Transmission Efficiency Initiative: Host Demonstration Project

Control of Reactive Power Sources for Improving Voltage Profile and Reducing Losses


Substation Yard

- Demonstrate the benefits of installing dynamic reactive power compensators and advanced control strategies to reduce transmission system losses and improve utilization.
- Monitor before and after energy losses and document the results.
- Benefits include improved voltage profile and transmission system utilization and reduced losses.

Project Scope

As part of EPRI's Transmission Efficiency Initiative, FirstEnergy is evaluating a possible demonstration of control strategies for reactive power resources to improve voltage profile and transmission system efficiency.

The principal objective is to capture the benefits of implementing the control scheme for reactive power compensators, in terms of transmission system utilization and efficiency improvements.

Technology Description

Planning reactive power compensation focuses on the optimal allocation and size of the reactive power sources to comply with the applicable reliability standards. The purpose is to find the right tradeoff between the investment cost of the new volt-ampere-reactive (VAR) source and the benefits in system operation derived from the additional reactive power compensators. Installing compensators to comply with the reliability standards can provide additional benefits such as loss reduction, available reactive power reserves under normal and contingency conditions, improved voltage control, and more room in the transmission and distribution network to move real power and potentially increase transfer limits.

Reactive power supply can be divided into two categories: static VAR resources and dynamic VAR resources. Dynamic VAR resources such as static VAR compensators (SVCs) have a fast response time, whereas static VAR resources such as mechanically switched capacitors have a relatively slow response time. Usually, there is a need to install static as well as dynamic compensators in the power system. Indeed, the North American Electric Reliability Council dictates that a proper balance between static and dynamic characteristics must be provided.

Static compensators and SVCs are normally operated in voltage-controlled mode (V-controller), implemented by means of a proportional–integral regulator using local input variables. A coordinated voltage control scheme of reactive power devices installed at different substations facilitates achieving a voltage profile across the grid that further improves voltage stability margins, reduces losses, and improves the loadability of the system. Another strategy is to combine the V-controller with other control logic that maintains the output of the SVC at a predetermined VAR level that is not voltage-dependent (Q-controller). It is a coordinated control that actuates on the SVC and the fixed capacitors and reactors installed either in the same substation at which the SVC is installed or in other substations. This controlled strategy allows minimizing reactive power flows on the grid and, consequently, reduces losses.

FirstEnergy has commissioned in 2009 a rebuilt SVC installation at the Atlantic substation. It consists of two 130-MVAR capacitors, a 130-MVAR thyristor control reactor, and a 2x130-MVAR fixed capacitor bank. This upgraded dynamic reactive power source, along with the control strategy implemented, allows improvement of transmission system performance and reduces losses by 3.4 MW at peak load conditions.

Expected Benefits

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

- Lower real and reactive losses
- Higher voltage stability margin and reactive power reserves
- 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 and energy savings will be determined based on transmission load flow cases for the studied system with and without operation of the Atlantic substation SVC.
- Line load and losses will be measured and compared over a specified period and compared to the calculations. This will lead to an industry-accepted methodology for projecting savings from advanced dynamic rating systems.
- Performance indices for evaluating the impact of the implemented SVC control on loss minimization and voltage improvement will be developed.

Data Requirements

FirstEnergy will provide transmission system data and information about the physical and operational characteristics of the Atlantic substation SVC. It will also provide all the information needed to quantify the impact on lifecycle carbon footprint, increased utilization of transmission system, and impact on system losses, according to the M&V approach defined by EPRI.

Project Schedule

The schedule of the project tasks is as follows:

1. Define baseline conditions against which to assess loss reduction and other benefits.
2. Monitor active and reactive power flows, transmission-related losses, and generation dispatch and margins for 12 months.
3. Assess impact on transmission system utilization and efficiency using the EPRI evaluation methodology.
4. Document the results according to the EPRI demonstration protocol.
5. Final project report, December 2011.

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