Transmission Efficiency Initiative: Host Demonstration Project

Dynamic Voltage Compensation to Improve Transmission System Efficiency and Utilization

- Demonstrate the benefits of dynamic voltage compensation across the system.
- Apply consistent M&V methodology to quantify and verify actual savings and improvements.
- Benefits include improved transmission capacity and reliability, reduced system losses, and reduced carbon footprint.

Voltages affect the flow of reactive power in the grid, which in turn has a strong influence on system losses and congestion. Thus, voltage control is an effective methodology for reducing losses and increasing transmission capacity. Managing and control voltage reduces resistive losses and minimizes reactive power flow on the grid, which allows operators to maximize the amount of real power that can be transferred across congested transmission lines. Indeed, reactive power flows in the grid consume transmission and generation capacity, thus limiting a system's ability to move real power. Reactive-power flows must, therefore, be minimized.

Long Island Power Authority (LIPA) has proactively installed shunt facilities to improve power factor at load buses, resulting in lower reactive power transfer across the grid. This activity has allowed LIPA to achieve the following benefits:

- Increased the availability of reactive resources from generators
- Reduced transmission and distribution facility loadings
- Reduced system losses

Even though the installation of reactive power compensation to optimize power factor has significantly improved transmission system operation and efficiency, LIPA, through comprehensive studies and operation experience, has detected that its system presents deficient transient voltage recovery performance under certain operating and contingency conditions that can imperil operational security relating to cascade effects.

Study results recommended the installation of a dynamic volt-ampere-reactive (VAR) compensator (DVC) to mitigate this problem. In response, LIPA has initiated a plan to install reactive power support hardware in different parts of its system. The DVC plan consists of two phases:

- Phase 1 includes the installation of DVC at the 69-kV Canal substation, on the South Fork of Long Island. The DVC solution combines static synchronous compensator (D-VAR) technology and switched shunt capacitors. It consists of nine 4-MVA D-VAR modules (36 MVA) and four 36-MVAR mechanically switched capacitors. Phase 1 resolves the local transient voltage recovery issues and defers the need for capital infrastructure (deferred second Riverhead to Canal 138-kV line). It also contributes to the solution of a larger-scale voltage performance issue, including the potential loss of Iroquois Gas Supply. Phase 1 is planned to be concluded by mid-2010.
- Phase 2 comprises the installation of approximately 300 MVAR of static and dynamic compensators at multiple sites. It will help to address system-wide voltage recovery and reduce the need to dispatch uneconomic generation

in an area to protect against voltage collapse. Various technologies are under consideration for this phase, targeted to be in service by mid-2012.

Project Scope

As part of EPRI's Transmission Efficiency Initiative, LIPA is evaluating a possible demonstration of dynamic reactive power compensation to improve transmission system efficiency and utilization.

The objective of this project is to quantify, through a consistent measurement and verification (M&V) methodology, the actual efficiency and utilization gains from the DVC plan being developed by LIPA. This project will focus specifically on Phase 1 of the plan. In addition, lessons learned and experience with the implementation of this technology will be documented.

Expected Benefits

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

- Lower real and reactive losses
- CO_2 emissions and fuel savings
- Better transient voltage recovery performance
- 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 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 compensators.
- 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 savings from advanced dynamic rating systems.
- A life cycle carbon footprint methodology will be developed for the advanced dynamic rating system.

Project Plan

The schedule of the project tasks is as follows:

1. Data collection. LIPA will provide EPRI with the information required for the study, which will include the following:
   - Detailed data of the DVC project, specifically Phase 1
   - Power flow model and selected operating scenarios
   - Generation fleet and export/import operation characteristics
2. Monitoring of active and reactive power flows, Import/export power flows, transmission-related losses, and generation dispatch and margins for 12 months, completing in September 2011
3. Evaluation overall system losses based on a consolidated efficiency evaluation methodology
4. Evaluation of transmission system utilization improvements based on appropriate metrics
5. Evaluation of CO_2 savings
6. Documentation of results using EPRI demonstration protocol
7. Final project report

Electric Power Research Institute
3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com