:

- (1) ensure that a resource using the participation model is eligible to provide all capacity, energy, and ancillary services that the resource is technically capable of providing in the RTO/ISO markets
- (2) ensure that a resource using the participation model can be dispatched and can set the wholesale market clearing price as both a wholesale seller and wholesale buyer consistent with existing market rules that govern when a resource can set the wholesale price
- (3) account for the physical and operational characteristics of electric storage resources through bidding parameters or other means
- (4) establish a minimum size requirement for participation in the RTO/ISO markets that does not exceed 100 kW”

Although the AESO is not mandated to follow FERC Orders, Order 841 provides a clear direction as to where the U.S. is headed with regard to facilitating the integration of energy storage.

Currently across the U.S. and other global jurisdictions, energy storage technologies are being considered and installed for many purposes, including:

- Energy price arbitrage
- Ancillary services
 - Operating reserve including regulation, spinning, non-spinning (also known as supplemental)
 - Load shed services
 - Black start services
- Transmission and distribution investment deferral
- Voltage and frequency support
- Back-up supply
- Enabling intermittent generation dispatch
- Emissions reduction

Roadmap approach

The AESO's VP led, cross-functional, energy storage team developed the Energy Storage Roadmap, and is responsible for facilitating the integration of energy storage technologies across the AES.

PURPOSE

The *Energy Storage Roadmap* and AESO's energy storage team have been established to:

- Facilitate the integration of energy storage technologies across the AES
- Enable energy storage to participate in a reliable and fair, efficient and openly competitive (FEOC) manner
- Ensure consistency in principles and approach to energy storage across the AESO

PROCESS

The *Energy Storage Roadmap* content has been established on a strong foundation of existing work led by the AESO, dating back to 2012. Insights have been provided from a range of stakeholders including storage proponents, and owners of generating facilities, transmission facilities and electric distribution systems.

As energy storage impacts most of the work streams across the AESO, the roadmap has been led centrally by a cross-functional energy storage team.

Within the team, four integration pillars of energy storage have been created, grouped based upon close interdependencies.

The energy storage team has:

- Reviewed past internal work and jurisdictional reports
- Documented the current state of energy storage across the AESO
- Contemplated energy storage in a potential future state
- Developed actions to bridge gaps between the current and future state

The actions identified to bridge the gaps between current and future states were used to develop an integrated plan, combining interdependencies and expected timing for implementation. The integrated plan is detailed on page 20 and a graphic version is attached in Appendix 1.

The integrated plan considers existing work and projects that may be leveraged to accelerate energy storage integration, such as:

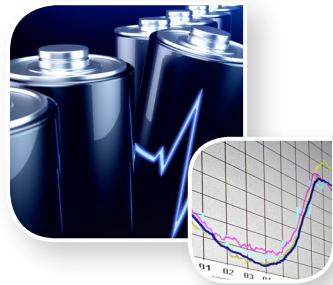
- 2020 ISO tariff
- Energy Management System (EMS) upgrades
- Information Technology (IT) system changes for energy and ancillary services (EAS)
- Market roadmap

The *Energy Storage Roadmap* implementation will also include stakeholder engagement and potential working groups will be identified as required.

➤ **Energy storage ‘working’ definition**

To ensure a consistent approach to energy storage across the work streams, the AESO and the Government of Alberta (GoA) reviewed other jurisdictional definitions and developed the following ‘working’ definition for energy storage:

“Energy storage is any technology or process that is capable of using electricity as an input, storing the energy for a period of time and then discharging electricity as an output.”



- “From 2012 to 2017, battery costs fell more than 15 per cent per year, for a total five-year drop of more than 50 per cent ... The cost of a utility-scale system declined by more than 20 per cent per year mostly due to falling balance-of-system costs.”

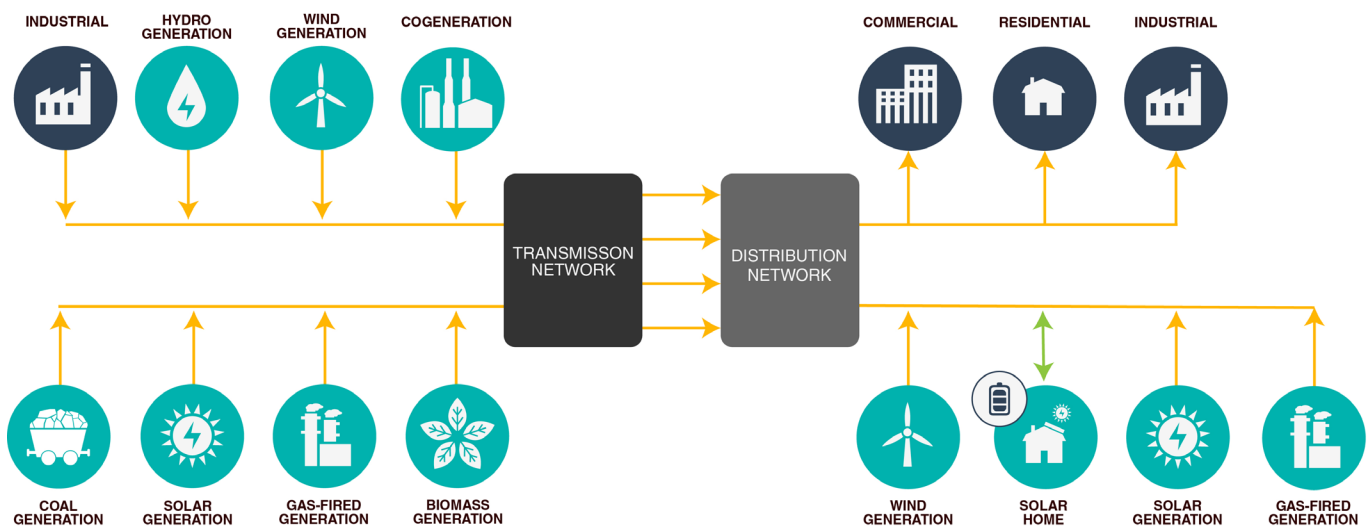
McKinsey & Company: The new rules of competition in energy storage

Current state

Industry around the world continues to invest in research and development to further reduce costs and improve capabilities, building significant momentum that is driving energy storage technology forward.

Today, Alberta does not have any transmission-connected energy storage. The current electric system is illustrated in Figure 1:

Figure 1: AIES current-state diagram



**While energy storage is visually depicted as a battery icon graphic, it is intended to represent multiple energy storage technologies.*

Under the current market framework, in order for energy storage to participate in Alberta's electricity markets, it needs to be treated as a generator and/or a load. While the current legislative framework does not prohibit the participation of energy storage in the EAS markets, in practice the existing legislation, regulations and AESO Authoritative Documents do not fully contemplate the unique attributes and challenges associated with energy storage participation on the AIES.

As laid out in its 2018 ISO tariff application, the AESO is engaging stakeholders in a review of the bulk and regional tariff design and this review will consider applicable tariffs or opportunity services as they may relate to energy storage (or other technologies).

AESO forecasting models and transmission planning processes do not consider energy storage, and will need to be modified to include energy storage operating parameters, configurations and capital costs.

The ancillary services markets requires market participants to comply with technical qualification parameters and market rules that were originally developed without energy storage technologies in mind.

The current ISO rules, technical standards, and procedures do not contemplate hybrid assets that combine energy storage with a different technology, such as intermittent generation. The result is a lack of clarity on how to treat proposed hybrid assets that are in the AESO's connection queue.

With the AIES having no transmission-connected energy storage facilities, there are currently no operating results in Alberta demonstrating energy storage capabilities, performance or value.



Integration pillars to enable energy storage

The market systems and ISO rules will enable operators of energy storage facilities to easily and clearly offer into and operate their assets in the markets.

The four integration pillars of energy storage enablement – Transmission, Markets, Tools and Regulatory – have been developed to provide focus as the AESO progresses this complex initiative. Figure 2 shows the focus of the energy storage pillars and the work streams.

The work streams have interdependencies that have been identified and integrated as required.

Figure 2: Integration pillars of energy storage enablement

ENERGY STORAGE



Transmission

Forecasting & Market Analytics
Transmission Planning
Transmission Engineering & Standards
Transmission Connection

Markets

Market Design
Tariff Design
Operations Planning & Engineering

Tools

Operations Systems
Grid & Market Operations
Finance & Settlement
IT Systems

Regulatory

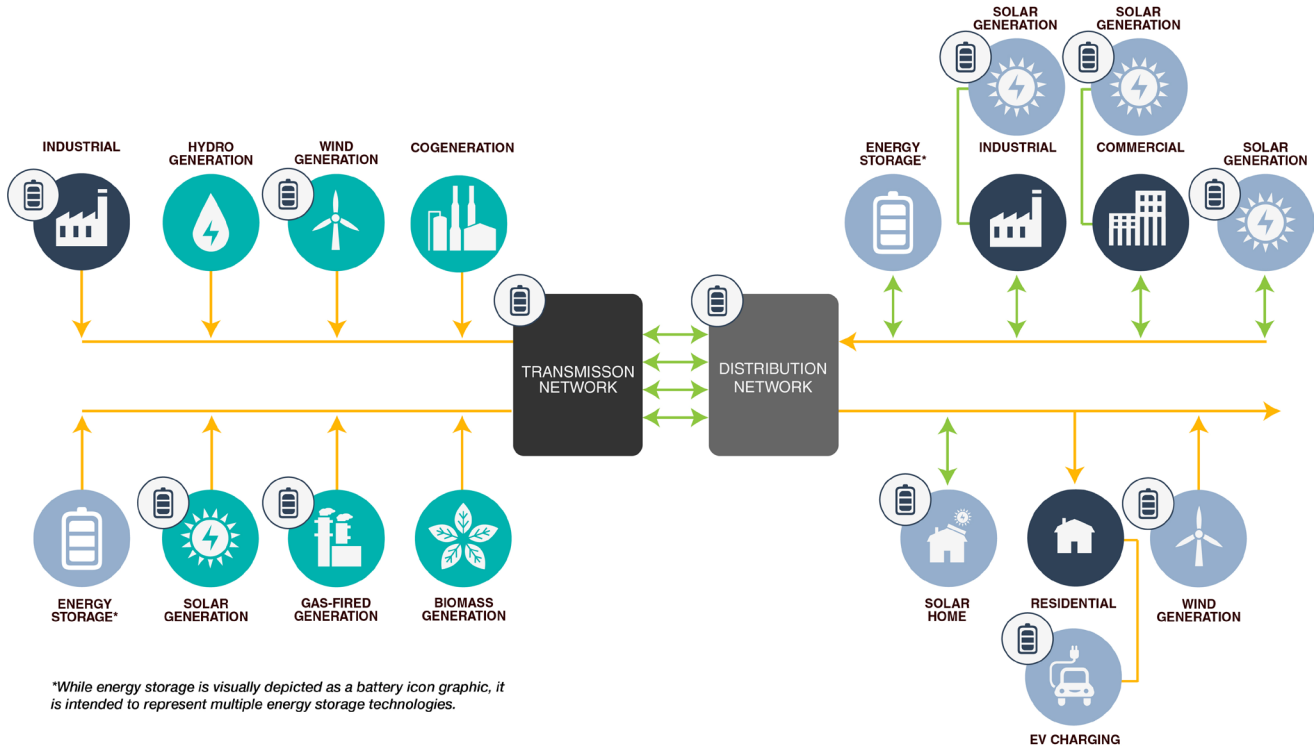
Legal & Regulatory

➤ Potential future state

Energy storage has many different applications and attributes. The application may look like generation, load, transmission or distribution. Figure 3 attempts to illustrate all of these future applications and combinations, with two-way flows prevalent across the network.

For each work stream, the AESO has considered the potential future state integration implications and the corresponding actions that will help to close the gaps.

Figure 3: Potential future state diagram





INTEGRATION PILLAR - TRANSMISSION

The transmission pillar is set up to include the following work streams:

- Forecasting & market analytics
- Transmission planning
- Transmission engineering & standards
- Transmission connection

These four work streams are accountable for the development of the AESO's Long-term Outlook (LTO) and Long-term Transmission Plan (LTP). The LTO is a 20-year forecast of AIES load and generation. The LTP provides general timing and location of transmission facilities required for the next 20 years, and also indicates where there is forecasted transmission capacity available. Transmission engineering and standards specify the functional requirements in transmission projects, develop ARS, technical ISO rules, and provides modelling and metering support, including the calculation of loss factors on the AIES.

➤ Forecasting & market analytics - potential future state

In the future, LTOs will include energy storage as a technology, if it is deemed probable to develop in Alberta during the LTO time period. Updated energy storage cost information, technology adoption trends seen in other, similar jurisdictions and in high probability locations across the AIES (including on electric distribution systems) where intermittent generation exists or is growing will be considered when evaluating the inclusion of energy storage in the LTO.

In the long term, forecasting will fully integrate energy storage into models and methodologies in the LTO. Suitable forecast modelling software will be in place and the required energy storage models will be developed to incorporate energy storage cost models as well as operational performance and behaviour models. A process will be in place to ensure cost models for energy storage technologies are updated for the forecasting work stream and used across the AESO, together with operational and performance data from actual installations. Although key in the transmission pillar, forecasting & market analytics will support all integration pillars.

Bridging the gap

- Develop energy storage forecasting models
- Define the hourly storage profiles for energy storage forecasting into the future
- Develop a process to incorporate actual operating data from energy storage facilities in Alberta
- Gather cost information and develop models for various energy storage technologies for consideration in future LTOs
- Determine the optimal approach to model and analyze ancillary services

➤ **Transmission planning - potential future state**

In the future, LTPs will fully integrate energy storage on the transmission and distribution networks through the planning process, including developing the appropriate methodologies and models. Energy storage will be considered as one of the solutions used by the transmission planning work stream when considering the need for new transmission.

The AESO central power system model will include modelling of energy storage. These power system models will reflect, as appropriate, asset capabilities such as voltage support, fault current contribution and frequency support. As market participants connect energy storage, more information to reflect the operating model (specifically, the planned charging and discharging cycles, volumes, durations, etc.) will allow the transmission planning work stream to more appropriately include energy storage into the LTPs for a more realistic outlook at grid capacity and areas requiring expansion.

Transmission planning will develop consistent and clear criteria and guidelines that enable further consideration of energy storage applications in Alberta from a system perspective.

Bridging the gap

- Develop technical guidelines to run the power system model under specific forecast and system conditions that incorporate energy storage for system reliability studies
- Include energy storage into the next LTP for market participation and various planning solution options
- Explore the use of energy storage as a potential solution for transmission deferral

➤ **Transmission engineering & standards - potential future state**

In the future, the AESO central power system model will include modelling of the various energy storage technologies and configurations from transmission-connected assets to distribution-connected assets. These models must include the full asset capabilities such as voltage support, fault current contribution, and frequency support as these abilities are impacted by the distance between the asset-connection point and the transmission-connection point.

Bridging the gap

- Within the power system model, develop models required for energy storage technologies with operating parameters for use by the transmission planning and transmission connection work streams
- Establish metering practices for energy storage facilities
- Determine loss factor methodology for energy storage facilities, if any
- Consider if the following ISO rules should be technology neutral instead of remaining specific to batteries, or if separate ISO rules for other energy storage technologies should be written:
 - Section 502.13 of the ISO rules, *Battery Energy Storage Facility Technical Requirements*
 - Section 502.14 of the ISO rules, *Battery Energy Storage Facility Operating Requirements*
- Update Alberta Reliability Standards, if applicable

➤ **Transmission connection - potential future state**

In the future, additional energy storage information will be requested from proponents in the SASR forms to ensure all data required for the connection is available to the AESO. Connection study results will demonstrate the effects related to charging and discharging the energy storage facility to that node location under various scenarios.

With the potential for a large number of energy storage assets connecting to the distribution system of the AES, a process for improved collaboration and integration with distribution facilities owner (DFO) planning will be in place.

Bridging the gap

- Update SASR form to gather the required information for energy storage
- Create study scenarios reflecting a series of credible, stress-tested models for energy storage
- Develop technical assessment methodology to guide the technical planning and operational dispatch of energy storage assets in models and studies
- Build a process for improved collaboration and integration with DFO planning groups





INTEGRATION PILLAR - MARKETS

The markets pillar includes the following work streams:

- Market design
- Tariff design
- Operations planning & engineering

At the AESO, the market design work stream is responsible for the design and evolution of Alberta's electricity market framework. This involves assessing needs in Alberta EAS markets, designing and implementing market changes, and maintaining effective functioning of existing market rules. The market framework is based on legislation, ISO rules, Information Documents and market system tools.

The tariff design work stream ensures that just and reasonable rates, including terms and conditions are designed and implemented, for fair AIES cost recovery, through the ISO tariff for the provision of system access service.

The operations planning & engineering work stream procures operating reserves on a day-ahead basis and performs eligibility assessments of providers seeking to participate in any type of operating reserves. In addition, operations planning & engineering performs technical assessments on the eligibility of service providers in Load Shed Services for imports (LSSi) and Black Start services.



➤ **Market design - potential future state**

In the future, energy storage assets will be able to fairly access markets for which they meet the technical requirements. ISO rules for qualification and participation in the various energy, and ancillary services markets will: provide clarity for energy storage assets given their unique operating characteristics; support the AIES needs for reliability; and, ensure the FEOC operation of the markets.

The market systems and ISO rules will enable operators of these energy storage facilities to easily and clearly offer into and operate their assets in the markets. In addition, the AESO system controllers will have software applications to monitor and control these energy storage facilities in support of power delivery and balancing across the AIES. This will allow for the reliable operation of the system.

Bridging the gap

- Determine and define:
 - system asset types
 - market participation asset types
 - requirements for participation in the EAS markets
 - requirements for hybrid assets in the EAS markets
- Assess whether energy storage installed as a regulated transmission asset should be permitted to participate in electricity markets, and if so, under what rules
- Explore and understand how self-supply should work for energy storage when market participants are charging the asset versus charging from the AIES

➤ **Tariff design - potential future state**

In the future, the AESO will ensure that the unique characteristics of energy storage are considered in ISO tariff applications submitted to the AUC for approval.

The AESO is currently engaged in an ISO tariff consultation process with industry, the outcome potentially leading to new tariff considerations in 2020. The ISO tariff includes multiple transmission system access services; therefore, rate offerings for energy storage could be developed to reflect the value and costs to the transmission system. This will ensure storage has appropriate rate tariffs based on its technology capability and resultant value to the AIES.

Future ISO tariffs will ensure that energy storage pricing signals incent FEOC market behaviour; do not distort the energy or ancillary services markets via cross-subsidies; fairly allocate transmission costs to consumers; and, are aligned with distribution tariffs.

Bridging the gap

- Complete a jurisdictional review on the tariff for energy storage-specific solutions
- Investigate the potential for a separate rate class for energy storage in the 2020 ISO tariff
- Review the demand transmission service (DTS) rate as applied to energy storage assets
- Assess whether a different rate structure is required when energy storage assets are being used to provide system services, such as ancillary services, versus for energy price arbitrage or provision of commercially contracted services with a third party
- Review application of the generating unit owner's contribution (GUOC) to energy storage under current legislation and regulation, and determine if changes are required

➤ **Operations planning & engineering - potential future state**

In the future, when energy storage facilities are operating on the AIES, the AESO will have sustainable processes in place to collect and analyze technical operating data from these facilities. This information will be used to regularly review the technical requirements for market participation and procurement for the ancillary service markets. This will enable the AESO to make appropriate changes to the technical parameters or procurement structure to capture the value generated through the unique attributes that energy storage facilities provide.

Bridging the gap

- Review and ensure there is technical consideration for energy storage technologies as part of any changes considered in the market roadmap
- Determine the reliability benefits of fast-ramping assets
- Review the technical requirements for the ancillary services market and provide recommendations to modify as required
- Review the technical requirements for LSSi participation and assess eligibility of energy storage
- Review the technical requirements for Black Start services to determine the size and duration requirements for technical eligibility



INTEGRATION PILLAR - TOOLS

The tools pillar includes the following work streams:

- Operations systems
- Grid & market operations (GMO)
- Finance & settlement
- IT systems

Operations systems and GMO support the AESO's reliability mandate to ensure the safe and reliable operation of the grid. GMO balances supply and demand for electricity in Alberta, while operations systems supports the grid through modelling, studying and analyzing the AIES and EMS as well as the implementation of market systems tools.

➤ Operations systems - potential future state

In the future, modelling and structure of energy storage assets will be similar, regardless of the application or configuration and with the capability to charge and discharge to the grid. Other changes and functionality on the EMS tools with respect to energy storage will require further investigation pending outcomes of market and tariff design.

Bridging the gap

- Assess how energy storage assets should be modelled and represented in the control room
- Assess possibility of developing a solution with the EMS vendor to model energy storage as a single device across all EMS applications
- Define how supervisory control and data acquisition (SCADA) telemetry monitoring and visibility will be represented on the displays, and how new types of data will be used
- Assess and identify if there is a need for new SCADA-related requirements
- Utilize actual operating data to refine AESO energy storage models
- Assess if the Power Ramp Management tool needs to be modified from its current state

> Grid & market operations - potential future state

In the future, the AESO will have the required ISO rules and operating parameters in place, supported by the legislation and regulations. With this framework as a solid basis, the models and software tools will have been updated to enable fully functioning energy storage resources to be managed and controlled in a manner that facilitates the entire range of operating abilities these assets can provide to the AES.

Bridging the gap

- Explore and answer essential questions around the operating parameters of energy storage
- Real-time operations personnel will require visibility to the energy storage assets and their state-of-charge, with this data incorporated into dispatch support processes to confirm supply adequacy
- Control methods and mechanisms need to be developed to address instances when energy storage operations do not conform to the agreed operating profile
- Assess the possibility of updating market tools to enable appropriate visibility and control of ES facilities
- Study the behaviour of energy storage assets and explore the potential need for a new display

> Finance & settlement and IT systems - potential future state

In the future, Finance & Settlement and IT Systems work streams will have roles and accountabilities that span the AESO, providing support and enablement to all other work streams in the course of implementing changes identified to facilitate energy storage.

Settlement of energy storage will be addressed as market and tariff design decisions are established.





INTEGRATION PILLAR - REGULATORY

The regulatory pillar is set up to include the following work stream:

- Legal & regulatory

This work stream is accountable for the development of AESO Authoritative Documents, including the ISO tariff and ISO rules in accordance with applicable legislation, regulations, and AUC rules.

➤ Legal & regulatory - potential future state

In the future, energy storage facilities will not face unnecessary barriers to integration and the ISO tariff structure will appropriately recognize the unique technical and operating characteristics of energy storage technologies, allowing them to deliver full value to the AIES.

Bridging the gap

- Develop a policy engagement plan with the GoA to help ensure effective engagement on energy storage matters
- Participate with the GoA and other governing agencies to determine an appropriate industry definition for energy storage
- Identify potential changes to AESO Authoritative Documents and Information Documents that may be needed or beneficial to enable energy storage and to enable a coordinated 'one ask' approach versus a 'case by case' approach
- Work with the GoA to determine the priority of potential changes for the purpose of advancing the changes through the established legislative, regulatory, and policy processes, taking into account the impact that these processes may have on the AESO's plans and the timing of energy storage facility connection projects



- In the future, energy storage facilities will not face unnecessary legislative or regulatory barriers to integration.

Integrated plan

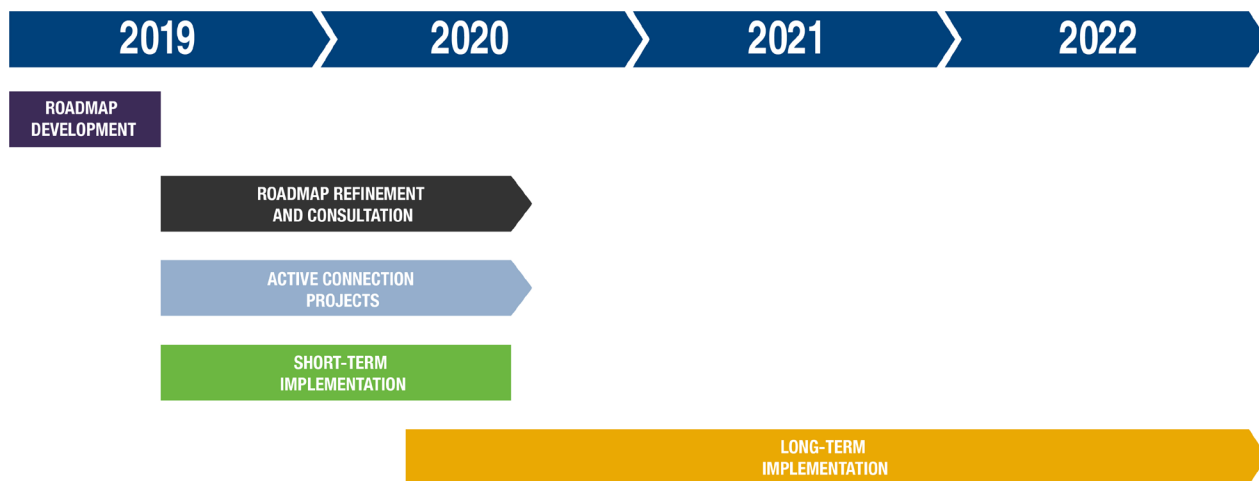
The AESO intends to support and enable active energy storage projects by implementing short-term actions that can be undertaken in parallel with longer-term market framework changes.

The AESO has developed an integrated plan shown in Figure 4. Two deliberate phases of implementation work have been developed to support and enable connection projects requesting 2020-21 in-service dates and other short-term implementation scope. The longer-term implementation specifically covers the development of AESO Authoritative Documents and considers the stakeholder engagements and AUC proceeding timelines and longer-term AESO grid & market systems changes:

- Phase 1 - Short-term implementation (within the next 9 to 12 months)
 - Active connection projects
 - Short-term implementation
- Phase 2 - Long-term implementation (longer than 12 months)

A summary of the phases and their timelines is provided in Figure 4. An integrated project schedule has been developed (see Appendix 1) that provides additional detail on the timing and sequence of the activities described in the following sections.

Figure 4: High-level integrated plan



PHASE 1 - SHORT-TERM IMPLEMENTATION

➤ Active connection projects

The AESO is considering how, in the short term, to provide energy storage projects with clarity for participation in the markets under the existing ISO rules, should energy storage projects come online prior to the implementation of the longer-term changes to the market framework. Information Documents may be required to enable energy storage facilities in the short term.

Specifically, the work that will be completed during this phase is as follows:

1. Internal working sessions to review:

- (a) Use of Acceptable Operating Reasons (AOR)
- (b) Modelling of energy storage in adequacy assessments
- (c) Use of outage reporting processes and forms
- (d) Hybrid asset operation
- (e) Qualification and participation requirements for ancillary services
- (f) Technical and market requirements for participating in multiple markets

2. Initiate the development process of AESO Authoritative Documents and Information Documents as required

3. The AESO will be developing interim system modifications to support in-service dates for active connection projects as required

➤ Short-term implementation

Actions that need to be completed during Phase 1 are as follows:

1. **The AESO will facilitate internal working sessions to answer the following groups of critical questions:**
 - (a) Determine and define selection of asset types and metering requirements
 - (b) Determine and define recommendations on EAS markets participation requirements
 - (c) Determine and define recommendations on hybrid asset participation requirements in EAS
2. **Modification of the SASR form, to improve the collection of connection information required for energy storage assets**
3. **Operations Planning & Engineering will:**
 - (a) Review operating reserve technical parameters
 - (b) Review the LSSi technical requirements
 - (c) Review the Black Start technical requirements
4. **Tariff Design will:**
 - (a) Complete a jurisdictional review on tariffs for energy storage specific solutions
 - (b) Investigate the potential for a separate rate class for energy storage in the 2020 ISO tariff
 - (c) Review application of GUOC to energy storage under current legislation and regulation
5. **Transmission Planning will:**
 - (a) Develop technical guideline to run the power system model under specific forecast and system conditions that incorporates energy storage for system reliability studies
 - (b) Explore the use of energy storage as a potential solution for transmission deferral



PHASE 2 - LONG-TERM IMPLEMENTATION

The activities in this phase will build upon the work completed in Phase 1 and will require external stakeholder engagement and approval by the AUC.

The AESO's current schedule, in Appendix 1, is from 2019 to 2022. Enabling energy storage will continue beyond 2022, primarily as a mature technology in a sustainment phase.

Specifically, the work that will be completed during this phase is as follows:

1. **Completion of studies started in Phase 1**
 - (a) Ancillary services size and duration reviews
 - (b) LSSi and Black Start reviews
2. **Determine and define recommendations on hybrid asset participation requirements**
3. **External engagement on study scopes and resultant findings from the studies for inclusion into the development of the implementation plan, as required**
4. **Development of further ISO tariff changes with all required supporting documentation for engagement and approval**
5. **Development and implementation of forecasting and planning models to support the next LTO and LTP to be published**
6. **Development and implementation of software modifications required for systems control of energy storage**
7. **Development of ISO rules for engagement and AUC approval**



Next steps

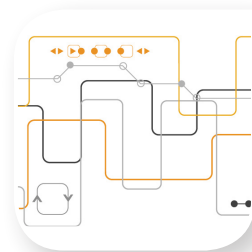
Industry engagement will be a priority over the short term to ensure changes to AESO Authoritative Documents, and ultimately grid and market system changes, successfully enable energy storage in Alberta.

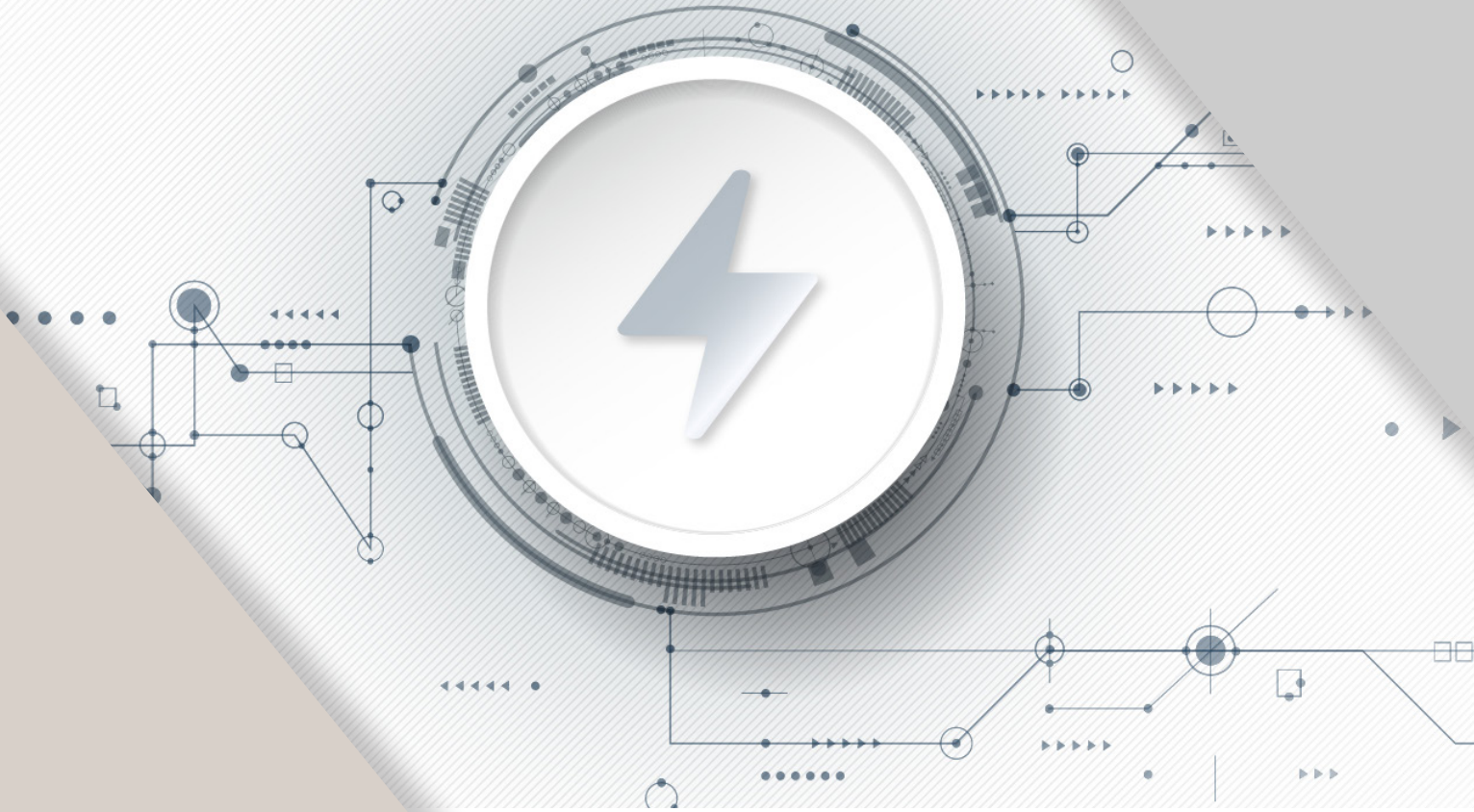
The AESO energy storage team has completed an important step in enabling energy storage in Alberta by assessing the current state, looking to the future state, and starting to determine the work needed to bridge the gap.

In order to continue the implementation of this work the following next steps are proposed:

- Engage with industry and identify working groups, as required
- Action Phase 1 short-term implementation
- Provide clarity to active energy storage connection projects currently in the connection queue

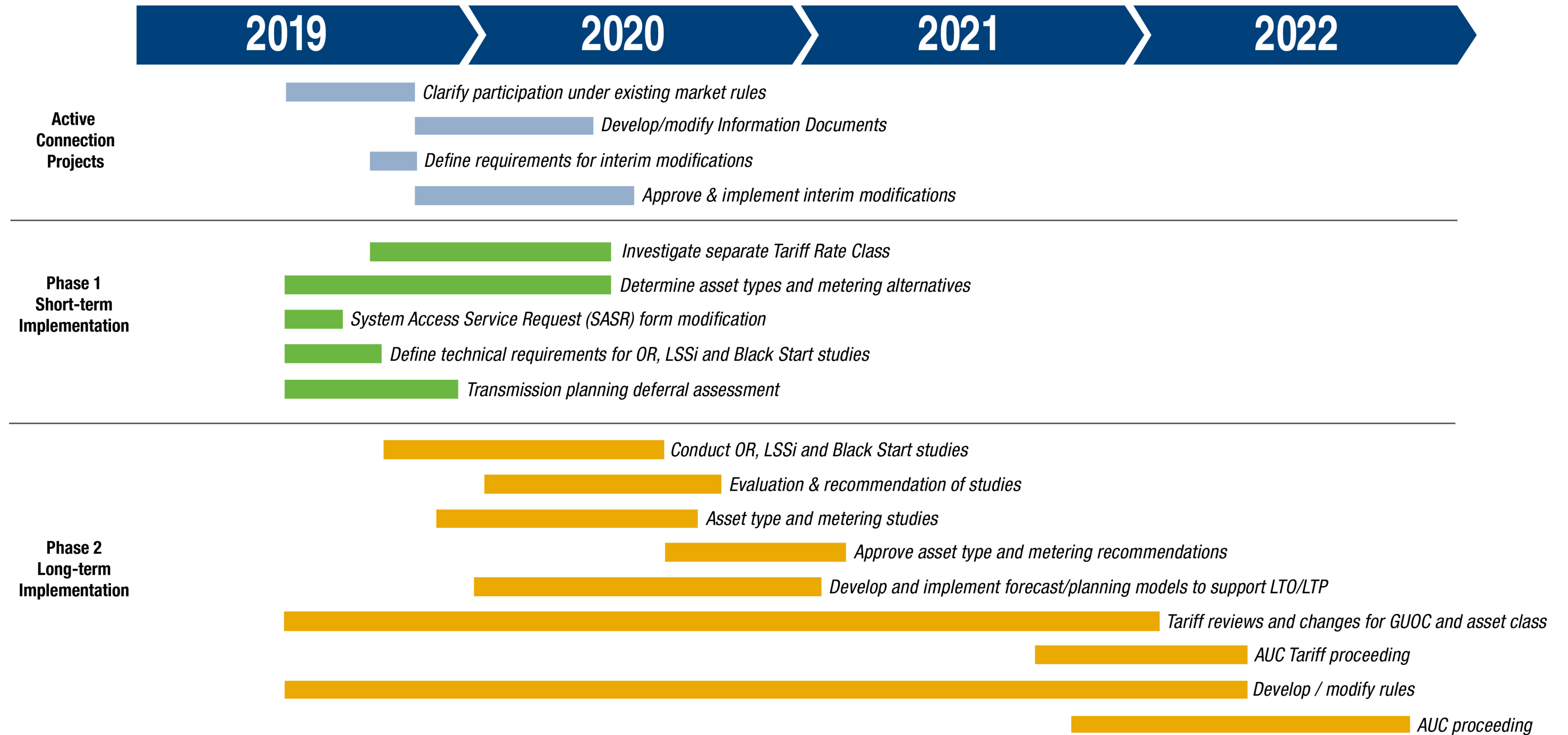
Continued dialogue between industry, government, other agencies, the AUC and the AESO will be required to enable competitive energy storage projects to connect to the AIES and participate in a fair, efficient, and reliable manner.





Appendix 1

Figure 5: Integrated Project Schedule



Alberta Electric System Operator

2500, 330-5th Avenue SW
Calgary, AB T2P 0L4
Phone: 403-539-2450
www.aeso.ca

