Energy Storage Working Group Proceedings

PNWER Annual Summit – Whistler, British Columbia

July 22nd, 2014

Co-Chair: Rep. Jeff Morris, Washington State Legislature

Co-Chair: Mark Oens, Senior Manager, Substation Metering & Telecomm Services,

Snohomish PUD

Speakers

Phil Jones, Commissioner, Washington State Utilities

Brent J. Sheets, Research Manager, Alaska Center for Energy and Power,

University of Alaska Fairbanks

Helen Whittaker, Manager, Technology Innovation, BC Hydro

Mark Oens, Senior Manager, Substation Metering & Telecomm Services,

Snohomish PUD

Russ Weed, VP Business Development & General Counsel, UniEnergy Technologies (UET)

Jeff Morris introduced the session by describing how energy storage had emerged as a key issue within PNWER, and that an action item emerged to update the regulators on energy storage issues.

Mark Oens stated that the Snohomish Public Utility District (SnoPUD) is very active in the energy storage space.

Advances and Challenges with Energy Storage

Phil Jones began his talk by indicating that energy storage has been a focus of his career, and gave an overview of new developments and challenges in energy storage. There have been a number of recent advances in technologies such as compressed air energy storage, lithium batteries, and both stationary (utility scale) and mobile (customer scale) energy storage. These technologies are still very expensive, but the good news is that the cost curve is coming down. Large companies are also involved in these advances – energy storage is not just a start-up field. Another good sign for both technology and cost is Tesla's announcement of a battery factory, which is causing a lot of excitement in the Southwest US. State governments are also having significant influence over the industry. California continues to lead the way in energy storage. Their recent commitment to have 1325 MW of energy storage by 2020 is having a major impact on the industry. Washington recently created a $40 Million Clean Energy Fund under the leadership of Governor Inslee, a significant portion of which has been allocated for energy storage projects in the State.

Phil Jones continued to discuss the price drop in energy storage and how to support the viability of energy storage. The cost of a lithium battery in 2010 was $900/kw, today its $364/kw, and studies by McKinsey say it could drop to $200/kw. Tesla's battery factory will encourage this drop. However, Utilities are very conservative; they can be fined by the Federal Energy Regulatory Commission (FERC) for being unreliable. There will be a transition to a smarter, more distributed, energy model, but it has to happen in a more reliable and affordable way. The industry has to get behind R&D, testing and benchmarking, and help work through the challenges we're facing. Energy storage solutions will not become viable without a concerted targeted industry-wide effort.

Q&A

Jeff Morris stated that the unclear regulatory pathway for energy storage seemed like a barrier.

> Phil Jones confirmed that this was true, and that because distribution is the role of States, but Transmission is the role of the Federal regulator, FERC, than it can get pretty complicated. He indicated that the State regulated distribution organizations were much easier to work with. However his organization was meeting regularly with FERC to clarify how energy storage is addressed between these different regulators. They are also looking at cyber security issues, which could begin at a distribution (State) level, and progress up into the overall system.

Paul Manson stated that interest in storage has mostly been as an ancillary service, but that in Europe pump storage has been used to address the intermittency of renewables. He asked if there were any communication channels with Europe to learn about these new initiatives.

> Phil Jones responded that yes, colleagues had recently returned from Denmark, and that a number of Energy Commissioners go to Germany regularly, and meet with European regulators once per year. However, he encouraged attendees to not just look to Germany, but also learn about what Japan is currently doing. They are unlikely to return

to Nuclear, and are undergoing an energy revolution. They are becoming leaders in generation, storage, home energy systems, smart grid and trying to divest generation from transmission.

Alaska and Energy Storage Technologies

Brent Sheets began his talk by providing an overview of energy issues in Alaska. There are extremely high energy costs in Alaska; from $0.26/KWh in Fairbanks up to $1.00/KWh in rural areas. Many communities have to get diesel fuel shipped in by barge. Most communities have islanded electric grids; they are not connected to a State grid. Alaska is a great place to develop resources, but it's hard to get money to do it given the small population and limited funds. Between the harsh climate, limited road network and limited grid access these resources become stranded.

Brent Sheets moved on to describe his organization, the Alaska Centre for Energy and Power (ACEP), whose goal is to develop and disseminate practical, cost effective and innovative energy solutions for Alaska and beyond. Their 20 staff work on projects across the State covering a wide variety of areas such as low temperature geothermal, biomass energy, islanded grid system efficiencies, waste heat utilization and transmission and distribution. They've also set up a test site for trialling new technology safely, without fear of brand damage to your company if the technology fails.

Brent Sheets then described the key role that energy storage plays in Alaska. Over 60 communities have wind turbines, but create excess power due to the communities being so small. In addition, diesel generators work best when they run consistently – they don't like being turned on and off all the time. Energy storage could support load leveling, power quality, efficiency gains, and enable integration of intermittent resources. However, batteries create other issues. They are very heavy, which is an issue to transporting them to remote villages. The technology can be complex, creating issues for maintaining them. And when they are finished, they are hazardous materials and disposal becomes a major issue.

Brent Sheet continued by providing specific examples of energy storage projects that ACEP are working on or which are operating in Alaska today. For example, ACEP is working on flow battery testing, and is working with Hatch Engineering on flywheel storage. Fairbanks currently has the world's largest battery system. Its can run all of Fairbanks for 5-10 minutes, helping to reduce the impacts from blackouts. He concluded by encouraging people to make use of ACEP's test site, the Power Systems Integration Lab, to test their technology, before trialing it in a community. More information on ACEP is available at the following link: www.uaf.edu/acep

Q&A

An attendee asked who owns the small utilities in Alaska.

> Brent Sheets responded that there are several different models. Many are village owned and operated, with government providing support. Most communities have prepaid meters – they swipe their card and see their use immediately. As a result, villages are very aware of their energy use and what they are spending on energy, and are very energy efficient.

Energy Storage Update from BC Hydro

Helen Whittaker began her talk by stating that as the strategic planner for emerging technologies at BC Hydro, she surprisingly spends more of her time trying to slow people down than speed them up. She also remarked that BC Hydro didn't have much need for large scale energy storage, as their reservoirs served that function. The energy storage required is mostly for small scale or local applications. Part of her role is to evaluate new technologies that could become useful to BC Hydro, based on strategic objectives, safety, financial, reliability and environmental metrics. She presented a graph showing different technologies, how far off they were from being realized, and their value to BC Hydro. She emphasised that no energy technologies were ready for the near future. Only home energy management systems were in the middle, but they had a low value to BC Hydro. Integrated Renewable Energy Systems, on the other hand, were very high value, but were a long way off from being ready.

Helen Whittaker then moved on to discuss several energy storage projects that BC Hydro has worked on. In May 2014 they worked on an integrated renewables project with BCIT, utilizing small scale solar purely for vehicle charging. One major pilot was completed recently in Field, BC. The community suffered from frequent and long blackouts due to the long transmission line from the town of Golden, which took a long time to fix due to the remote and rugged terrain. 2MW of energy storage (sodium salt battery) was proposed to improve reliability of the system. The process started with an application to the Clean Energy Fund in 2009, and the system wasn't operational until 2013. The process was so time consuming largely because the technology was new – they had to rewrite the rules and language as they went. They had issues around importing the battery from Japan because the government wasn't sure how to tax it. Both regulators and BC Hydro weren't sure how to classify the battery system – was it a substation or a transmission centre? In terms of what the community experienced, the project was a major success. Reliability was significantly improved, with the impact from one major blackout being reduced from 24 hours to only 1 hour due to the backup battery system.

Helen Whittaker concluded her talk by emphasising the need to test experimental systems nearby and in test labs. It isn't practical to have an experimental system that needs regular adjustment and maintenance in a remote area. BC Hydro now has a test lab in Surrey, Powerteck Labs, specifically for this purpose. She emphasised that Utilities have to be slow and conservative since they are regulated and have a responsibility to their customers to provide reliable service. The test lab reduces the risk to the grid from new technologies.

Q&A

An attendee asked if the main purpose of the battery system in Field was to reduce outages, not peak management.

> Helen Whittaker confirmed that this was the case, although the system also helped with peak management.

The attendee asked if BC Hydro had looked into Zinc Air batteries.

> Helen Whittaker responded that they had, but that when they were reviewing Zinc Air, that the companies proposing it didn't actually have a product that fit the application. BC Hydro knew that the system integration piece would be very difficult, and wanted to minimize risk from the battery itself. So they went with a more established battery technology.

Helen Whittaker indicated that the cost of the battery system was compared to the cost of installing a diesel system. The diesel system was more cost effective, but 50% matching funds from the government helped get the battery system cost close to diesel. What helped tip the scales was that no one wanted a diesel system in a National Park.

Grid Energy Storage Initiatives in Snohomish County Public Utility District (SnoPUD)

Mark Oens started by describing the Snohomish County context in terms of energy use. SnoPUD currently buys most of their energy from BPA; they only generate a small amount of their own power. However, they want to change this, and meet future load growth with renewables. The challenge is that renewables are variable, and between the wind fluctuating and demand fluctuating, it's very difficult to manage and integrate. Their goal is the integration of distributed generation, increased reliability, and optimization of the electric system. They want to maximize use of existing infrastructure and limit further expansion (that is both unnecessary and costly).

Mark Oens then outlined how grid scale energy storage was a key technology that would help enable SnoPUD to reach these goals. Storage helps with renewables integration, peak shaving, and deferring capital investments and new infrastructure. However, current grid energy storage offerings are expensive ($100 thousand for a 25 KWh system) and lack the ability to integrate with the Utility / grid system. In addition, most utility scale battery systems are "one-off" demonstration projects that are unlikely to transfer to another application or scale. SnoPUD identified an opportunity to create standardization in the grid scale energy storage industry. By creating a system that uses energy storage system building blocks, you will eventually be able to exchange bits and pieces in the battery/power/control system package. This will reduce the cost of the system components and also increase use.

Mark Oens then detailed the specific pilot projects that SnoPud was engaged in. Snohomish received $7.3 Million government funding for battery storage projects. The first is called MESA 1, which is a 2MW Li-ion battery. Phase 1a will be implemented by the start of 2015, and 1b will be implemented by the end of 2015. The project deliverable is to design, deploy and test the first modular component-based utility energy storage system. They will also demonstrate a multi-vendor solution, and integrate the system into the district's communication and control systems. The test site is located only 2 miles from his office, which helps with R&D – if something goes wrong they can fix it quickly and easily. Li-ion batteries however like a controlled environment – they had to install an HVAC system just for the battery, and had to keep in mind environmental and fire safety issues.

Mark Oens moved on to detail the MESA 2 pilot project. MESA 2 is a 2MW/6.4MWH Vanadium Flow System that uses technology from several different vendors (an integrator from 1Energy, a PCS from AEG, and a battery system from UET). The focus of both pilots was on control systems and optimization. They are also looking at what the best application would be for each battery type. Mark Oens concluded by mentioning the MESA Standards Alliance whose work on open standards for energy storage is gaining momentum in the industry.

Q&A

An attendee asked what applications MESA 1 and MESA 2 are looking at.

> Mark Oens responded that applications include checking battery performance, peak shaving, and volt-VAR.

<u>Safe, Reliable and Flexible Batteries for the Power Grid</u>

Russ Weed began by introducing his company, UET, which is a technology vendor and relatively new startup based just north of Seattle. (They are the company that supplied the vanadium flow battery to SnoPUD's MESA 2 pilot project). He continued by describing their core technology, a 500KW vanadium flow battery system located adjacent to the UET facility. The system is cost reduced, space/footprint reduced, and operational conditions/limitations reduced. They use standard sized shipping containers as inexpensive battery housing, and require only 4 of them covering roughly 820 sqft (1/5th the footprint of the prior generation of vanadium flow batteries). The system is passively cooled – it does not require an HVAC system like Li-ion – and safely operates in a broad temperature range. The system has successfully charged and discharged off of the SnoPUD grid. UET will soon have a 2MW system with SnoPUD (the MESA 2 pilot), and also a 1MW system with Avista. UET is growing rapidly; it had only 2 employees in March 2012, and now has 50 employees. Their goal is to become a major global provider of bulk energy storage solutions through innovation, strategic partnerships and quality. UET is scaling up manufacturing to 100 MW/year (1000 containers/year). The containers are completely self-contained systems to reduce complexity of installation. All the client needs is a concrete pad and an interconnection.

Russ Weed then moved on to discuss the market for grid scale batteries, and the advantages of vanadium flow systems. The 1.325 GW of mandated energy storage in California is driving the North American energy storage market; they will likely be the majority of market through 2020. Analyst firms now project that the grid storage market will be over $100 Billion by 2020, with a CAGR over 30%. UET's technology is a 3rd generation vanadium flow battery that has significantly improved upon previous generations. It uses a new electrolyte with a broader working temperature range. The chemistry is stable, non-reactive, and has the same low hazard rating as liquid nitrogen. Vanadium itself is not a rare-earth mineral; it is the 7th most common metal on earth, and can be produced from steel production.

Q&A

An attendee inquired about the cost of a single shipping container battery.

> Russ Weed responded that it depended on the application, but roughly less than $0.75 / KWh.

An attendee asked about fire safety, and if they were communicating with the local first responders.

> Russ Weed confirmed that they were.

Another attendee inquired that the technology was moving very quickly, and was regulation going to follow.

> Russ Weed confirmed that that made sense.

Another attendee asked Phil Jones if with the new 111D rule coming in, would more importance be placed on using what is actually generated.

> Phil Jones responded that the 4th building block of the rule is energy efficiency, and that this will likely have the greatest impact. The 111D rule could link into energy storage

through mandating storage with the addition of new renewables to the system, to prevent or at least reduce the "duck curve" they're experiencing in California.

Action Items Discussion

Russ Weed advocated for getting the word out about energy storage projects that are happening in the region.

An attendee asked Helen Whittaker where she gets her information.

> Helen Whittaker responded that BC Hydro belongs to a number of organizations which all share information with utilities. They also get information from vendors and organizations like Gartner that help you understand where new technology is and what the risk is. A lot of info is out there.

Phil Jones suggested the group could promote a sharing mechanism for all the projects going on.

An attendee asked Mark Oens about permitting new technology, and how there often isn't a way for municipalities to learn from each other.

> Mark Oens stated that no one had put a battery system like this in before, but that SnoPUD would be happy to share the work they did with permitting - Its public knowledge.

Another attendee suggested that a cheat sheet, with experiences, lessons learned, and challenges faced due to new technologies would be really useful.

> Mark Oens responded that SnoPUD had put together a lessons learned for their MESA 1 and MESA 2 projects. They needed to learn quickly because these projects are under a lot of time pressure.

Jeff Morris built on the comment by adding that lessons learned about planning, procurement, permitting and funding would be really good for policy makers.

Another attendee suggested that lessons learned and how to track them should be a discussion topic at their next PNWER meeting.

Another attendee said she would be interested in case study write-ups with a clear consistent format, and key elements of interest.

Helen Whittaker responded that the DOE has a number of case studies, but that they may need to be edited for this audience.

Paul Manson suggested that the group could consider making recommendations to consider pump storage on the Columbia River, to the Canadian Federal Government in the Columbia River Treaty Negotiations.

Jeff Morris responded that the group should discuss pump storage more in the future.

Phil Jones supported the previous suggestion that the group could take a look at lessons learned in respect to smart grid integration, funding, and energy storage.

Action Items Summary

1) Create a tracking system for lessons learned on energy storage.

2) Develop a planning, procurement and permitting cheat sheet / lessons learned.

3) Catalogue of case studies for the region

4) Summarize / simplify DOE's existing case studies – reducing the engineering lingo in case studies so they are more relevant and clear for policy makers.