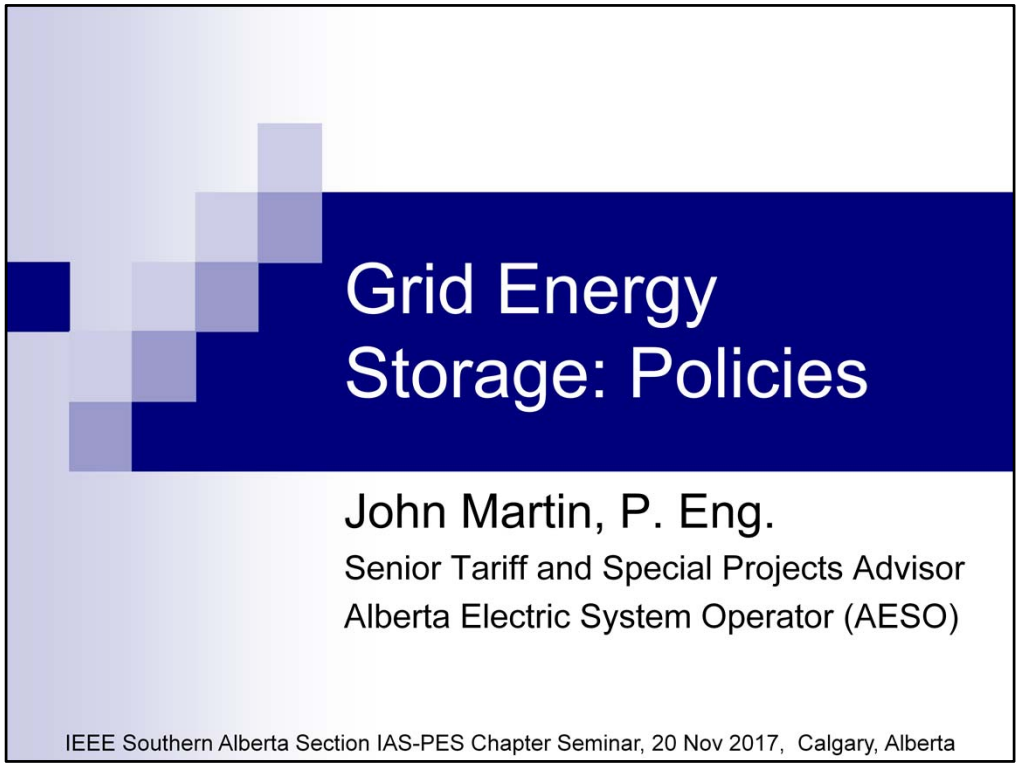
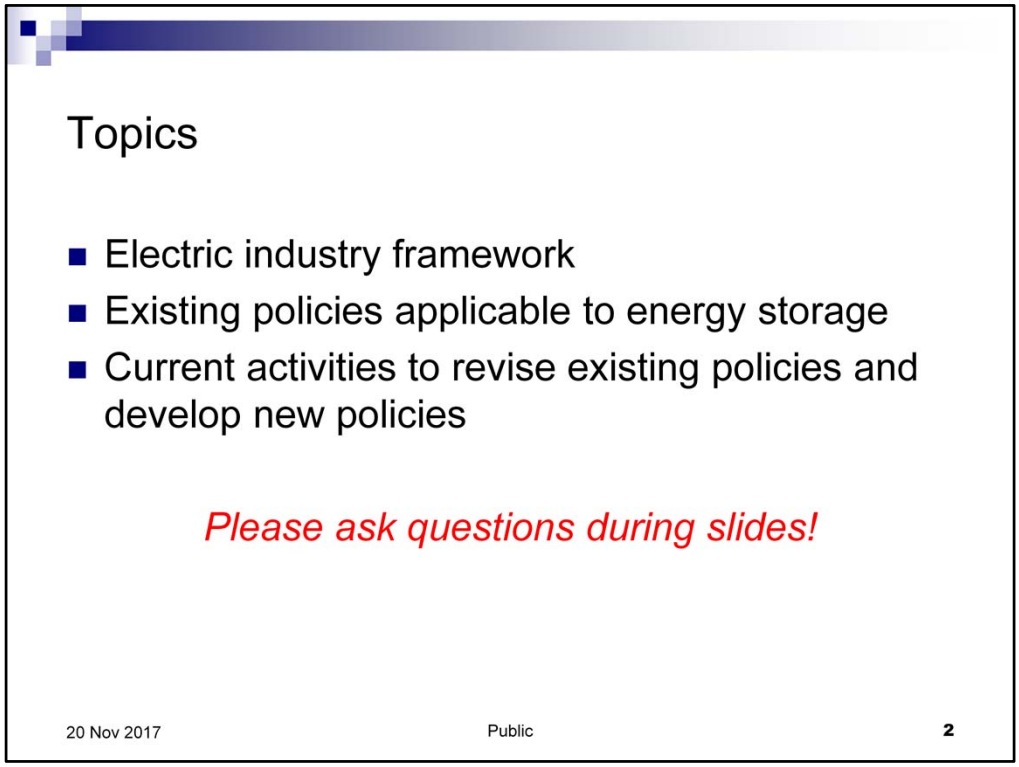


Grid Energy Storage: Policies

By John Martin, P. Eng., Senior Tariff and Special Projects Advisor
Alberta Electric System Operator

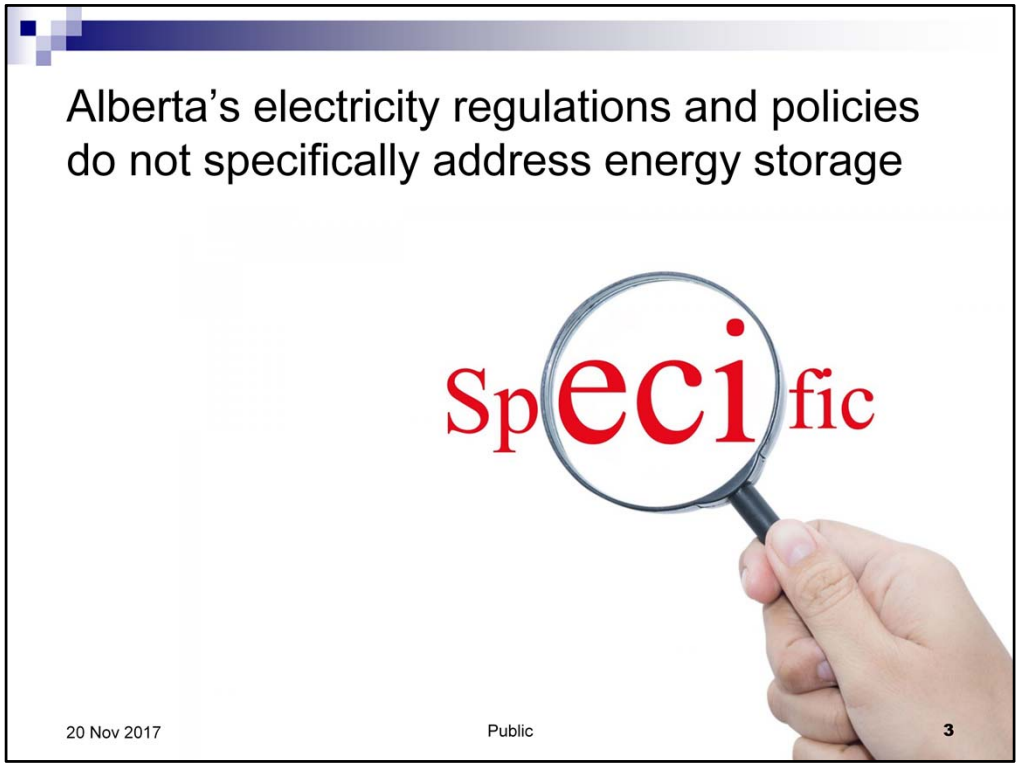
Alberta established the regulatory framework for its electric system when generators and loads were clearly differentiated. Energy storage facilities are blurring those distinctions with their ability to rapidly switch between supplying electricity to the grid and withdrawing electricity from it. Requests to connect energy storage facilities to the transmission system have prompted the Alberta Electric System Operator (AESO) to examine the costs that should be attributed to energy storage facilities, the technical standards with which they must comply, and the rules under which they must operate. The AESO currently has initiatives underway to clarify and, where appropriate, develop tariff provisions, standards, and rules that apply to energy storage facilities. Although the existing regulatory framework provides some guidance, participants in Alberta's electric industry can also contribute to the evolution of grid energy storage policy.



I will first provide general information on the electric industry framework within which energy storage must operate in Alberta. I will then cover some of the existing policies that are applicable to energy storage. I will conclude by reviewing current activities to revise existing policies and develop new ones.

I note that many of the points I cover are also applicable to distributed generation resources, where generation is installed behind the meter at a load site. However, the focus in this presentation will be on grid-connected energy storage.

As well, I will be speaking primarily about energy storage that is connected to the transmission system. Energy storage may also connect to a distribution system, where the distribution system owner would be responsible for requirements for distribution access.

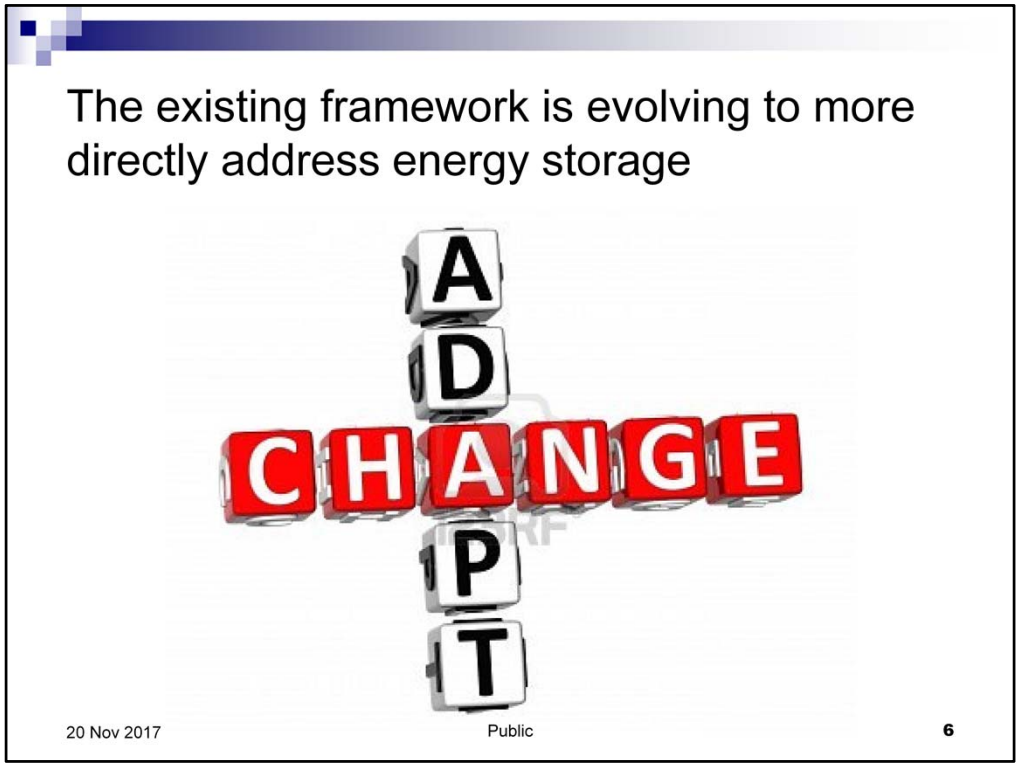


As a starting point, Alberta's electricity regulations and policies do not specifically address energy storage. Those regulations and policies usually assume a facility is either a supplier of electricity — that is, generation — or a consumer of electricity — that is, load. The existing framework does not contemplate a facility that operates like energy storage, supplying electricity in one interval and consuming it in the next.

As a result, you may be wondering where existing policies are sufficient for energy storage and where more clarity is needed.

One challenge in Alberta is that few people are familiar with all aspects of the electric industry. When something like energy storage shows up, it can be difficult to know which existing policies are relevant.

The existing electric industry framework does provide some guidance, but it can be difficult to know where to start. It's also hard to know where a lack of specific provisions may potentially be a problem.



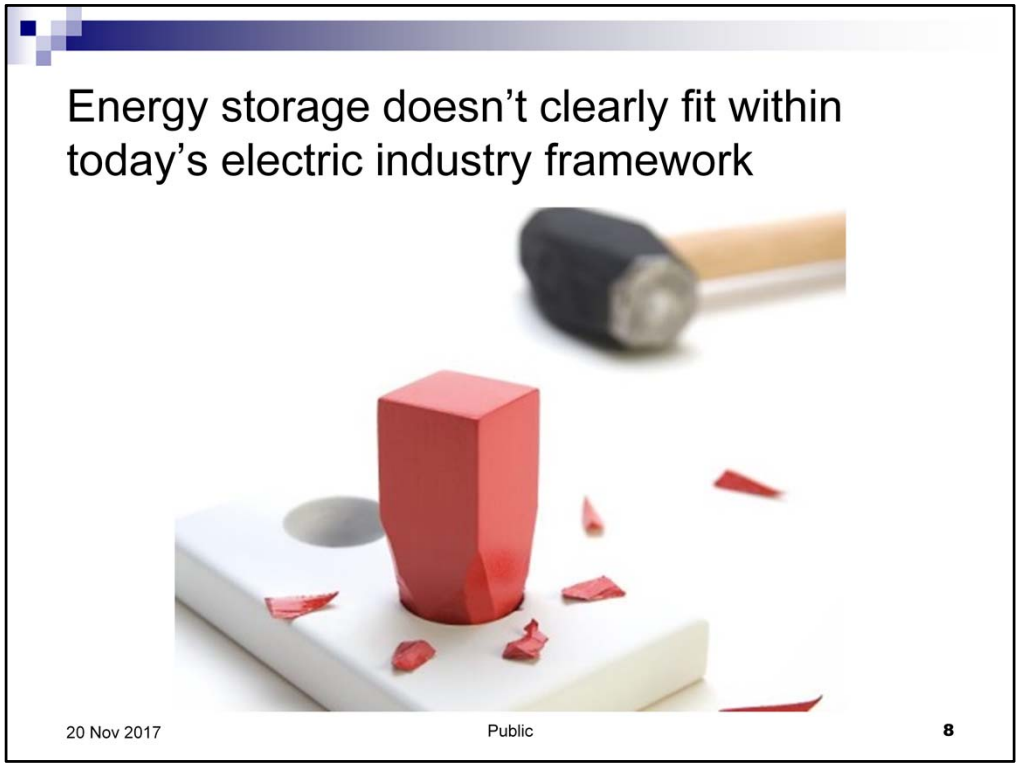
The existing framework is evolving to more directly address energy storage. That evolution is being accomplished in different ways:

- by adapting existing policies to accommodate energy storage;
- by changing policies when they are unnecessarily technology-specific; and
- by creating new policies where they are needed.

Opportunities exist for you to participate in changes to address energy storage

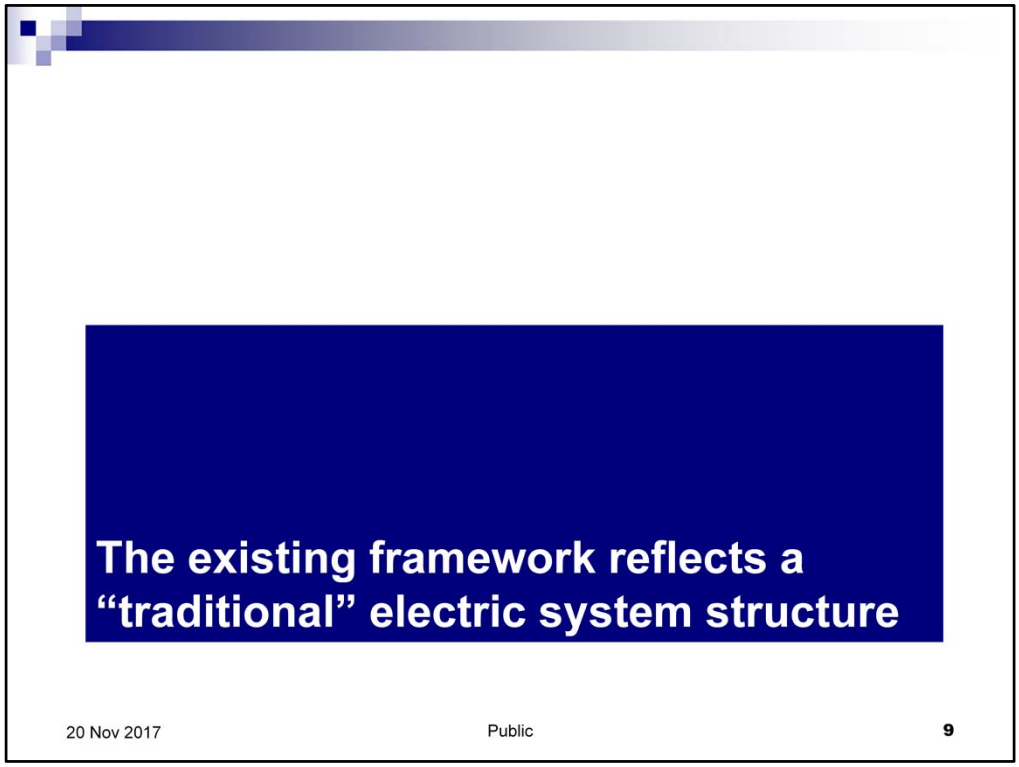
Opportunities exist for you to participate in changes to address energy storage.

For example, you can engage in regulatory proceedings or consultations specifically dealing with energy storage policies or you can comment on larger-scale initiatives to ensure energy storage is considered in their development.

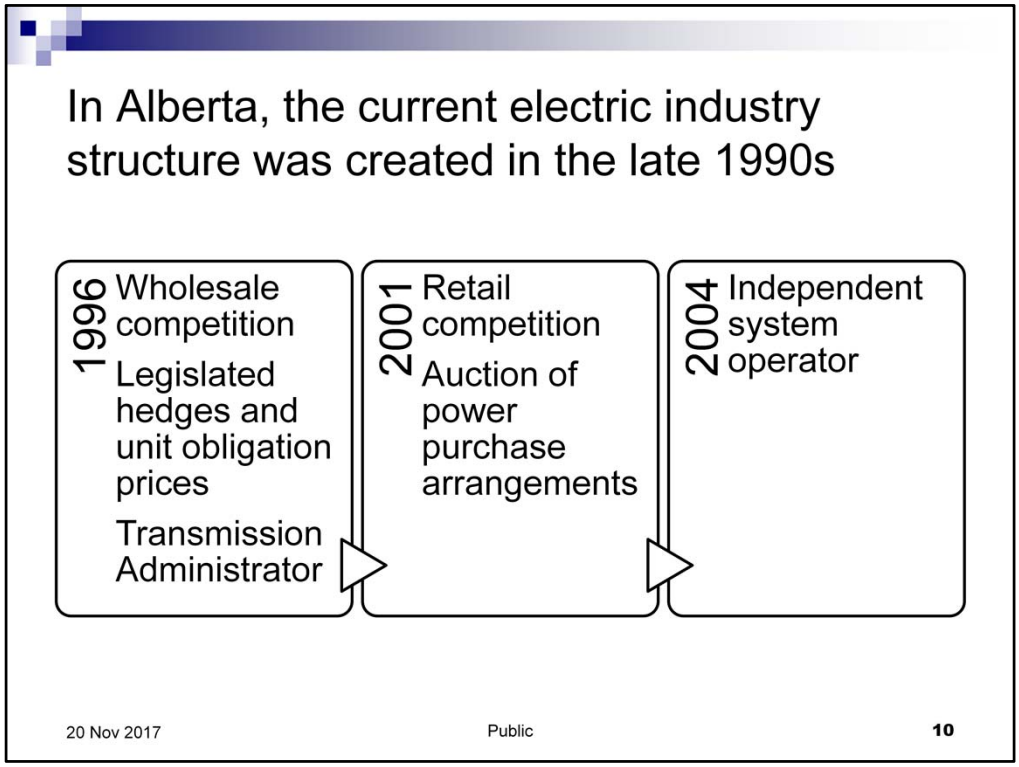


Let's begin by looking at the existing framework. Energy storage doesn't clearly fit within today's electric industry framework.

Some people say it's like trying to fit a square peg into a round hole.



"Square peg" comments usually result because the existing framework reflects a "traditional" electric system structure. That traditional structure served the electric industry well for many years.



In Alberta, the current electric industry structure was created in the late 1990s and early 2000s, in three stages.

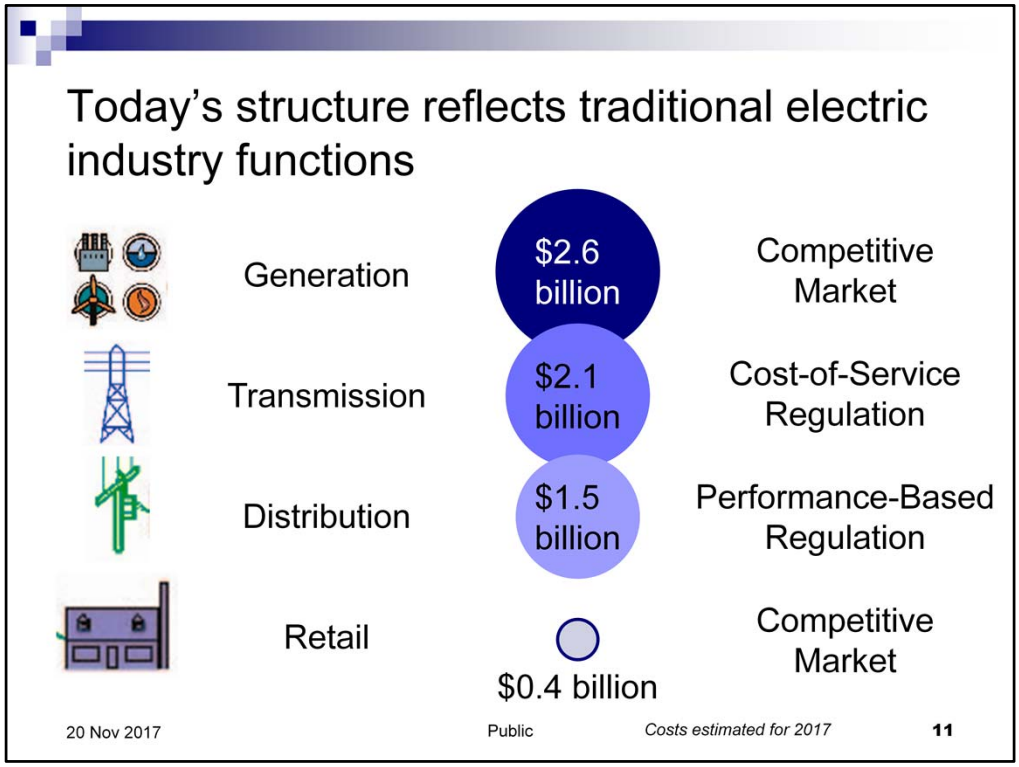
In the first stage, wholesale competition between generating units was introduced. A system of “legislated hedges” and “unit obligation prices” addressed the rights of existing generation owners and protected consumers. A transmission administrator was also created to oversee the planning of the transmission system.

Next, retail competition began in 2001. All consumers were given the opportunity to choose who to purchase electricity from. As well, the rights to the output of existing regulated generating units were auctioned off, with the proceeds of the auction paid out to consumers.

Finally, in 2004 the Power Pool and the Transmission Administrator were merged into the independent system operator. The AESO:

- plans and operates Alberta’s electricity grid;
- develops and operates Alberta’s wholesale electricity market; and
- connects electricity generators and industrial customers to the grid.

Although a few energy storage facilities have existed for decades in other jurisdictions, energy storage started attracting broader attention well after these stages of industry development in Alberta.

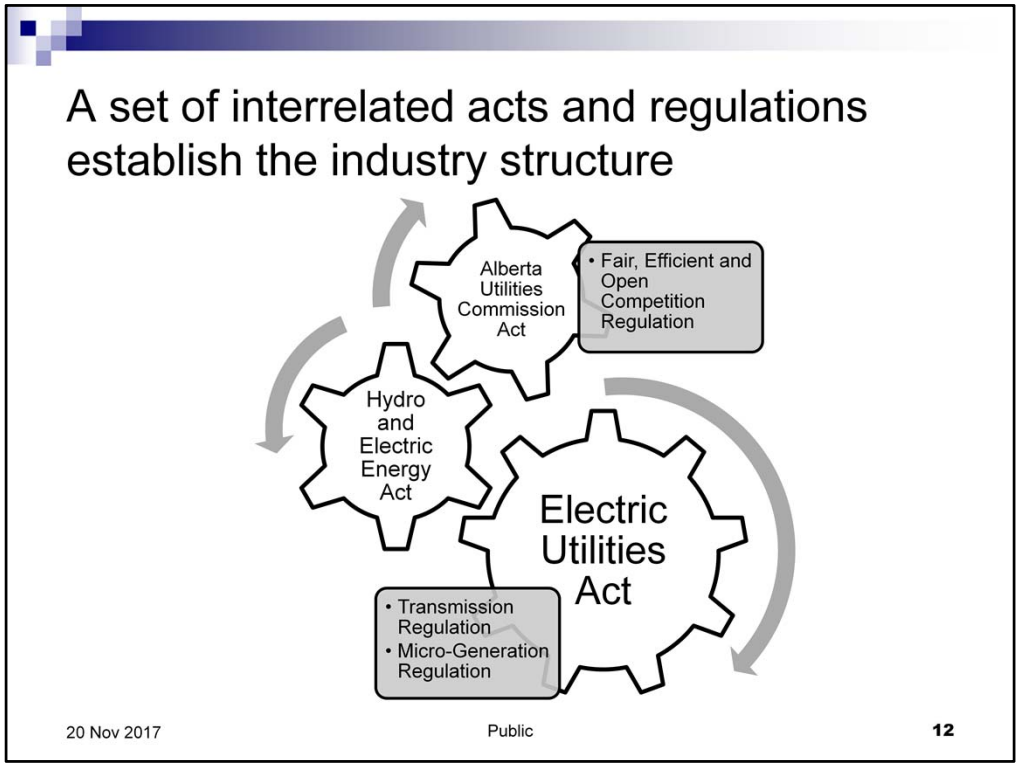


Throughout these changes, the electric industry structure reflected traditional electric industry functions. Companies were required to functionally separate their businesses into generation, transmission, distribution, and retail entities.

Generation remains the largest function, involving almost $3 billion of energy sales annually. Generation operates in a competitive market and energy prices have been historically low this year.

Transmission is the second-largest function, followed by distribution. Both of these electricity delivery functions remain fully regulated. However, transmission is regulated through a cost-of-service model, while distribution is regulated through a performance-based model.

The retail function is the smallest and is competitive, like generation. For example, as a residential consumer I have over 100 retail options available for my electricity supply.

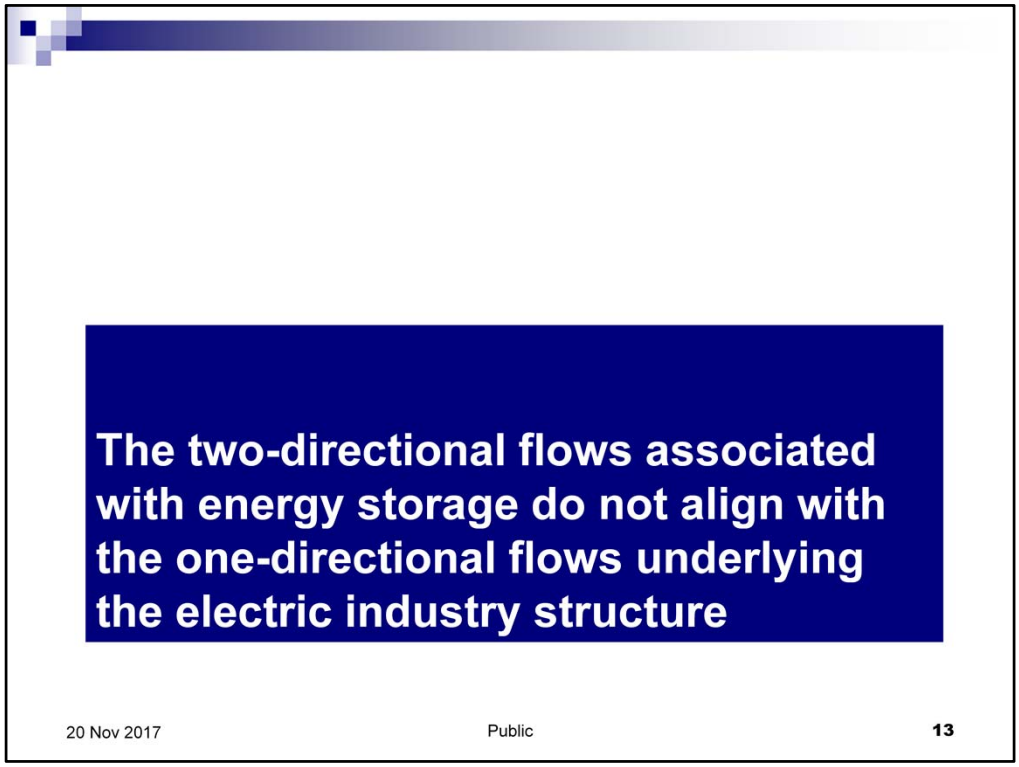


A set of interrelated acts and regulations establish the industry structure. I'll mention three of the most important.

The *Electric Utilities Act* provides the underlying framework for the regulation of Alberta's electric industry. The Act establishes the Independent System Operator (AESO) and the Balancing Pool, and sets out the AESO's powers and duties.

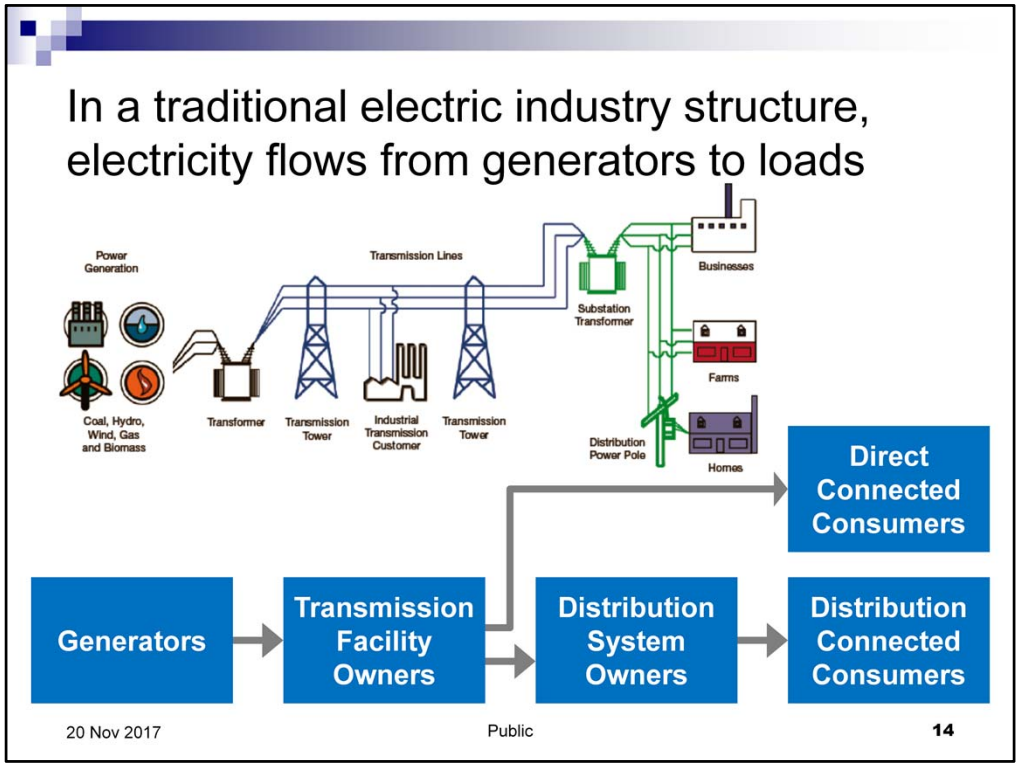
The *Transmission Regulation* is made under the *Electric Utilities Act* and sets out the details of the AESO's duties and obligations regarding transmission, including consultation, transmission system planning, and reliability standards. The regulation also specifies requirements for the construction of transmission facility projects. It also establishes the responsibilities of the Alberta Utilities Commission regarding approval of transmission facilities and transmission tariffs.

The *Hydro and Electric Energy Act* establishes rules and requirements for the generation and transmission of electric energy in Alberta. The Act includes requirements for approval by the Alberta Utilities Commission of construction and operation of hydro developments, power plants and transmission lines. It also establishes requirements for approval by the Alberta Utilities Commission to construct and operate an electric distribution system, and for the determination of service areas for electric distribution systems.



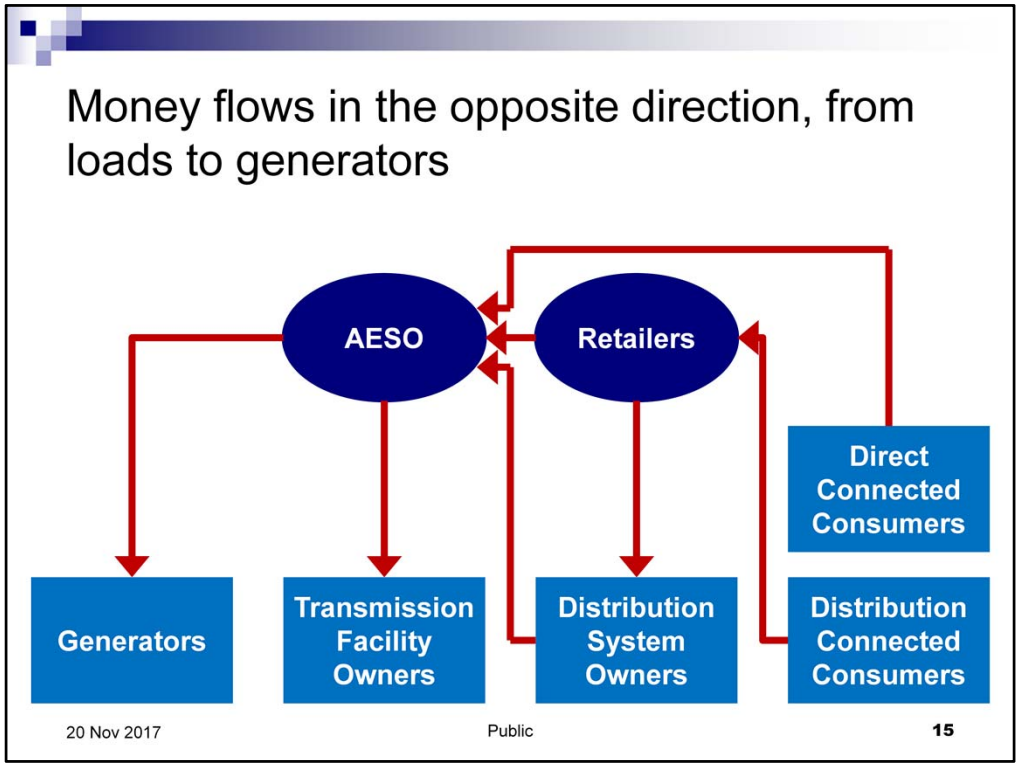
The existing electric industry structure I've just described does not readily accommodate energy storage. Specifically, the two-directional flows associated with energy storage do not align with the one-directional flows underlying the electric industry structure.

The terms "one-directional" and "two-directional" apply to both the flow of electricity and the flow of money.



First, let's look at the flow of electricity. In a traditional electric industry structure, electricity flows from generators to loads. In this illustration, electricity flows in one direction, from left to right.

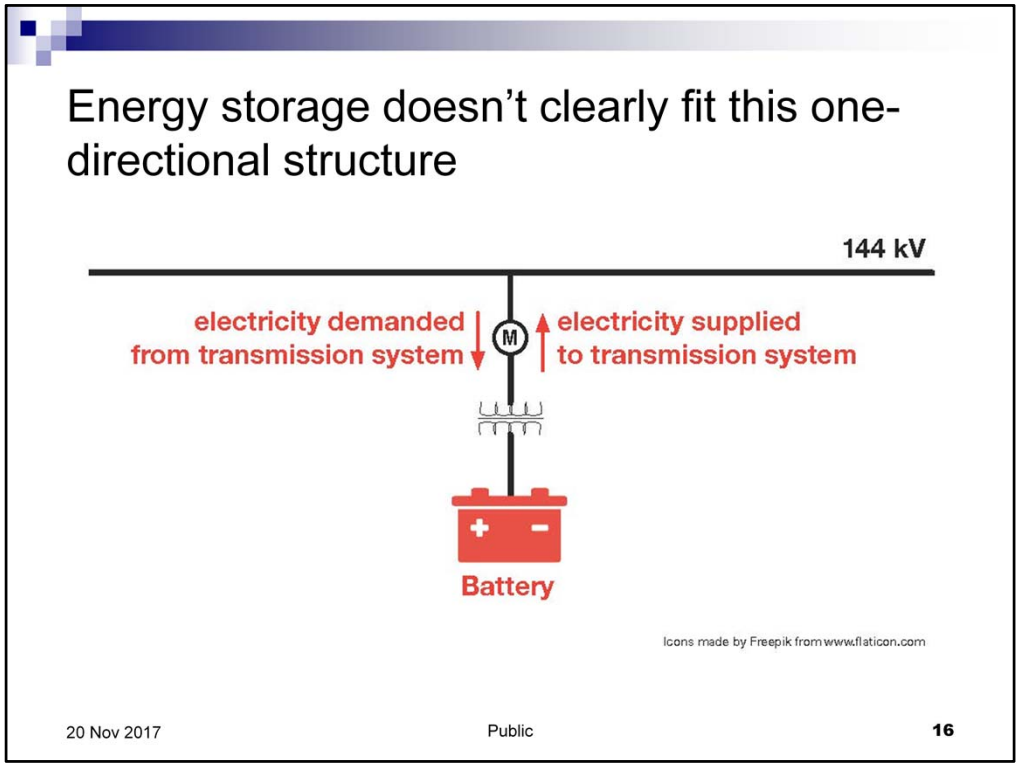
This structure evolved in an era of large centralized generation facilities supplying electricity for many distributed loads. It reflects the physical connection of generation to the transmission system and of loads to the distribution system. It also allows for the connection of large industrial and commercial loads directly to the transmission system.



In contrast, money flows in the opposite direction, from loads to generators. The flow of money also involves two additional entities, retailers and the AESO. Neither retailers nor the AESO own any substantial physical assets.

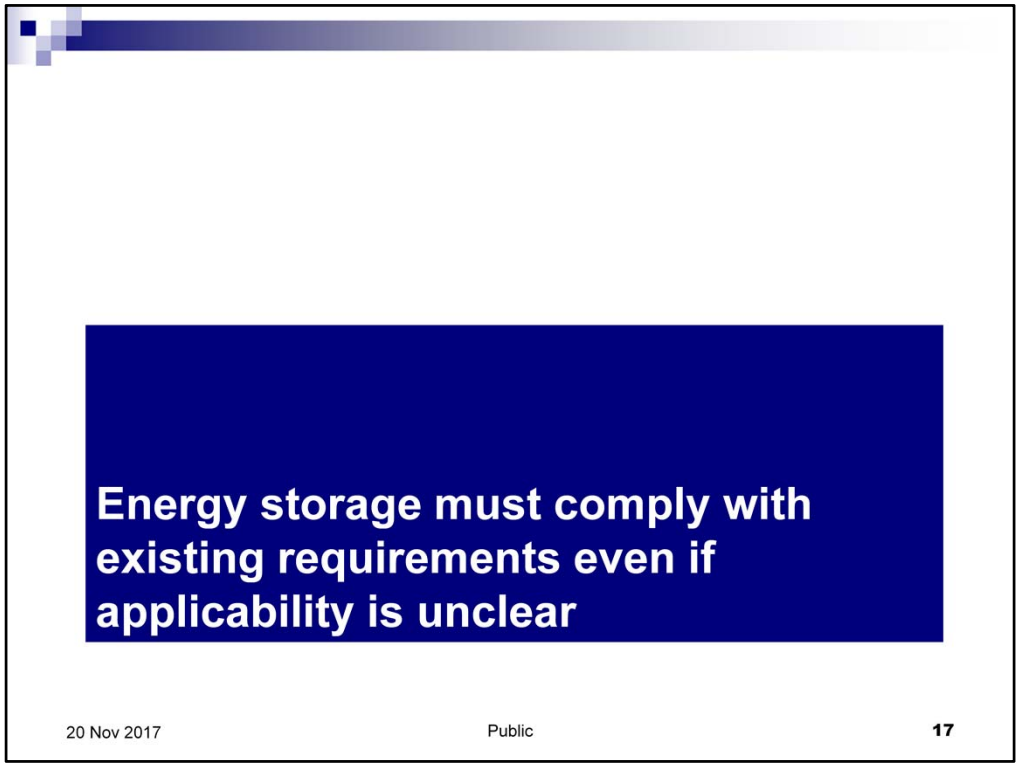
Note that the entities that are physically connected for the flow of electricity are not directly connected financially.

As well, generators do not pay for access to the transmission system. Costs paid by generators would be incorporated into their energy market offers and would ultimately increase energy costs to loads. Not requiring generators to pay for transmission access avoids energy market price distortions from the regulated transmission function and provides transparent pricing to loads for transmission service.

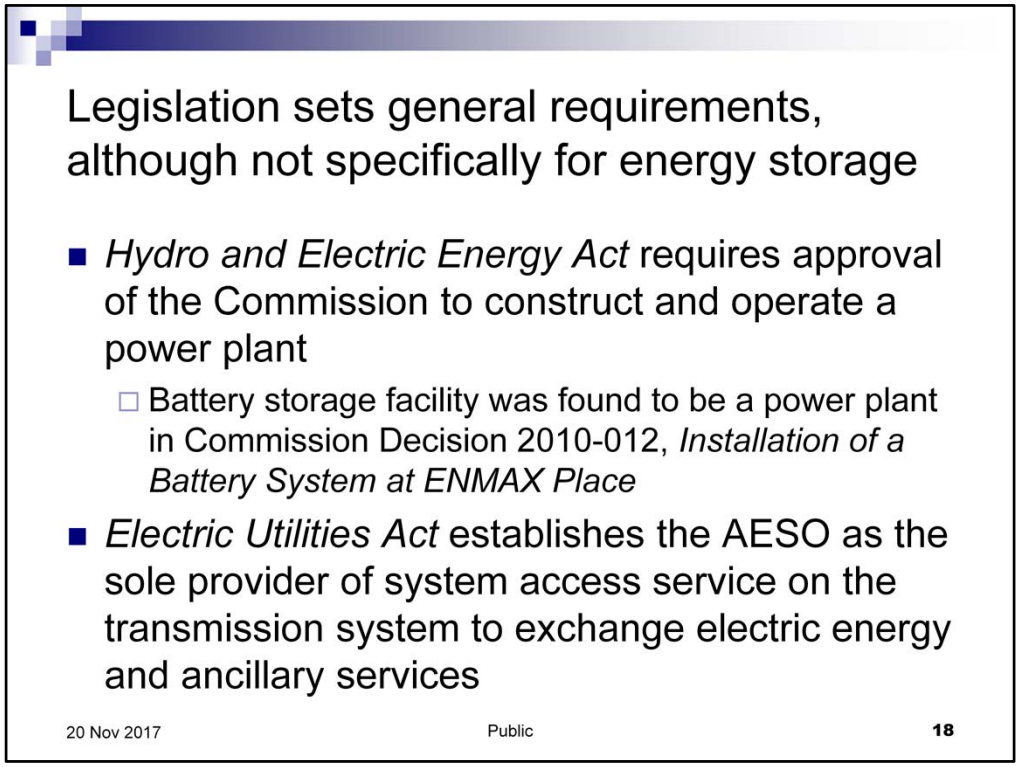


Energy storage doesn't clearly fit this one-directional structure. From an electricity flow perspective, energy storage both supplies electricity to and withdraws electricity from the electric system. At a point in time, an energy storage facility could appear as generation or as load to the system operator.

With electricity flowing in two directions, it is also unclear how money should flow to or from energy storage.



Although energy storage does not clearly fit into the existing electric industry structure, energy storage must comply with existing requirements even if applicability is unclear.



Legislation sets general requirements, although not specifically for energy storage.

In particular, the *Hydro and Electric Energy Act* requires approval by the Alberta Utilities Commission to construct and operate a power plant. The question of whether energy storage is a power plant was addressed in a 2010 decision of the Commission, where it was found to indeed be a power plant.

In addition to approval by the Commission, energy storage will need a connection to the transmission system to exchange electric energy and ancillary services. The *Electric Utilities Act* establishes the AESO as the sole provide of system access service, so an energy storage owner will need to apply to the AESO for system access service.

References

- *Hydro and Electric Energy Act*
  11 No person shall construct or operate a power plant unless the Commission, by order, has approved the construction and operation of the power plant.
- *Electric Utilities Act*
  1(1)(yy) "system access service" means the service obtained by market participants through a connection to the transmission system, and includes access to exchange electric energy and ancillary services.
  28 The Independent System Operator is the sole provider of system access service on the transmission system.

Alberta Utilities Commission Rule 007 sets out requirements for facility applications for power plants, substations, transmission lines, and other facilities. AUC Rule 007 describes the application requirements for the construction and operation of those facilities. It also includes guidelines for participant involvement programs (public consultation).

In addition, AUC Rule 007 sets out the process and elements for needs identification document applications to be filed by the AESO for transmission facilities.

As well as Rule 007 itself, the Commission provides application guidelines for power plants and other facilities on its website.

The AESO's connection process sets out requirements for system access service. Market participants must identify the requirements of their projects and assist the AESO in placing the projects into an appropriate project category.

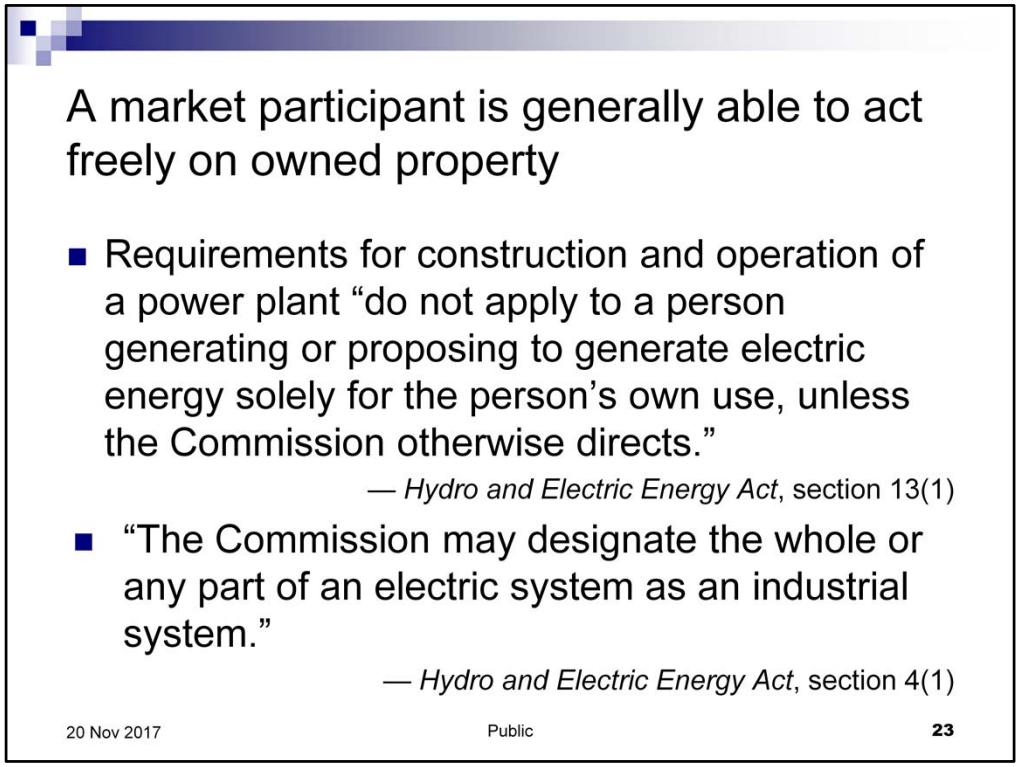
Energy storage project categories were recently added to the AESO's connection process documents. Three energy storage projects are currently included on the AESO's connection project list. They are in the early stages of the connection process where connection proposals and applications to the Commission are prepared.

Market participants must also apply to the AESO to be registered as a pool participant for the provision of energy or ancillary services or for the purchase of energy. Pool registration occurs near the end of the connection process. If an energy storage facility registered as a pool participant today, it would likely select a status of "other" as a specific "energy storage" status is not available.

The AESO encourages market participants who are connecting to the transmission system to become familiar with a variety of documents, including the current ISO rules, energy trading system manuals, the current ISO tariff, and settlement guides.

Many of the regulations and policies just discussed do not specifically mention energy storage. Where lack of clarity exists, the limitations of the policies are being addressed and new policies are being developed.

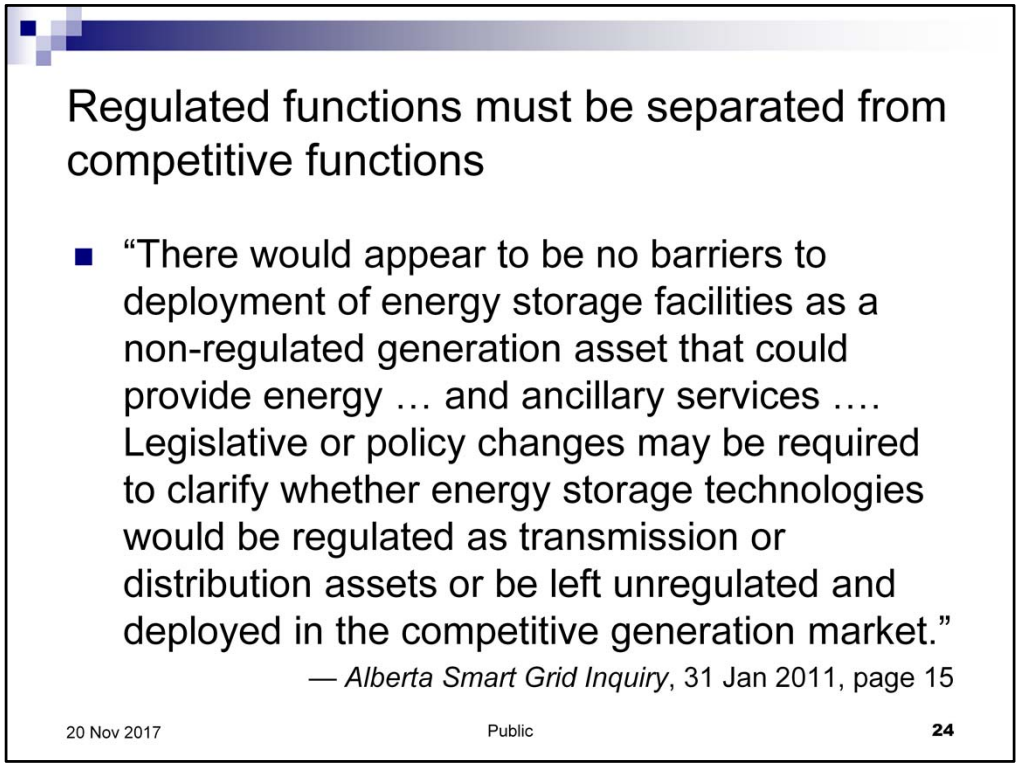
Even where it does not specifically address energy storage, legislation can provide some policy guidance.



First of all, a market participant is generally able to act freely on owned property. However, owned property does not allow electric lines to cross road allowances.

The primary restriction for use on owned property is that no electricity is supplied from the facility to the transmission system. This suggests that behind-the-meter energy storage can be readily accommodated within existing policies.

Where surplus electricity is expected to be supplied to the transmission system, the Commission may designate the property as an industrial system. The industrial system designation is intended to address an electric system that includes a generating unit that is highly integrated with one or more industrial operations. It is not clear whether an energy storage facility would qualify for inclusion in an industrial system designation.

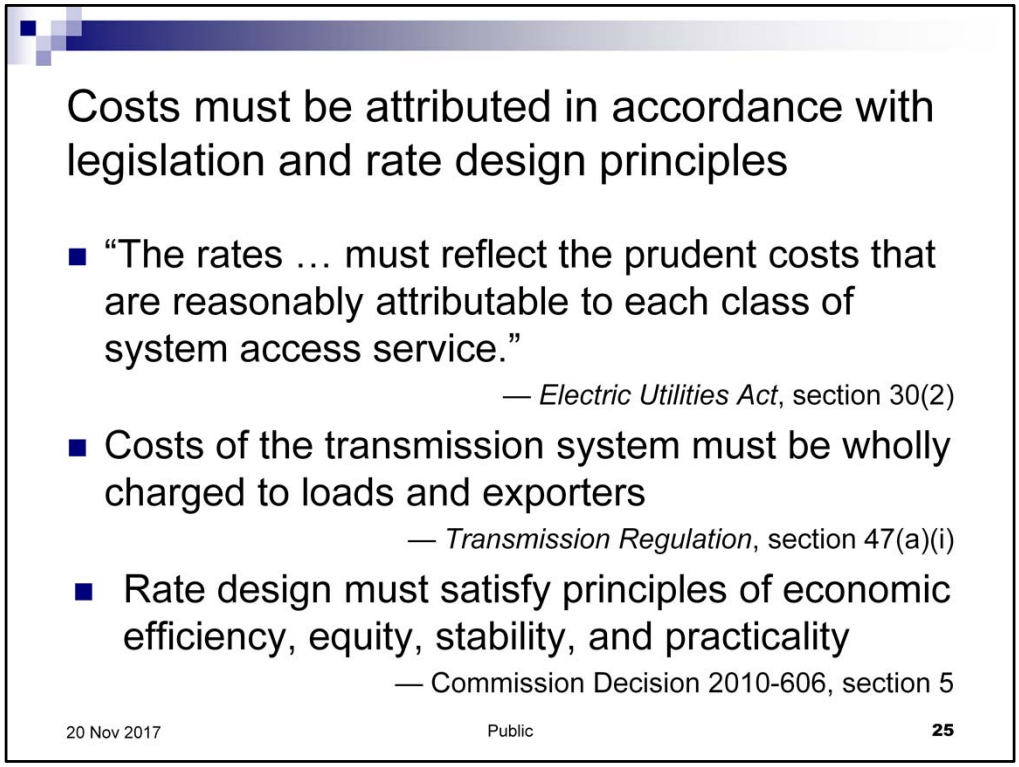


Regulated functions must be separated from competitive functions. That is, facilities which operate as part of a transmission or distribution system cannot also operate in competitive markets for energy or ancillary services.

With respect to the regulated transmission system, the *Electric Utilities* Act requires that the AESO alleviate constraints or other conditions on the transmission system by expanding or enhancing the system. A non-wires solution may be proposed as a specific and limited exception only where there is limited load growth and material cost savings with the non-wires solution.

References

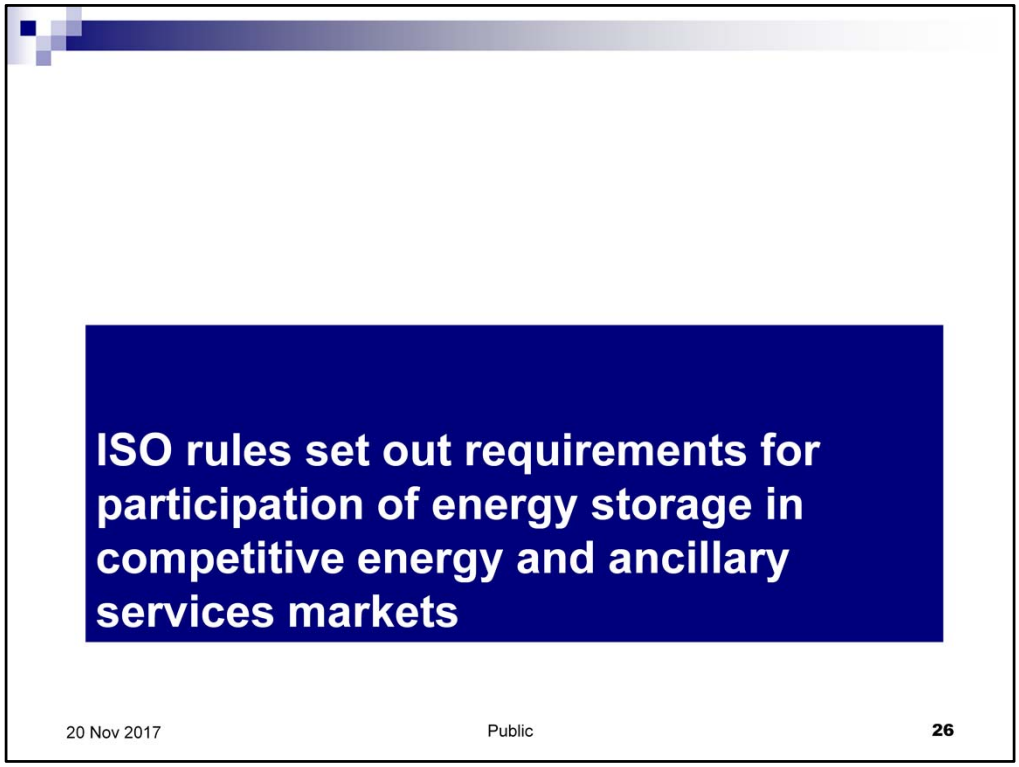
- *Electric Utilities Act*
  1(1)(bbb) "transmission facility" … does not include a generating unit.
  34(1) When the Independent System Operator determines that an expansion or enhancement of the capability of the transmission system is or may be required to meet the needs of Alberta and is in the public interest, the Independent System Operator must prepare and submit to the Commission for approval a needs identification document ….
- *Transmission Regulation*
  15(3) In considering the design and planning of the transmission system, the ISO may make or provide for specific and limited exceptions to the requirements of subsection (1) and propose a non-wires solution ….



Costs must be attributed in accordance with legislation and rate design principles.

In particular, the *Transmission Regulation* requires that costs of the transmission system be wholly charged to loads and exporters. When energy storage is withdrawing electricity from the transmission system while charging, it appears very similar to loads and exporters. It seems reasonable to charge transmission costs to energy storage when it is charging.

The reasonableness of the attribution of costs to energy storage will be examined in accordance with rate design principles through an AESO tariff proceeding before the Alberta Utilities Commission.



In addition to legislative guidance, ISO rules set out requirements for participation of energy storage in competitive energy and ancillary services markets.

Technical and operating requirements apply to facilities connected to the transmission system. Specific requirements for battery storage facilities were developed in 2016.

Other types of storage facilities, such as pumped hydro or compressed air, would be subject to requirements for generating units and loads, as the equipment used in those facilities are generally conventional generation and load equipment.

Other requirements apply to specific subcomponents of all facilities, including:

- protection requirements;
- communication system requirements;
- SCADA requirements; and
- reporting of facility modelling data.

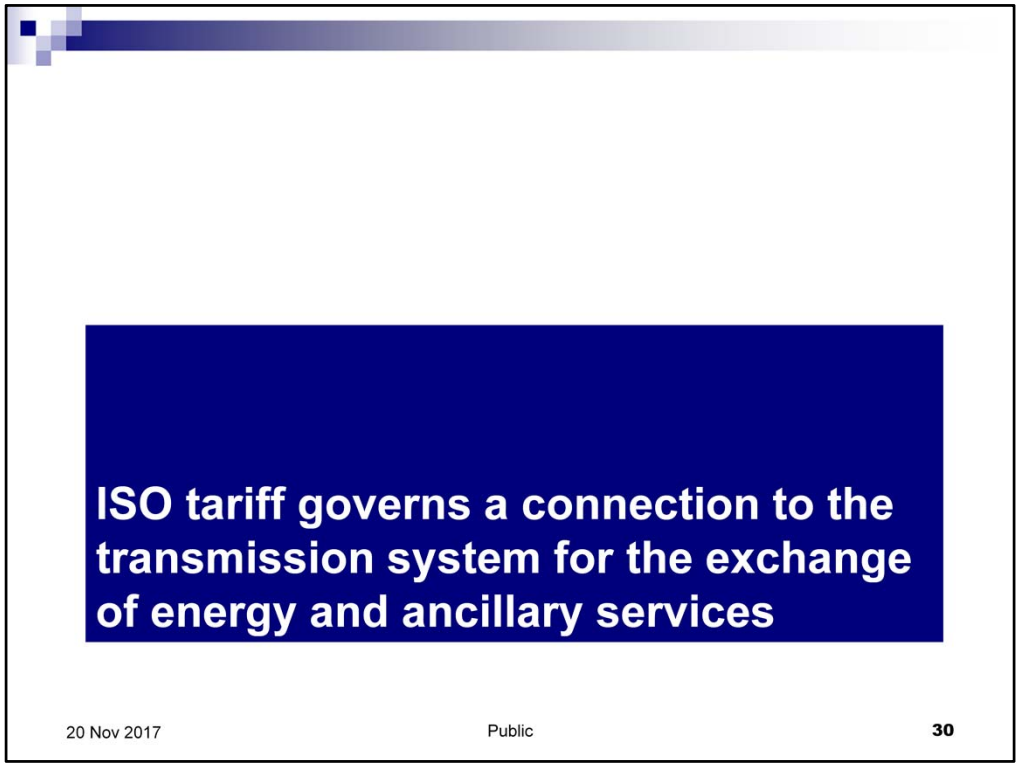
"Market rules" govern participation in the energy and ancillary services markets.

The AESO has a duty to facilitate the markets in a manner that gives all market participants a reasonable opportunity to participate. Rule amendments to facilitate the participation of energy storage facilities are currently in the final stage of consultation.

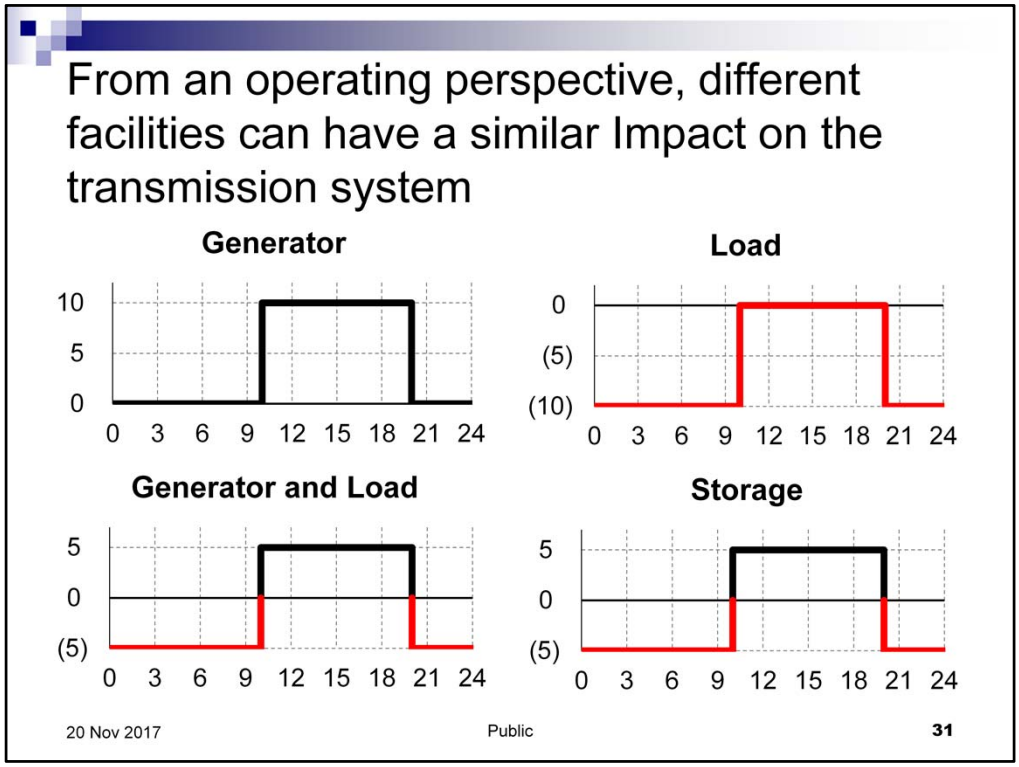
Under the existing language in the ISO rules, certain technologies are excluded from participating in the operating reserve market. Some of these technologies, such as battery storage, may be physically capable of meeting the technical and performance requirements to provide operating reserves. But they are unable to qualify to participate in the market under the existing language in the rules. The proposed rule amendments will enable qualified energy storage facilities to participate in the operating reserve market.

Rules governing participation in competitive markets continue to be reviewed for technology neutrality. In particular, "energy storage facility" was added in 2016 as a defined term for use in AESO rules, tariff, and reliability standards.

The technology-neutral definitions for resources include "regulating reserve resource", "spinning reserve resource", and "supplemental reserve resource".



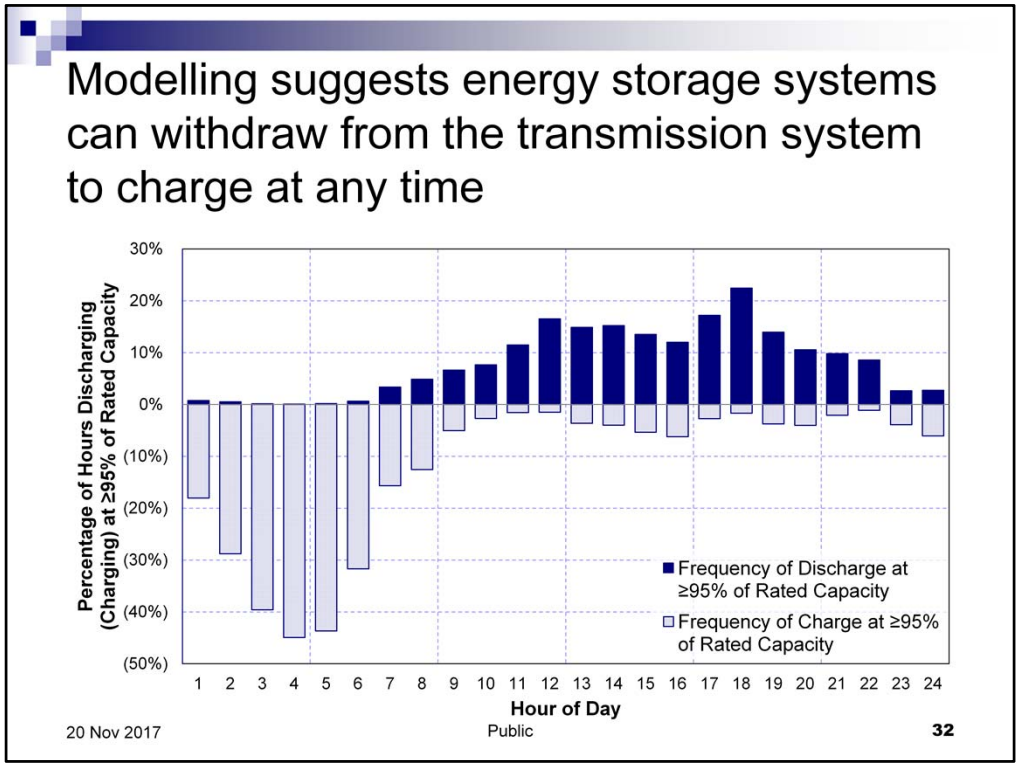
The ISO tariff governs a connection to the transmission system for the exchange of energy and ancillary services. The tariff includes rates and terms for the provision of system access service. The ISO tariff must be approved by the Alberta Utilities Commission as just and reasonable before the AESO can put it into effect.



From an operating perspective, different facilities can have a similar Impact on the transmission system. The AESO must consider whether a generator, load, generator and load, or storage facility will have different impacts on costs of the transmission system.

Based on its consideration, the AESO has proposed that:

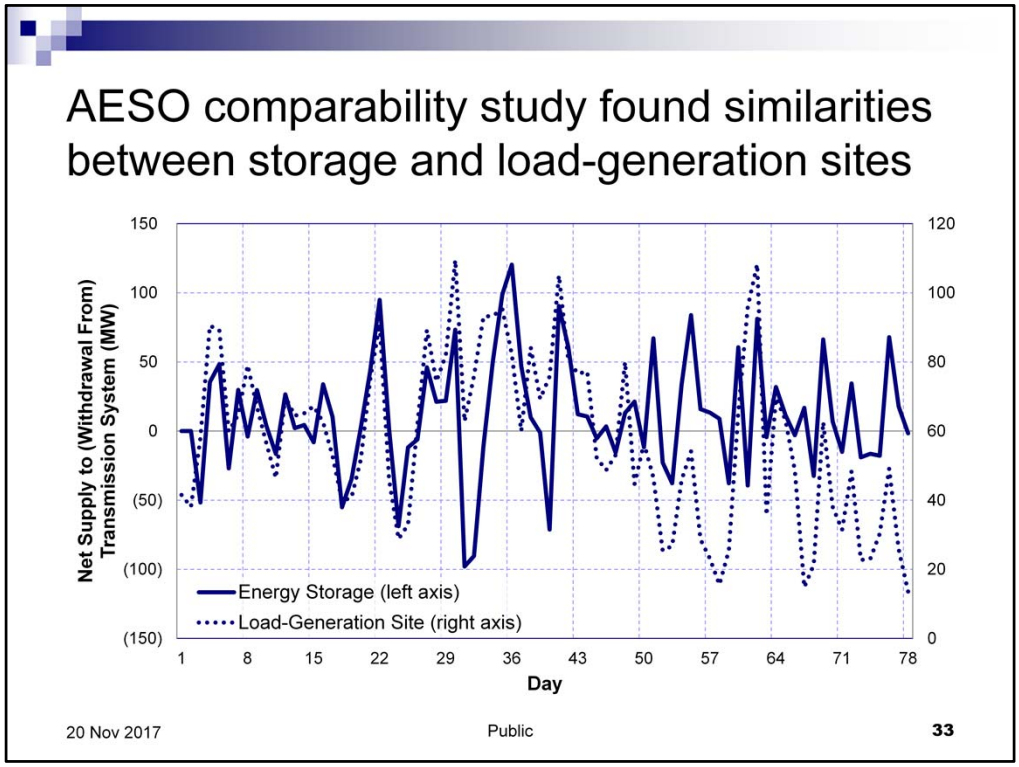
- Rate DTS, *Demand Transmission Service*, apply o energy storage facilities, in hours in which the energy storage facilities are withdrawing electricity from the transmission system (charging); and
- Rate STS, *Supply Transmission Service*, apply in hours in which the energy storage facilities are supplying electricity to the transmission system (discharging).



The University of Calgary completed an operational and economic dispatch study of energy storage facilities for the AESO in 2016. The study modelled the operation of eight energy storage facilities comprising different technologies and sizes, based on actual hourly merit orders over five years from 2010 to 2014. The study predicted the operation of the energy storage facilities in attempting to maximize profit through energy price arbitrage.

The dispatch modelling showed that the typical daily charge-discharge cycle of an energy storage facility had an indirect correlation with system demand. The modelling showed that supply to the transmission system tended to occur during high pool price hours (which correlated to higher system demand) and withdrawal from the transmission system tended to occur during low pool price hours (which correlated to lower system demand).

The dispatch modelling also showed that withdrawal from the transmission system (charging) could occur during any hour of the day, including at close to the rated capacity of the energy storage facilities.



As the application of Rates DTS and STS to energy storage facilities would be similar to their application to sites with both load and generation, the AESO also compared the typical charge-discharge behaviour of an energy storage facility to the supply and withdrawal behavior at load-generation sites.

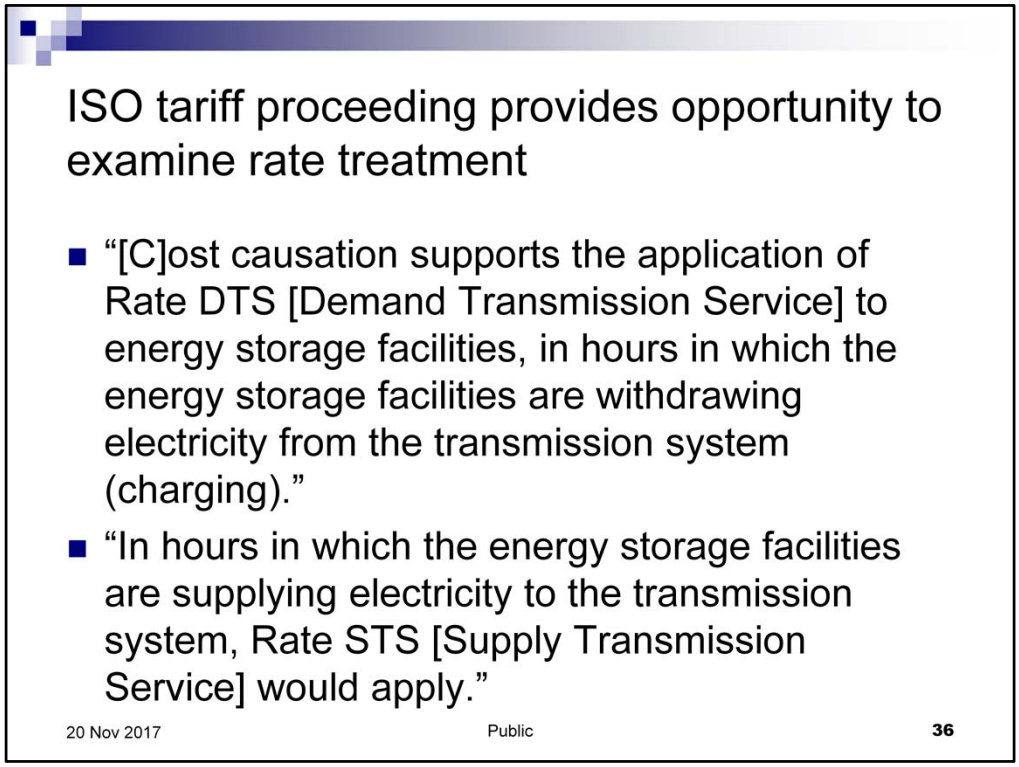
The AESO found that some load-generation sites exhibited similar demand variability as energy storage facilities, reducing demand in higher pool price hours and increasing demand in lower pool price hours. As Rates DTS and STS have been found to appropriately attribute costs to load-generation sites, the similarity of the supply and withdrawal patterns of energy storage facilities suggests that those rates may be appropriate for energy storage facilities as well.

Industry participants can help with existing policy revision and new policy development.

As an example, the AESO launched an energy storage integration initiative in September 2012, prompted by interest from stakeholders. Since then, the AESO has been exploring how energy storage facilities can connect to the transmission system and participate in the Alberta electricity market.

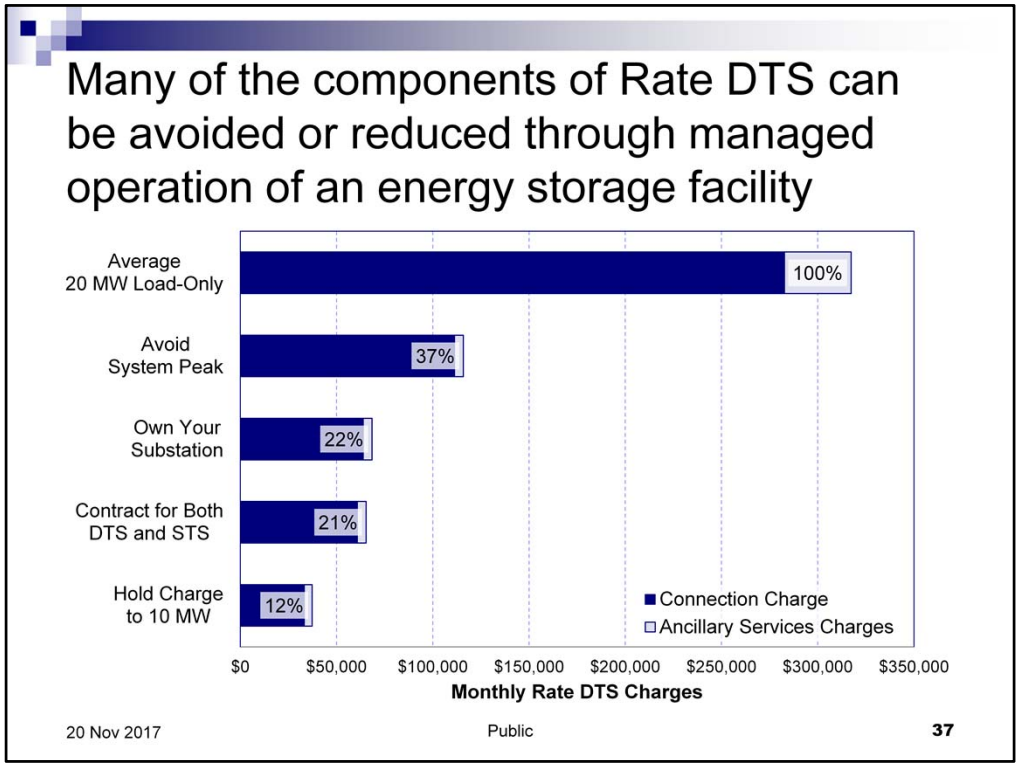
In particular, industry participants can participate in the AESO's tariff development.

The AESO filed its 2018 ISO tariff application in September 2017. The application will be reviewed by the Alberta Utilities Commission through a public process during the remainder of 2017 and continuing into 2018.



The ISO tariff proceeding provides an opportunity to examine the rate treatment proposed by the AESO.

The AESO's examination of energy storage led it to conclude that Rate DTS should be applicable to energy storage when it is withdrawing electricity from the system (charging) and Rate STS should be applicable when it is supplying electricity to the system (discharging). The AESO expects that this conclusion will be thoroughly examined in the tariff proceeding.

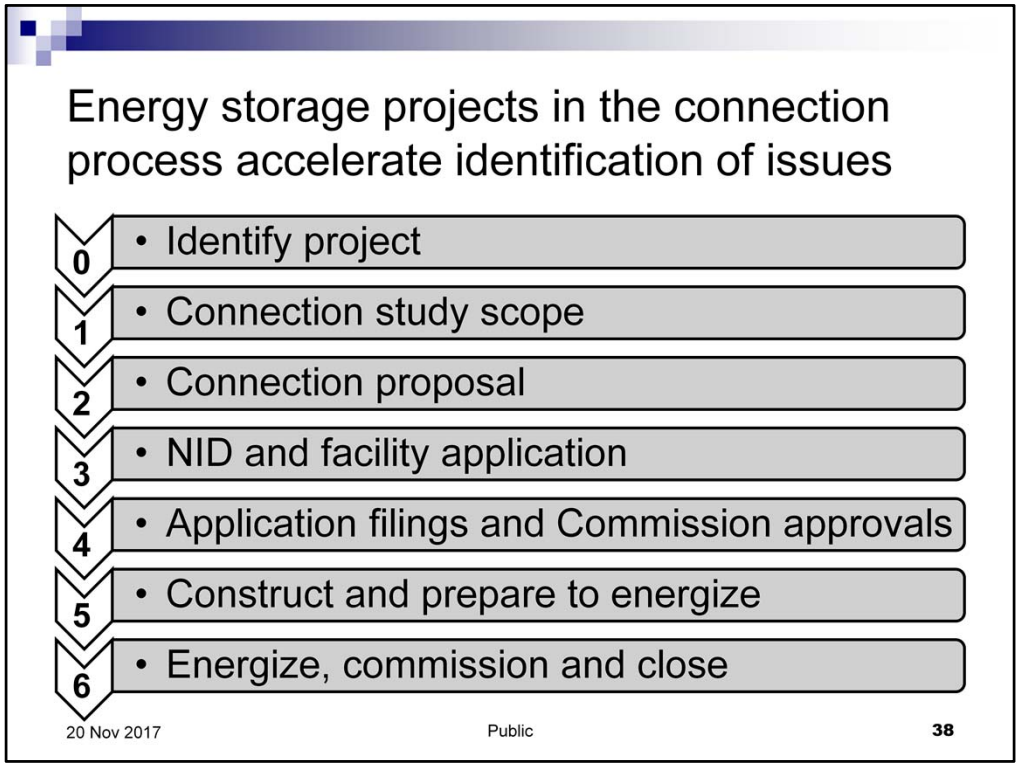


The AESO's examination of energy storage also led it to conclude that many of the components of Rate DTS can be avoided or reduced through managed operation of an energy storage facility.

In this chart, the top-most bar represents the monthly Rate DTS charges that would apply to a 20 MW load-only facility, including both the Rate DTS connection charge and charges for ancillary services.

The subsequent bars in the chart represent monthly Rate DTS charges that would apply to a 20 MW energy storage facility that:

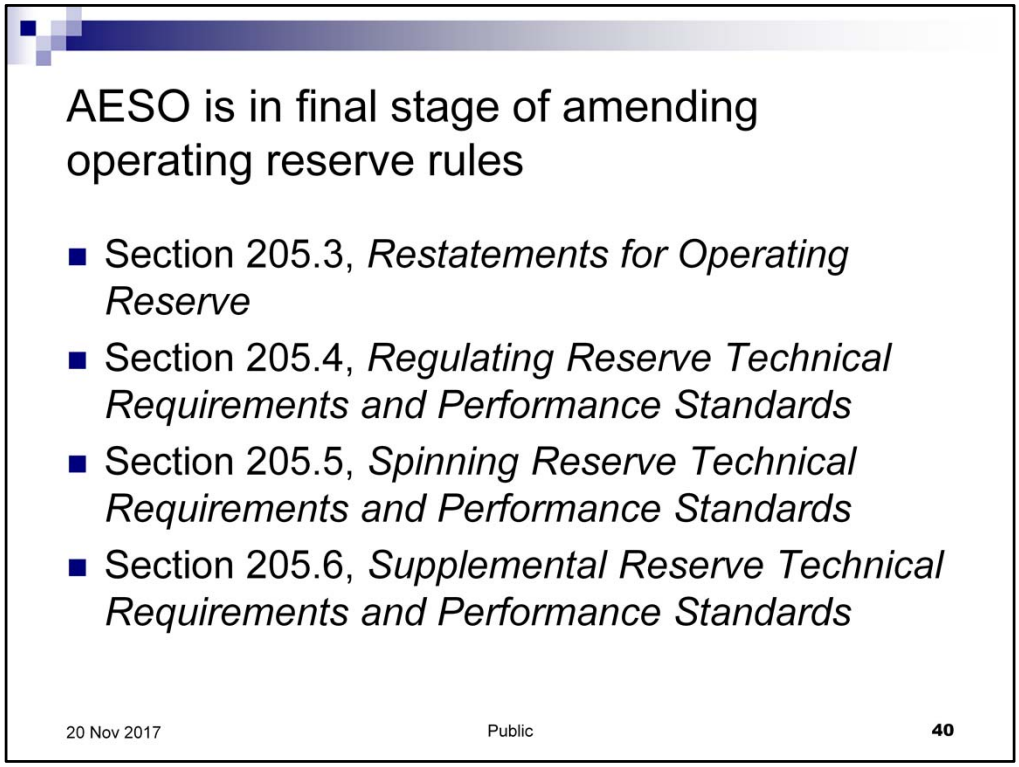
- avoided bulk system charges by avoiding withdrawals from the transmission system during hours of coincident system peak and reduced ancillary services charges by avoiding withdrawals from the transmission system during high pool price hours;
- reduced point of delivery charges through substation ownership (to provide primary service credits);
- reduced point of delivery charges through contracting for both Rate DTS and Rate STS system access services (to provide a smaller substation fraction under Rate DTS); and
- reduced regional system and point of delivery charges by reducing peak metered demand by limiting withdrawal (charging) rates to a lower value than supply (discharging) rates.



In addition to rates consideration, energy storage projects in the connection process can accelerate identification of issues. The terms and conditions of the ISO tariff include provisions that govern high-level aspects of the connection process.

The market participant initiates the six-stage process by submitting a system access service request to the AESO.

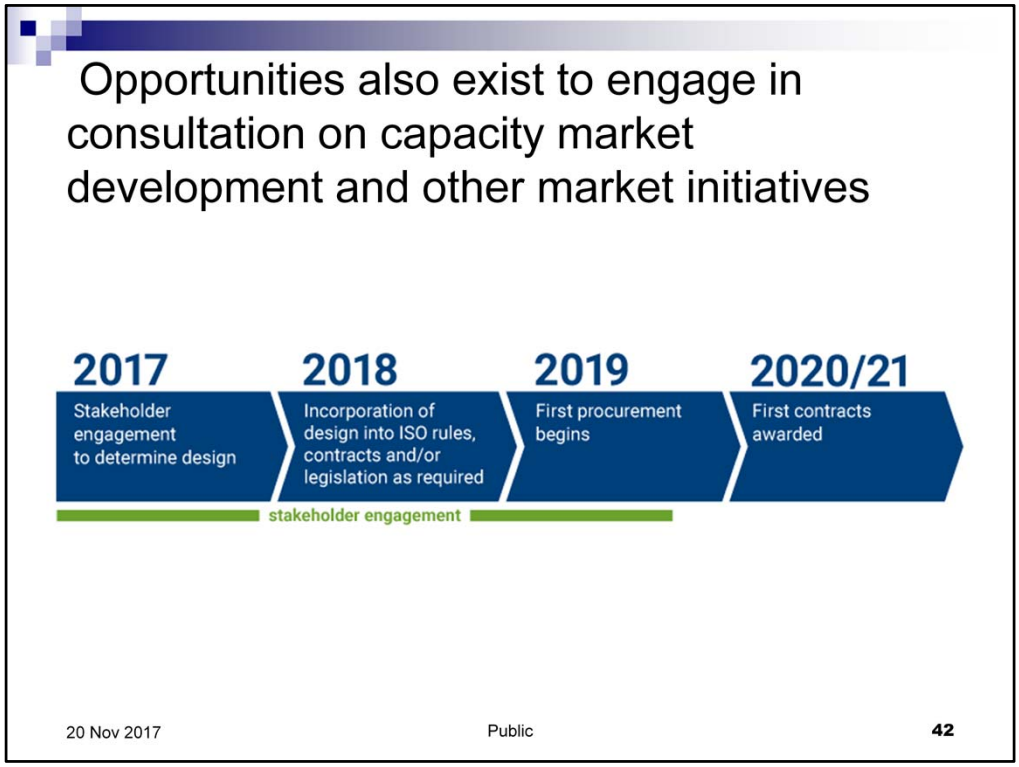
industry participants can also participate in the AESO's rule development.



The AESO is in the final stage of amending operating reserve rules, as already mentioned. Opportunity for participation is limited for those amendments.

However, the AESO has a formal consultation process for rules and standard development. The AESO creates new rules or amends existing rules on an as-needed basis.

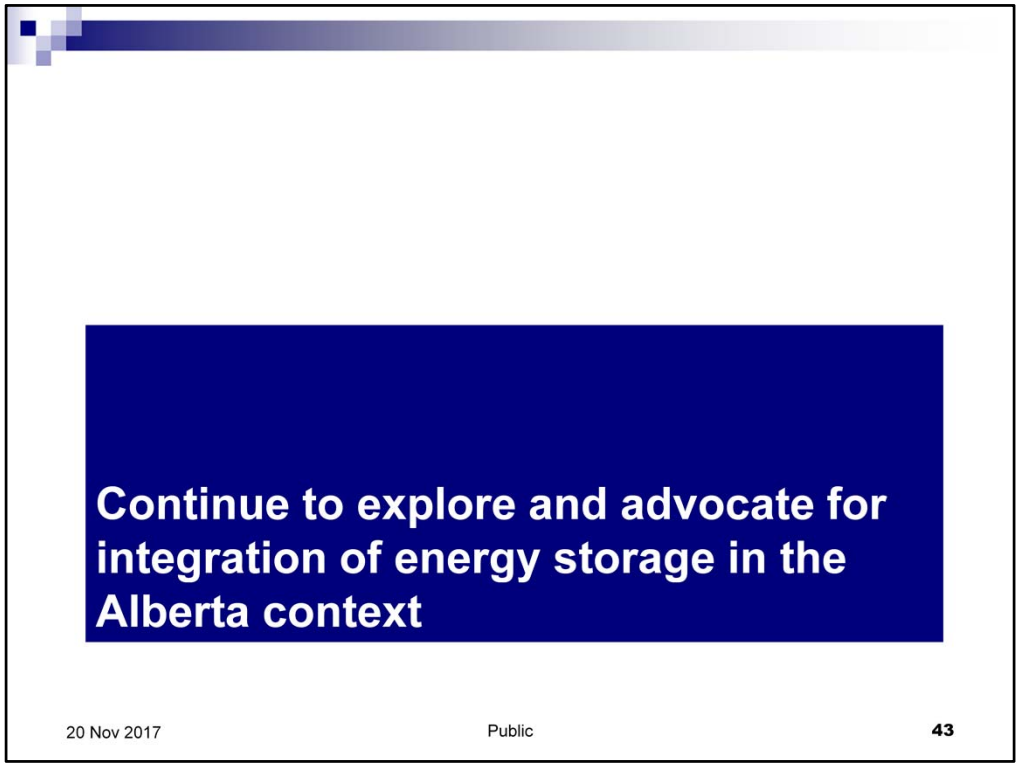
To stay informed of the AESO's rule-making stakeholder engagement activities, sign up for the AESO newsletter on the home page of the AESO website.



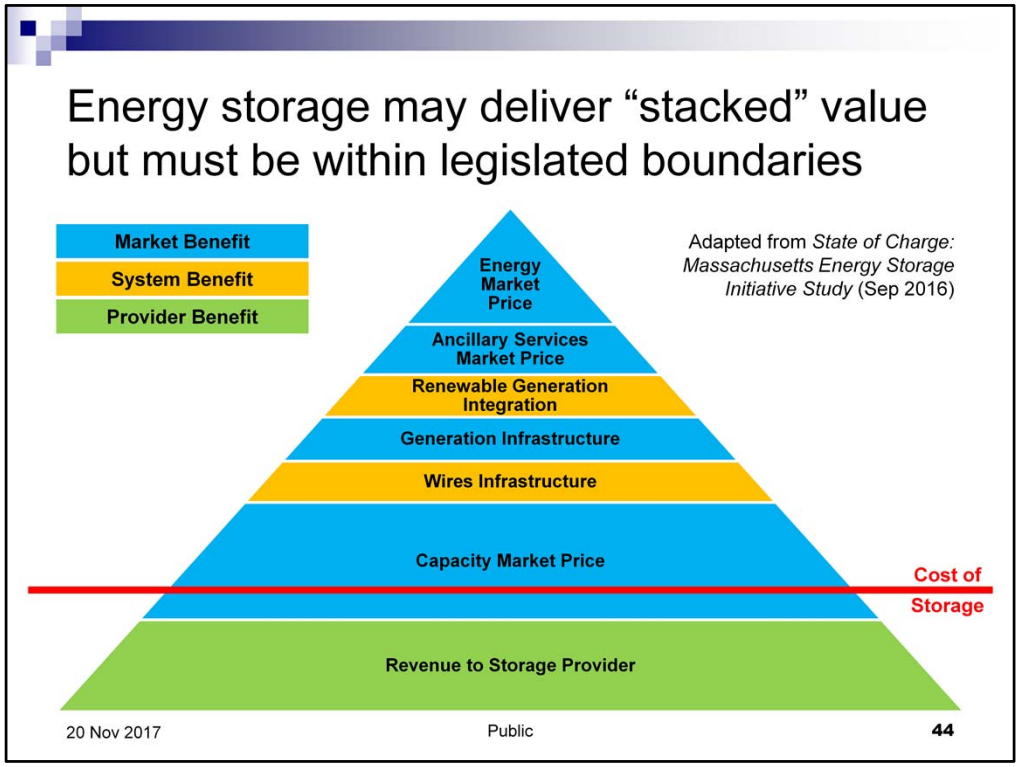
Opportunities also exist to engage in consultation on capacity market development and other market initiatives.

The multi-year stakeholder engagement for capacity market design is currently evolving to address interdependencies arising across working group design streams and to improve the efficiency of the AESO's design process. Working groups will continue to review the draft capacity market design and provide advice to the AESO about refining it. A draft comprehensive design will then be published for industry stakeholders to review and provide feedback on.

The Alberta Utilities Commission recently completed a hearing and submissions process in its distributed generation review proceeding. Several participants provided submissions addressing energy storage. The Commission will be issuing a report to the Minister of Energy later this year. The government may then develop policy to accommodate distributed generation.



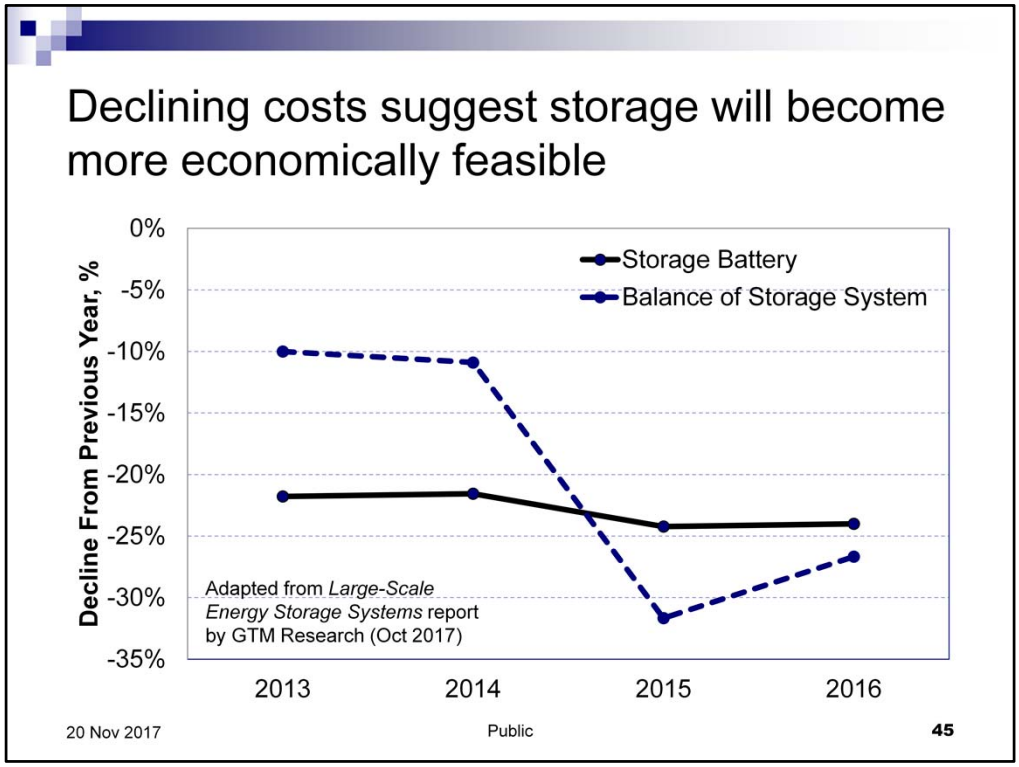
The AESO expects market participants to continue to explore and advocate for integration of energy storage in the Alberta context.



The AESO understands that energy storage may deliver “stacked” value but it must be within the legislated boundaries that exist.

Value arising from direct benefits to the energy storage provided should be readily captured. Value provided in a market should also be able to be captured.

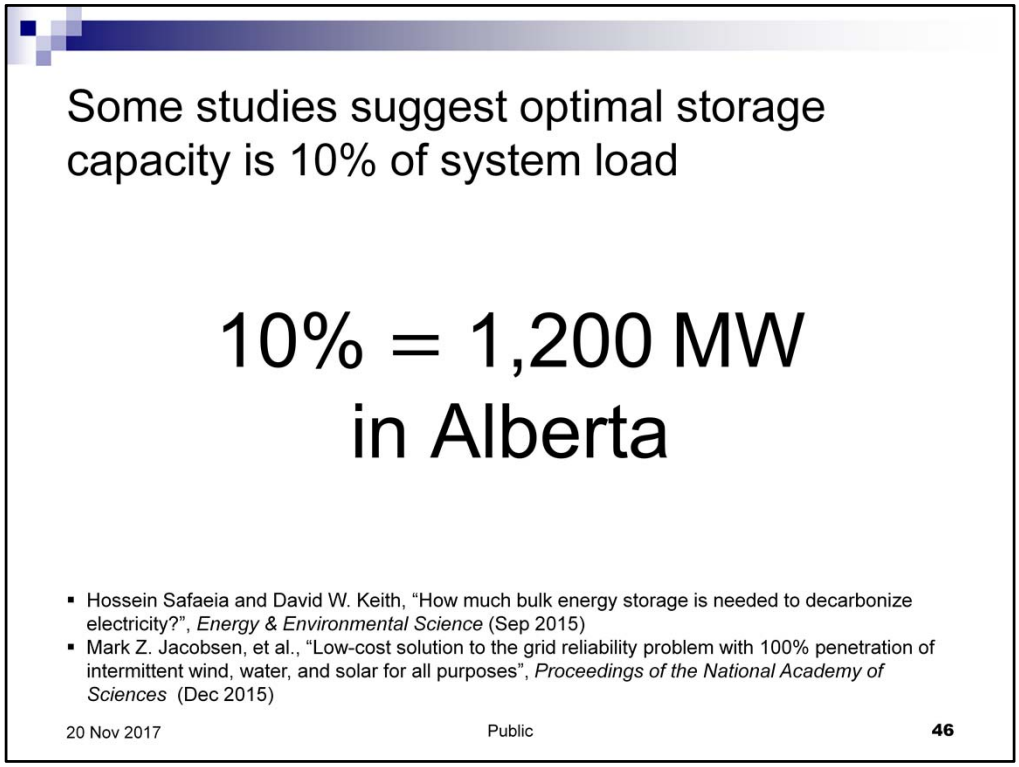
It is less clear whether value arising from a system benefit can be captured by the same project.



Regardless of the ability to "stack" value, declining costs suggest storage will become more economically feasible.

Battery prices have driven the majority of energy storage price declines. However, GTM Research recently predicted that both battery and balance-of-system costs will shape price trends of energy storage systems in the future.

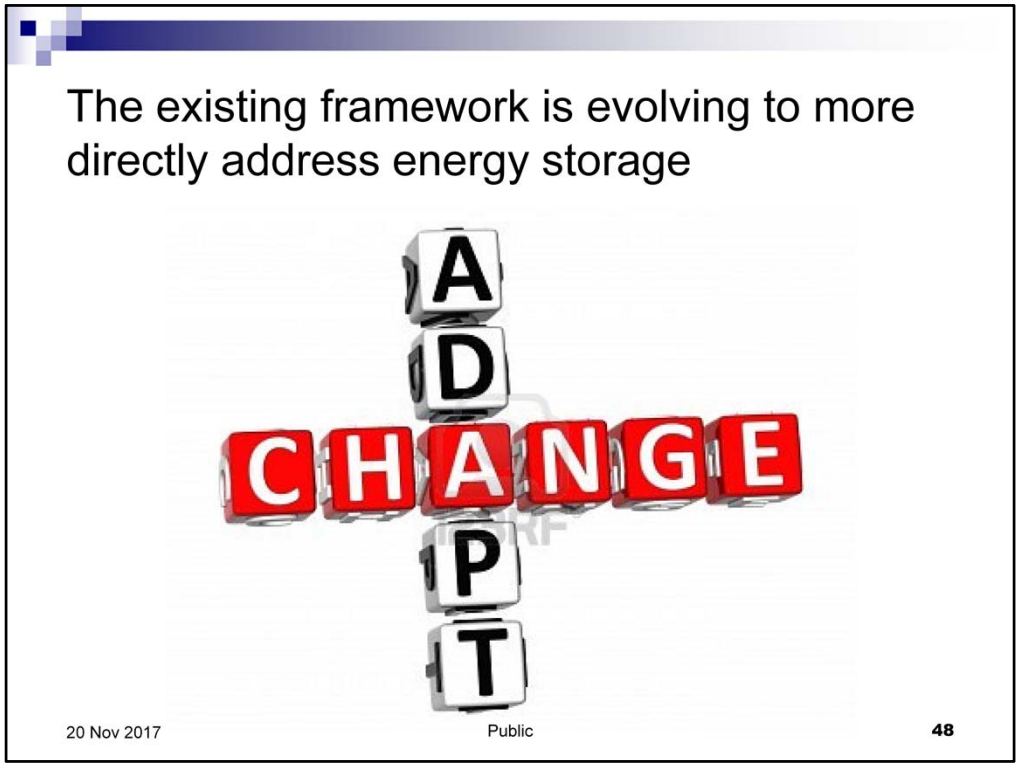
For utility-scale and large non-residential energy storage systems, balance-of-system costs declined 60 percent between 2012 and 2016. GTM Research predicted that they will fall 40 percent between 2017 to 2022.



Some studies suggest optimal storage capacity to integrate renewables and decarbonize the electric system is 10% of system load. In Alberta, that would be about 1,200 MW of energy storage.

The projects currently on the AESO project list total about 200 MW. There appears to be significant room to grow.

So, what have we seen about energy storage policy? We've found that the existing electric industry framework does provide some guidance, but it can be limited.



We've also talked about how the existing framework is evolving to more directly address energy storage.

Opportunities exist for you to participate in changes to address energy storage

Most importantly, though, we've looked at opportunities that exist for you to participate in changes to address energy storage.

Armed with this information, we can continue to work together to ensure policies exist in Alberta that are clear, reasonable, and appropriate for energy storage.


Thank you
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