Energy Storage Industry Learnings Forum Workshop 3

I. Purpose of this workshop

The purpose of the ESILF workshop is for members to share their expertise and key learnings on three topic areas that we believe the AESO would benefit from further discussion: Economic modeling; Sharing of experiences in commissioning and testing of new technologies or configurations; Modeling economics of transmission storage under the current framework.

II. Workshop agenda

Agenda Items	Est. time	Presenter
Welcome & Introduction	10 mins (8:30 – 8:40)	Luis Garrido
Topic: Economic Modeling	45 mins (8:40 – 9:25)	Paula McGarrigle Robert Stewart Travis Lusney
Discussion	45 mins (9:25 – 10:10)	Luis Garrido
Break	10 mins (10:10 – 10:20)	
Topic: Sharing of experiences in commissioning and testing of new technologies or configurations	30 mins (10:20 – 10:50)	Hesam Yazdanpanahi Laura Oosterbaan
Discussion	30 mins (10:50 – 11:20)	Luis Garrido
Topic: Modeling economics of transmission storage under the current framework	15 mins (11:20 – 11:35)	Hao Liu
Discussion	15 mins (11:35 – 11:50)	Luis Garrido
Wrap up and next steps	10 mins (11:50 - 12:00)	Biju Gopi

III. Attendees

Attendees	Company
ABB (ASEA Brown Boveri)	Dan Gustafson
Alberta Energy	Michael Fabiyi
Alberta Government - UCA	Megan Gill

Alberta Electric System Operator
Calgary Place, 2500, 330-5th Avenue SW Calgary, AB T2P 0L4
Phone: 403-539-2450 | Fax: 403-539-2949
www.aeso.ca
@theaeso

Attendees	Company
Alberta Innovates	Christophe Owttrim
Alberta Utilities Commission	Olex Vasetsky
AltaLinK	Hao Liu
ATCO	Hesam Yazdanpanahi
ATCO	Humud Said
CanWEA	Evan Wilson
Chapman Ventures	Dan Chapman
Energy Storage Canada	Justin Rangooni
FortisAlberta	Neil Cumming
Market Surveillance Administrator	Derek Olmstead
Nutana Power	Graeme Harrison
Power Advisory	Travis Lusney
RMP Energy Storage	Robert Stewart
Solas	Paula McGarrigle
Suncor	Dan Visser
TERIC Power	Craig Barnes
TransCanada	Michael Edwards
TransAlta	Akira Yamamoto
TransAlta	Laura Oosterbaan
WindRiver (TPG)	Kipp Horton
AESO	Biju Gopi
AESO	Terry Martin
AESO	Luis Garrido
AESO	Steve Waller
AESO	Noeline Kanagalingam
AESO	Ruppa Louissaint
AESO	Pravin Koshti
AESO	Leon Weinstein
AESO	Kathryn Kuber
AESO	JR Cabalo

Attendees	Company
AESO	Ting Zhang

IV. Overall outcomes from the day

The meeting began with a short welcoming of all attending members and was led by Luis Garrido. Mindful of time and duration of the workshop, the presentations began on the first topic '*Economic Modeling'.*

Because the workshop was designed for the AESO to learn from the experience and expertise of the members, each presenter was allotted 15 minutes, on their selected topic, to provide information they believed would add value to the AESO in integrating energy storage in Alberta. Once presentations for each topic had completed, a discussion was held which allowed the AESO and ESILF members to ask questions and obtain clarity on said topic.

After the completion of the first topic, Economic Modeling, and the discussion period, the workshop resumed with topics 2, Sharing of experiences in commissioning and testing of new technologies or configurations, and 3, Modeling economics of transmission storage under the current framework, and corresponding discussion periods.

Workshop presentations can be found on the Energy Storage page of the AESO website.

V. Discussions

Below are questions, statements, recommendations and concerns, and corresponding responses which occurred during the discussion periods after presentation on each topic.

Economic Modeling – presentations by Solas, RMP Energy Storage and Power Advisory

- Question from Solas for Power Advisory regarding emission reduction and energy storage that is standalone or hybrid, with either wind or solar, where emission reductions will have to come from renewable energy based on the current framework.
    - Power Advisory representative stated its on curtailment.. As we talked about the feedback loop, if we are at $170 and assume no one changed their behavior, 100 to 120 dollars MWh, if that is the case, you can just build renewables and you can start spilling energy 20 to 40% of a wind or solar, and still be made financially whole. However, all that spill has an impact on pool price.
    - Follow up question from Solas on whether the asset would actually be spilling, because it is still generating the electricity?
    - Power Advisory representative responded that the asset would be curtailed, would not creating an emission reduction, and not creating the energy.
    - Follow up question from Solas on whether or not this is a physical constraint because there is insufficient transmission, or because there is an economic constraint?
    - Power Advisory representative responded that it could be either or; the model looks at both. But regardless the asset would not be allowed to deliver energy, and would have foregone energy to use. The asset would not be getting environmental attribute revenue, because it is not delivering anything. It depends on the contract and if energy will be spilt. MWh must be delivered in order to claim that environmental attribute. If storage is added without a full carbon price, or some way of shifting credits, it is not enough for storage to make economic sense.

- Solas representative added that there was a GE study that dealt with how much curtailment was required and focused specifically on Alberta. It indicated that there was no high expectation of curtailment and would not drive the need for energy storage because of curtailment.
- Power Advisory representative added that the GE study did not include local transmission constraints, it only looked at bulk transmission. At the end of the day you need to be able to delivery energy. If you do not have enough load for the amount of energy output, you will turn off renewables. Depending on where the price is, one can turn off for a long duration and still be financially whole.
- Follow up question from Solas regarding what sort of percentage integration is being assumed for renewable energy? And what percentage of power is coming from renewables now?
- Power Advisory representative responded that they modeled up to 15,000mw of installed capacity of renewables.
- Solas questioned how much renewable energy can bed integrated without massive curtailment? Hawaii is going through this at the moment, and curtailing approx. 25% wind in the mornings. So is the suggestion that the AESO needs to build more transmission?
- Power Advisory representative responded that not necessarily; more energy storage could be used at renewable generation locations.

- Question from AUC in reference to the charts in the Solas presentation which show that the value proposition for stand-alone storage is quite low. The AUC recently completed a distributions systems inquiry, and heard from stakeholders that where distributed energy resource, of which storage is part of, we get the most value when combined with cogeneration or internal load. Have these combinations been modeled? Also is there value if adding a storage to a load alone, without cogeneration?
  - Solas representative responded that with regard to load, it was not modeled in this case, but we have modeled it before. It is going to depend on coincident peak, and the cost of the battery energy storage system (BESS), duration of the BESS, and the operating cost of the BESS. The first place it will be economic at load, is peak saving. In California the price of energy storage is coming down quickly. In Alberta, DTS charges are impacting economics. The speed of which we integrate energy storage into our grid will be wholly determined by how we treat it for DTS and STS.
  - Representative from Chapman Ventures also added that it is not that its being priced out of the market, it is that the market is fundamentally designed for thermal generation, and that makes it bias such that energy storage cannot participate.
  - Representative from TransAlta added that the difference between Alberta and other jurisdictions is that Alberta had a different type of model in terms of transmission planning. Other markets have chosen a “transmission light” model rather than a “transmission heavy” model. However, we are seeing other jurisdictions moving closer to the direction that Alberta is currently in. When looking at energy storage and where it is with costs, it has not hit the mark where it becomes economic on a grid-alone basis, but obviously those dynamics will change in the future.
  - Representative from Chapman Ventures added that if we have to build unconstrained transmission to support massive renewable development, we will have a large add to DTS much greater than today.
  - Power Advisory representative also added that how do we make sure the asset is utilized as much as possible for the benefit of the system in all key stakeholders. That is the more

appropriate frame of mind principals to uphold and minimize new build-out until it is absolutely necessary. This may result in adjustments to regulations, planning, and market incentives to do that maximizations.

  - TransAlta representative added that to get the cost down on the transmission system, we have to increase its utilization. But we don't want to increase so much of its utilization that we create a large build-out on that transmission system.

- Question from the AESO for RMP Energy Storage in regard to compressed air storage. How fast is the transition from charging to discharging?
  - RMP Energy Storage representative responded that cycling between charging and discharging, a diabatic system will have a sub 5 min ramp rate. The compression can be shut off quickly and effectively as long as you have the surge system designed properly, you can shut if off immediately. And discharge can ramp to full capacity in less than 5 mins. I am uncertain what it would be in an adiabatic system, as they have not been as well proven.
- Question from the AESO in reference to Solas' presentation as to what assumptions were used with regard to DTS contract capacity in the economy of different cases presented. Is the contract capacity a critical percentage of the energy storage capacity, or is the assumption that the DTS contract capacity is the same as the energy storage capacity?
  - Solas representative needed to leave the session for a while and will respond directly to the AESO.
  - (A member of ESILF indicated that the contract size that you take is going to be relative to how you monetize the value stream. For instance, if you have energy storage and you have opportunities to shift that energy into a different space, and timeframes have volatility in them, you may need to contract for full charge capacity. This is to make sure you have maximum amounts of charge to discharge when the system price is better.

Sharing of experiences in commission and testing of new technologies or configurations – presentations by ATCO and TransAlta

- Question from the AESO in regard to ATCO's energy storage project and how they will manage the variability. And with the project being in a remote location, what kind of challenges are expected in real-time operations?
  - ATCO representative responded that the microgrid controller will coordinate all the devices and monitor/prioritize the generation relative to the load needs. The microgrid controller understands the frequency, voltage, load consumption, and solar generation, and will start dispatching the battery as needed. A tremendous amount of effort is needed to ensure the right parameter settings are configured for each system.
  - AESO representative also asked if any surprises were faced when commissioning the system.
  - ATCO representative responded that one of the surprises was the ventilation of the 9kw of heat in summer. Another was during night fall, and the battery did not respond fast enough. The plant was only on one unit, and the underfrequency tripped the plant, which caused the community to go dark for 6 minutes. This resulted in a change to the parameter settings to ensure faster battery response.
- Question from the AESO for TransAlta based on commissioning experience; and if there any technical challenges to be shared with the forum?

- TransAlta representative responded that they had to work very closely with Tesla to learn and understand all the capabilities and settings of the battery. Would suggest working closely with the OEM to fully understand “on”, “off” and “idle”, as well as ensure firewalls are open between IT security and the OEM system.

- Question from the AUC for ATCO in regard to insulation requirements for freezing temperatures, and whether those are indoor or outdoor requirements?
    - ATCO representative responded that the insulation requirements are to maintain indoor temperatures during winter. Although solar panels can operate in temperatures as low as minus 25 degrees Celsius, batteries have temperature sensitive components and require a temperature of 0 to 10 degrees. And in the summer, the opposite is required to keep temperatures from over heating due to the insulation. This is generally achieved through a ventilation system.
- Question from TERIC Power for ATCO on whether ATCO is able to share who the technology provider for the battery energy storage component is; this is in regard to the cold weather and packaging.
    - ATCO responded that the batteries are Samsung, however, the integrator was ABB. They do not build the enclosure, but rather hire a third party for the build.
- Question from Alberta Energy for both ATCO and TransAlta on their experiences in the project regulatory and approval processes from conception to execution. And how this experience compares to other jurisdictions.
    - TransAlta representative responded that they had worked very closely with Alberta Environment and Parks, the AUC and the AESO throughout the process. There are current rules and regulations that don’t factor in batteries easily, so collaboration with all the regulators began prior to project initiation to understand what the requirements would be in order to operate under the current framework. Without the constant collaboration, the process would have been much more difficult.
    - TransAlta representative added that there is great interest in energy storage, however, the difficulty is facing the regulatory uncertainty with the framework that does not contemplate the technology. This is considered a barrier to entry if you don’t know where you stand with regulatory agencies. And although some projects have been built and the regulatory agencies have caught up to a certain extent, unless the government and the agencies are thinking about how to smooth the path, it becomes a very big obstacle to move projects forward.
    - RMP Energy Storage representative also added that for a small developer in a merchant market, market barriers and uncertainty diminish innovation, stifle competition and result in job loss. It is understood that these barriers cannot be removed over night, but there needs to be a concerted effort. We are very hopeful that these barriers can be removed so we can build on energy storage opportunities as fast as possible.

Modeling economics of transmission storage under the current framework – presentation by AltaLink

- Question from the AESO for AltaLink in regard to the presentation. Would market participant energy storage and transmission energy storage have comparable availability? Also, are the two cost-comparable when service is not required and the transmission energy storage sits unused while the market participant energy storage participates in the market?
    - AltaLink representative responded that there are two transmission development routes defined, either direct assigned or competitive bid. The AESO will have to make a judgement on what

the best public interest on which route to take. As far as availability for transmission storage versus market-based storage, transmission storage will be 100% available because they will remain under the AESO's control and not participating in the market or providing other services. And for the market participant storage, they will generally not be available, or fully charged, when the pool price is high. Whereas the transmission facility is designed as a contingency support and will remain fully charged.

- Follow up question from the AESO in how this supports the FEOC market considering the different cost structure between a regulated versus non-regulated asset.
- AltaLink representative responded that this asset does not participate in energy market operation nor does it influence price signals. Due to this, there should not be any FECO issues. As part of the storage operation in providing transmission services, there may be occasions when responding to contingencies that charging and discharging occurs. However, that is no different than current transmission operations in the system when switching transmission lines and losses occur.
- Question from Chapman Ventures for AltaLink in reference to the value stacks slide in the presentation. We can see that the avoided cost of local transmission would be a cost realized by a TFO or regulated asset. The avoided LSSi cost, which is a market product, it seems that with price signals those same benefits could be realized by participants bidding into the market and providing that service. Could you clarify on how the value of mitigating the minimum unit contingency falls as a potential item that would be a regulated use case benefit, or a deregulated benefit.
- AltaLink responded that LSSi is a market product which is procured from the market service provider and the cost is charged on the transmission side. LSSi is a transmission problem when we do not have enough ATC on the intertie. And what could happen is the build another intertie, or the build of a storage facility to solve the problem. Because neither were done, LSSi went to the market side. If there is a transmission solution which could solve that problem more cost effectively, then the need for LSSi can be reduced.
- Follow up question from Chapman Ventures on whether or not a market participant owned asset could serve this purpose, assuming they are situated on the grid that relieves the constraint that a transmission owned asset would.
- AltaLink responded that yes, they could serve this purpose. However, a market participant would want to provide grid support when pool prices is low. Intertie support is typically during high priced hours, and that is when the market participant would typically be participating in the market, making its availability low compared to a transmission owned asset.

- Comment from TransAlta that AltaLink's presentation is a position from AltaLink focusing on a regulated structure versus a market structure, and suggesting that the TFO is the only one who could provide these services. This is false logic that only TFOs canprovide this service. There are many structures in which a market participant, that has a battery storage asset, can provide NWA that are the alternative to the transmission service. They do not have to offer their full capacity to provide that product, which would allow them room to be in the energy market.
  - Chapman Ventures representative agreed with TransAlta's comments.
  - AltaLink representative responded that what is being presented describes the difference between a fully available and partially available facilities. And there is a consequence on the market and price to the customers.

- TransAlta representative added that a non-wire service alternative for an energy storage service provider is not required to have full capacity of the energy storage asset. In actuality they would be considering whether it is more valuable for them to be in the energy market versus dedicating a certain amount of their capacity. If offering that service was lucrative enough, and were compensated by differing transmission costs, that is exactly what they would do. The analysis in the presentation is missing a large gap in where non-wire alternatives become very valuable. Which is, if a TFO built the battery, and thereafter the battery wasn't needed because they built a massive expansion to the transmission line that made that battery unnecessary for providing that non-wires alternative, that assets is now stranded in the TFO's rate base, unless they are going into the energy market. I don't think we've ever created a construct that suggested TFOs should be in the energy market with assets that are paid for by rate payers. What you've described here does not comport with the regulatory structure, and is creating a false narrative that the TFO is doing this at cheaper cost than energy market participants, without fully articulating what the true risk is for the rate payer.
- AltaLink representative responded that in integrating energy storage, you need find the least cost path and respect the current industry structure.

All mentioned studies and reports to be shared with the group.

VI. Wrap Up and Next Steps

Next session is planned for Fall in 2021, with topics to be determined by suggestions from the membership. The AESO is also planning on inviting representatives from other jurisdictions to share their learnings and experience in integrating energy storage into their systems.

The session summary and the third workshop topics and schedule to be published on the AESO website at www.aeso.ca. Any further questions can be sent to the Energy Storage inbox at energystorage@aeso.ca.