Technology Innovation Project

Project Brief

TIP 244: Advanced Life-Extending Control of Multiple Energy Storage Solutions to Reduce Load-Following Dependency and Wear on the Hydro Power System

Context

The abruptly increased production of wind power in the Pacific Northwest has proved both a blessing and a curse for BPA: A blessing in its promise to abundantly supplement the PNW's providential hydro resource; and the curse of its variable nature – on again, off again – which creates headaches for dispatching and greatly reduces system flexibility. An already topped-off transmission system can't accommodate more wind input. The obvious solution is to somehow store that wind energy and conveniently return it to the system when needed. Equally obvious is that there is yet no satisfactory storage solution. This project aims to remedy that nagging situation: Using the in-lab grid at the Wallace Energy Systems & Renewables Facility (WESRF), research is being conducted on the ability of wind farms to participate in automatic generation control (AGC) through utilization of energy storage resources (super capacitors, flow cell batteries, pumped hydro, flywheels (simulated), and superconducting magnetic energy storage (SMES) (simulated)). Results already show that with the addition of energy storage resources, wind farms are able to participate in AGC. With such understanding will also come the ability to analyze the potential financial benefits of energy storage implementation and propose solutions to the problem.

Description

The proposed project includes advanced "life-extending control" and coordination of multiple energy storage solutions to maximize cost-effective energy production, reduce dependency and strain on the hydropower system by buffering from variable renewables, reduce spinning reserve and peak load problems, increase transmission capacity and help stabilize power quality disturbances. Comprehensive modeling will be performed, in addition to using the in-lab grid, established at Oregon State University (OSU) through prior BPA funding, as an essential hardware verification system. Advanced forecasting tools will be developed leading to new operating protocols and guidelines to ensure reliable system operation. With the increased diversification of the power system, advanced approaches to monitoring and optimizing the mix of dispatchable and nondispatchable generation will be researched, to increase the efficiency of generation and to mitigate the negative impacts of integration of variable resources.

Why It Matters

BPA is currently in the unenviable position of having to curtail wind power input to the system because the variability of this providential resource has created havoc with system stability and peak load service. BPA engineers and planners have been working tirelessly to create "workarounds" to keep the system functioning optimally while accommodating as much wind power as possible; but the obvious solution is to store and buffer the renewable resource such that it can be added to the hydrosystem – which can't be readily turned on and off – at suitable times and with desirable financial consequences. This project proposes to develop this highly sought-after function.

Goals and Objectives

1. Advanced coordination and control of multiple energy storage solutions. Automated Generation Control (AGC) system compatibility, including optimizing energy storage locations. Extend energy storage system operation to run as Flexible AC Transmission System (FACTS) devices for short-term voltage support and reactive power control.
2. Research "life-extending control" (LEC) of energy storage specifically to mitigate wear-and-tear on hydro turbines, including developing tools for quantifying real-time mechanical damage and optimizing Coulee Dam operations.
3. Develop advanced forecasting tools leading to new operating protocols and guidelines to ensure reliable system operation. Research to reduce magnitude and frequency of large power scheduling errors due to ramp events.
4. Investigate optimal energy storage placement to best serve system needs.

Target 1: Enhance future Federal Columbia Power System (FCRPS) FCRPS reliability, operation and maintenance through advanced forecasting tools and LEC of energy storage resulting in less strain on the hydro system to perform load following, balancing, reactive support, and regulation; the investigation of extending multiple energy storage control so that it is Automated Generation Control (AGC) system compatible.

Target 2: Design operational improvements including LEC, to reduce costs by reducing hydro system maintenance requirements associated with the added strain of load following, balancing, reactive support, and regulation.

Target 3: Maximize existing asset use (e.g., for base load) and extend the useful life of assets through LEC and by educating students to be "work-ready" hires for BPA to address the concerns of the "aging workforce." This will be accomplished through Hydro Research Foundation fellowship opportunities integrated into project work.

Target 4: Decrease the FCRPS environmental footprint through reduced dependency on hydro reserves.

Target 5: Increase generation efficiency ("increased power per unit of water") through LEC to operate the system with real-time optimization.

Deliverables

Four Stage Gate Reports will be submitted, along with progress presentations and a final report that will include including lessons learned and next steps for technology development. Comprehensive simulations and a full lab-grid implementation can also be arranged.

Project Start Date: Nov 14, 2011

Project End Date: Sept 30, 2012

Reports & References

4 Stage Gate Reports

Funding

Total Project Cost:	$700,256
BPA Share:	$347,134
External Share:	$353,122
BPA FY2012 Budget:	$348,134

Participating Organizations

Built Environment and Sustainable Technologies Center (BEST)
Central Lincoln PUD (CLPUD)
Hydro Research Foundation
Grainger Center for Electric Machinery and Electromechanics (CEME)
National Science Foundation (NSF)
Oregon Institute of Technology (OIT)
Portland General Electric (PGE)
Wallace Energy Systems & Renewables Facility (WESRF)

For More Information Contact:

BPA Project Manager:

Stephen White
sawhite@bpa.gov