Transmission Efficiency Initiative: Host Demonstration Project

PMU-Enabled Volt/VAR Control at Devers Substation

Substation

- Demonstrate implementation and benefits of innovative, closed-loop, dynamic voltage control scheme that uses phasor measurements.
- Deploy the advanced control scheme at Dever substation.
- Benefits include improved voltage stability, reduced losses, increased system utilization, and reduced carbon footprint.

Synchronized phasor measurements have great potential for improving not only power system monitoring and visualization but also control. Southern California Edison (SCE) is actively pursuing electric power system control applications using synchrophasors.

As part of EPRI's Transmission Efficiency Initiative, SCE is evaluating a possible demonstration of a voltage and volt-ampere-reactive (VAR) control system at Devers substation based on phasor measurement technology. Devers substation has multiple VAR control devices— shunt reactors, static VAR controllers, and shunt capacitors at 500, 230, and 115 kV. The AA and A banks at Devers also have on-load tap changers. This program will coordinate these different devices so they do not counteract or negatively impact each other. Phasor measurement unit (PMU) technology will be used to obtain high-speed inputs from various devices, a valuable tool for coordinating controls. The integration of enhanced volt/VAR control systems into the existing centralized grid capacitor-control system will be also considered.

SCE has already implemented PMU-based control for secondary voltage control at the Rector substation. An innovative control scheme that uses synchronized phasor measurements in a closed-loop, dynamic fashion was implemented. That project is considered the first application in which synchronized phasor measurements are used in a closed-loop, dynamic control scheme. The Rector project demonstrated that, when coupled with the information available from wide-area monitoring using phasor technology, a secondary voltage controller can be a cost-effective solution to maintain voltage stability of the high-voltage transmission network. This demonstration project, on the other hand, is a big step forward toward further development and improvement of this technology.

In addition to documenting the lessons learned during the installation and operation of the PMU-enabled volt/VAR control, the project will quantify the impact of this technology on lifecycle carbon footprint, increased utilization of transmission network, and system losses.

Expected Benefits

One or more of the following benefits might be realized through the application of this technology:

- Improved voltage control and voltage stability
- Increased transmission capacity, and consequently higher transmission network utilization.
- Lower real and reactive losses
- CO_2 emissions and fuel savings
- Better use of reactive power resources
- Lower line and transformer loadings

Approach for Measurement and Verification

A key objective of EPRI's Transmission Efficiency Initiative is to verify and validate the "actual" benefits realized by the application of the technology using a consistent measurement and verification (M&V) methodology that will be developed as part of EPRI's transmission efficiency research portfolio.

The detailed methodology of M&V will be developed during the course of the project using the following general approach:

- Demand, energy, and CO_2 savings will be determined based on transmission load flow cases for the studied system before and after the installation of the system.
- Line load and losses will be measured and compared over a one-year period and compared to the calculations. This will lead to an industry-accepted methodology for projecting improvement of system utilization and savings from advanced PMU enabled volt/VAR control.
- A life cycle carbon footprint methodology will be developed for this case.

Project Schedule

The schedule of the project tasks is as follows:

Phase 1: Design and implementation (duration, approximately 36 months)

1. Conduct engineering, design, and installation of the VAR/power flow monitoring system.
2. Perform development of the volt/VAR controlling program.
3. Complete hardware selection and procurement.
4. Conduct system coding and lab testing.
5. Install and commission the system at Devers substation.

Phase 2: Monitoring and benefits assessment

1. Monitor power flows and transmission-related losses for 12 months after the control system is commissioned.
2. Evaluate impacts on system utilization, reliability, lifecycle carbon footprint, and transmission losses, according to the M&V approach defined by EPRI.
3. Document results using the EPRI demonstration protocol.
4. Prepare final report and documentation.

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