

Investing in Renewable Energy

SODIUM SULFUR BATTERY ENERGY STORAGE AND ITS POTENTIAL TO ENABLE FURTHER INTEGRATION OF WIND

Project Description

Xcel Energy installed a one megawatt (MW) wind energy battery storage system, using sodium sulfur ("NaS") battery technology, to validate the value of energy storage on the Xcel Energy system. NaS technology was selected because it has: high storage capacity; ability to handle numerous charge-recharge cycles from an intermittent wind source; potential for large scalability; a dynamic response to system changes; and was commercially available. The battery system is roughly the size of two semi-trailers stacked one on top of the other and stores about 7.2 megawatt-hours (MWh) of electricity. When fully charged, the battery could power 500 homes for more than seven hours.

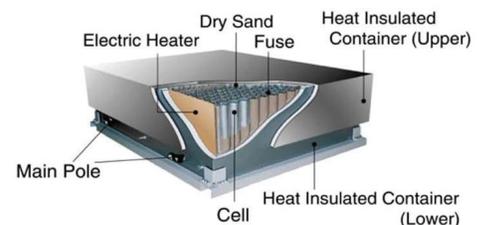
Methodology

The project was based near Luverne, Minn. with the battery installation adjacent and connected to an existing 11 MW wind farm. The battery went on-line in October 2008. Testing the battery under five different operating modes commenced at that time and continued throughout the project. Operating modes included: basic storage; economic dispatch of electricity based on market prices to capture arbitrage benefits; frequency regulation; wind smoothing; and wind leveling. Data was collected to evaluate battery impact from different charging and discharging cycles and cell life.



Partners

Minwind Energy LLC – Wind facility
S&C Electric – Project engineer
NGK Insulators- Battery manufacturer
GridPoint- Communication for system integration
University of Minnesota – Cost analysis
Great Plains Institute – Policy analysis
National Renewable Energy Laboratory – Integration analysis



Grantee: Xcel Energy Services, Inc.

Project Dates: 5/8/2009 – 4/15/2012

RDF Funding Cycle: 3

Project Funding: \$1,000,000 RDF Grant (Total project cost \$4,247,181)

Project ID: RD3-12

RDF Mission: To increase renewable energy market penetration, assist renewable energy projects and companies, and support emerging renewable energy technology through research and development.

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Executive Summary

Integrating a variable wind resource with a power grid that requires a high level of reliability is a challenging issue for the electrical industry. The project tested the hypothesis that effective storage of wind energy enables 'smoothing' of wind energy and reduces the impacts from the variability and limited predictability of wind generation resources. How battery energy storage supports the transmission and distribution grid was also evaluated, which is essential to integrating a much larger percentage of wind resources into the regional energy resource mix.

Benefits

There is a real potential for affordable energy storage systems in the next five years. Because of the knowledge gained, Xcel Energy is better positioned to strategically implement energy storage technology. Xcel Energy's customers have benefited from:

- Increased energy storage flexibility over traditional peaking resources because it is both a dispatchable load and a dispatchable generator
- Understanding how to determine a beneficial price range for energy storage deployment
- The fast-response services that a commercial storage system provides to the transmission system
- Increased company expertise in essential energy storage system functions
- Improved penetration of distributed generation by managing grid issues related to system reliability and performance

Lessons Learned

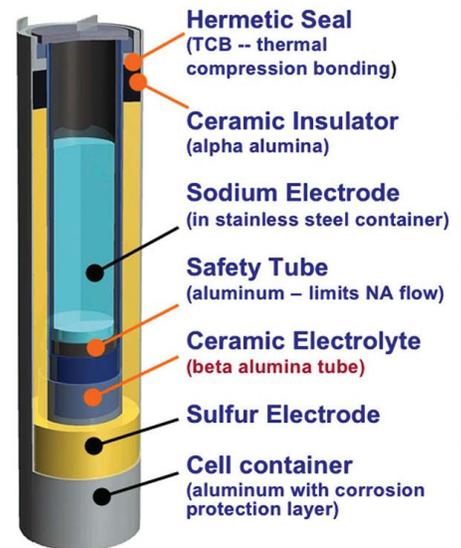
Xcel Energy gained an understanding of how to determine the price range at which energy storage will be cost beneficial.

- Based on arbitrage value, the optimum battery capacity to wind farm capacity appears to be between 20 percent and 40 percent
- Battery storage can smooth a wind resource's output ramp rate and provide a time shift function with the same system during the same time
- Offering the battery system in the MISO ancillary services market for stored energy resources can deliver more revenue than operating the system for arbitrage value
- Bulk energy storage assets must be competitive in price to traditional peaking generation
- A one MW battery effectively levels one MW of installed wind capacity

Outcomes

Test results indicate that the battery has the ability to:

- Effectively shift wind energy from off-peak to on-peak availability
- Reduce the need to compensate for the variability and limited predictability of wind resources
- Support transmission grid reliability by providing voltage support
- Support a regional electricity market by responding to real-time imbalances between generation and load



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