PERFORMANCE OF A 1 MW STORAGE SYSTEM IN VARIOUS GRID APPLICATION WITHIN A WIND R&D PARK

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Introduction
The Wind Energy Institute of Canada (Institute) is located on Prince Edward Island (PEI), Canada which has a peak load of 260 MW and an installed wind capacity of 204 MW. The Institute owns and operates a 10 MW Wind R&D Park and a 2 MWh Battery Energy Storage System (BESS). The BESS is used in a variety of use-cases to understand the technical and economic impact of a storage system.

Use-Cases
The Institute has tested the following use cases:
- Wind Time-Shifting: March 2014 to November 2014
- Demand/Energy Avoidance: December 2014
- Diesel Displacement: January and February 2015
- Automated Generation Control: July and August 2015

Results and Discussion
Wind Time-Shifting
Time-shifting so that energy is stored when demand is low and is released when demand is high provides a baseline for services but is not currently a financially viable option in PEI.

Demand/Energy Avoidance
Over the month 8517 kWhs were supplied to the turbines during periods of low wind to allow the turbines to yaw, run pumps and heaters. During an extended low wind period the battery reached its bottom state of charge threshold (5%) and therefore did not provide all the electricity the turbines required and was unable to avoid the demand charge.

Diesel Displacement
The Institute discharged 7 times during January with 6 instances occurring during diesel power usage. These 6 discharges resulted in 10.6 MWhs of high value electricity being sent to the network. Due to the heating requirements during idle periods the efficiency for January was 50.2%. For the charge/discharge cycles the average full roundtrip AC efficiency was 76.3%

Automated Generation Control (AGC)
AGC is used to ensure that the electricity generation and demand match on a second by second basis so that the frequency remains at the nominal frequency (60 or 50 Hz). Storage can provide this regulation service and a historical PIM dynamic AGC signal was sent to the storage system which, when wind power was available, charged and discharged according to the setpoint. In July the 1 MW nameplate was offered and in August 500 kW. The efficiency for the months were 75.9% and 60.7% respectively.

Conclusions
The Institute has found that energy storage can be used for many applications and each of these applications have a different operating cost and efficiency. Energy storage allows wind power to be a dispatchable resource. Next steps include other use-cases such as stacking services, voltage support and capacity.

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