

Transmission Efficiency Initiative: Host Demonstration Project

Incorporation of Efficiency in the Generation Economic Dispatch



Control Room

- Evaluate the application of a new economic generation dispatch algorithm with efficiency considerations.
- Monitor before and after energy losses and carbon emissions and document the results.
- Benefits include improved utilization, reduced losses, enhanced operation security, and reduced carbon footprint.

Project Scope

As part of EPRI's Transmission Efficiency initiative, the California Independent System Operator (CAISO) is evaluating a possible demonstration of a new generation scheduling concept that is intended to incorporate efficiency in the security-constrained unit commitment (SCUC) and economic dispatch processes. This technology is referred to as *efficiency generation dispatch* (EGD). In particular, three areas of efficiency improvement are being considered by the CAISO:

- Introduction of loss minimization; that is, general reactive power optimization in the SCUC objective
- Introduction of loss minimization as part of the overall market clearing process
- Introduction of integrated preventive-corrective handling of contingencies in SCUC

The CAISO determines day-ahead and hour-ahead generator dispatch and market clearing price for energy, based on a least-cost balanced schedule. It also procures adequate ancillary services on a least-cost basis. By applying the EGD concept, it is expected that system efficiency (that is, transmission loss reduction and asset utilization) will be improved through a better (optimal) market and system operation. The EGD technology will be developed in this project and incorporated in test mode into the CAISO SCUC.

Through a consistent measurement and verification (M&V) process, the expected benefit will be quantified and validated during the course of the project.

Technology Description

Currently, the SCUC in the CAISO day-ahead and hour-ahead markets are formulated and solved as an optimization problem in which the objective is the minimization of the sum of total market costs. It is a large co-optimization problem, which simultaneously clears energy, regulation, and reserves. In this formulation, transmission system losses are taken into account in the energy balance constraint equations by means of generator penalty factors, which is a common practice approach to handle losses in economic dispatch to provide locational economic signals to generators. In this formulation, loss minimization is not a goal in itself. Additionally, the CAISO SCUC, as any SCUC algorithm, in general, does not address reactive power and voltage control. Reactive power and voltage issues are addressed within security applications, in which the main objective is to maintain bus voltages and reactive power margins within secure limits by means of local voltage controls.

It is possible to formulate and solve SCUC active and reactive optimization within a single optimization problem, in which minimization of losses is added to the objective function and voltage controls are handled as control variables.

On the other hand, the introduction of integrated preventive-corrective controls in the SCUC formulation has the main goal to resolve constraints for each critical contingency with minimum necessary rescheduling of pre-contingency MW controls (preventive control) and to resolve as much possible in each individual contingency after the contingency actually occurs (corrective control). The result is a less constrained network with much lower operation cost compared to the option of handling all control actions in a preventive fashion.

Expected Benefits

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

- More efficient system and market operation
- Reduced losses and carbon emissions
- Improved asset utilization
- Optimized reactive power resources
- Improved operation security

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 CO₂ savings will be determined based on changes in generation dispatch before and after the implementation of the EGD software.
- An estimation of loss savings will be conducted with a system operation simulation software and power flow analysis. Actual losses will be measured to the extent possible and compared over a one-year period to calculations. This will lead to an industry-accepted methodology for determining savings from EGD.
- A life cycle carbon footprint methodology will be developed for the EGD application.
- System utilization improvement will be assessed by considering generation dispatch, congestion costs, and other metrics that will be defined.

Project Schedule

The schedule of the project tasks is as follows:

1. Analytical study to evaluate approaches and algorithms for incorporating transmission efficiency metrics into the EGD concept.
2. Definition of EGD scope (define which of the CAISO market stages EGD is most suitable for).
3. Off-line simulation to evaluate software performance and implications of EGD concept in the CAISO system operation.
4. Incorporation of the system operation software in test mode and performance testing, September 2010.
5. Monitor power flows, transmission-related losses, and generation dispatch for 12 months, completing in September 2011, and document the results using the EPRI demonstration protocol.
6. Final project report, December 2011.