Technology Innovation Project *Project Brief*

TIP 51: Transmission Planning Projects – Power Flow, Stability Controls & Monitoring

Context

BPA's transmission system is typically voltage stability limited. Traditionally, severe outages and grid disturbances threaten the voltage stability of the system. Today, BPA must additionally manage for generation patterns that are more volatile due to integrating large amounts of wind generation that provides lesser voltage control capabilities and changing load characteristics such as more air-conditioning and electronic loads. All of these factors conspire to increase instability on the grid. This project looks at a portfolio of operational and control solutions to maintain and increase voltage stability limits.

Description

The project's objective is to develop a comprehensive "defense" in depth control strategy to increase voltage stability across BPA's transmission system. The project encompasses the following issues.

- *Operator:* What tools do operators need to have better awareness of voltage stability risks?
- *Grid Level*: What coordniated voltage controls are needed to optimize for voltage stability and to deal effectively with fast wind ramps?
- *Supply Side*: What voltage controls do we need from wind generators?
- *End-Use:* How to model end-use behavior in dynamic stability studies? What are the risks of voltage-induced voltage instability in Pacific Northwest?
- What are the risks of voltage collapse cascading into Western Electricity Coordinating Council-wide outage?
- What is the appropriate regulatory framework to evaluate load-induced voltage instability risks and make capital investments?

Why It Matters

BPA's transmission system is mostly voltage stability limited and, on one side there's a desire to increase the transmission capacity at the lowest cost to the ratepayers. While, on the other side, the agency's facing very signficant reliability challenges due to:

- Greater variety and variability of generation patterns and reduced time for operational decision making;
- Changing voltage control characteristics and renewable generation capabilities;
- And changing load composition in Pacific Northwest.

A combination of situational awareness tools and response-based controls are needed to increase the voltage stability limits while meeting the emerging reliability challenges.

Goals and Objectives

The objective of the proposed project is to develop a comprehensive "defense" in depth control strategy to increase voltage stability limits across the BPA transmission system. The project encompasses multiple issues:

• *Operational tools:* Evaluate operational tools for better situational awareness of voltage stability risks
• *Grid Level:* Develop response-based voltage stability scheme. Develop a framework for coordinated voltage control
• *End-Use:* Develop appropriate models to study the phenomenon of load-induced voltage instability.

• *Risk & Investment:* Assess reliability risks, support the development of the regulatory framework for capital investment (NERC/WECC reliability standards drive transmission capital investment and operating limits)

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Project Start Date: October 2009

Project End Date: September 2015

Key Results/Conclusions

A combination of model-based stability assessment, measurement based tools and response-based Remedial Action Scheme (RAS) are needed to address voltage stability limits.

Operational tools:
Several measurement-based tools have been researched and are currently in the prototype phase.

Response-based RAS:
Wide-area control system is under the development. WACS will be deployed under the synchro-phasor capital program.California-Oregon Intertie reactive coordination studies are in progress.

Wind power plant voltage controls:
Voltage control requirements are developed. Secondary voltage control studies are planned.

Load-Induced voltage instability
Load models are developed by WECC. BPA did significant amount of equipment testing, model development and data preparation. Studies indicate that the Portland metro may be at risk of voltage instability due to air-conditioner stalling.The project supports the development of regulatory framework which will have huge impact on the capital investment needs.

Analysis tools:
Tools for analysis of wind power plant voltage controls.

Time-sequence power flow:
Time-sequence powerflow capabilities in Power World and PSLF; also, the time sequence for studying the impact of wind ramp events on system voltage stability.

Funding

Total Project Cost:	$2,667,253
BPA Share:	$2,667,253
External Share:	None
BPA FY2012 Budget:	$250,000

Participating Organizations

Western Electricity Coordinating Council (WECC)
US Dept. of Energy (DOE)
North American Synchro-Phasor Initiative (NASPI)
Lawrence Livermore National Laboratory (LBNL)
Expert Panel (alphabetically):
- Chris DeMarco
- Ian Hiskens
- Damir Novosel
- Carson Taylor
- John Undrill

For More Information Contact:

BPA Project Manager:
Dmitry Kosterev - TPP
dnkosterev@bpa.gov