EPRI ELECTRIC POWER RESEARCH INSTITUTE

conEdison

Transmission Efficiency Initiative: Host Demonstration Project

Design and Control of Transmission Network to Reduce Fault Currents and Improve Efficiency

Substation

- Investigate innovative design and transmission network control techniques to reduce fault currents and improve system efficiency and utilization.
- Monitor before and after energy losses and carbon emissions and document the results.
- Benefits include reduced short circuit current, reduced losses, increased system utilization, and reduced carbon footprint.

Due to increased load demands and reduced incentives to build new transmission devices, utilities are increasing power flows on existing transmission assets, which will increase short-circuit fault-current levels throughout power systems. Also, new generation plants to be added at transmission networks will increase power flows and, consequently, fault current levels. Under increased power flow conditions on existing assets, managing short-circuit fault currents is crucial for avoiding damage to equipment as well as for increasing system reliability.

Various technologies for limiting short-circuit fault currents in transmission networks have been developed, such as neutral grounding resistors, current-limiting reactors, increased transformer impedances, splitting of busbars, and fault current limiters. They can either physically improve the topology of a transmission network or actively mitigate fault currents under short-circuit conditions. However, some of those technologies, such as current-limiting reactors and increased transfer impedances, will increase system losses and reduce system efficiency. How to balance reliability and efficiency is a key technical issue to be investigated.

Project Scope

As part of EPRI's Transmission Efficiency Initiative, Con Edison is evaluating a possible demonstration of technology options for improvement of transmission efficiency with consideration of fault currents as constraints.

Expected Benefits

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

- Mitigate short-circuit fault current, permitting increased power flows on the network without jeopardizing system security, resulting in improved system utilization.
- Reduce transmission losses by preventing or reducing the use of current-limiting reactors.
- Reduce overall carbon footprint by reducing losses and facilitating greater dispatch of more efficient units.
- Increase system reliability

Project Schedule

EPRI will first work with Con Edison to develop a set of base cases to represent the current and future transmission systems. After the base cases are developed, the project team will perform the following tasks:

1. Investigate optimal design of transmission network. The EPRI project team will investigate the optimal transmission topology (in fact, the bus admittance matrix) of a transmission network to improve transmission efficiency and limit fault currents. Given a

set of base cases, EPRI plans to formulate the short circuit as a set of constraints and set the objective functions as transmission losses. EPRI will apply the advanced searching and optimization techniques to find an optimal transmission network design.

2. Investigate optimal allocation of fault-current limitation measures. According to the optimal design, the project team will evaluate the strategies of integrating selected fault-current-limiting measures and apparatus. The approach could include performing sensitivity analysis to quantify the impact of the controllable variables (such as line or transformer impedance) on the short-circuit issue of the transmission network. Then, the project team will determine the optimal allocation of available fault-current-limiting measures and apparatus in a transmission network to enhance its fault-current mitigation ability.
3. Investigate control strategies of fault-current-limiting measures. The project team will study a variety of operating scenarios to find out when the system needs fault-current-limiting measures to prevent short-circuit problems. Based on the study results, the project team will develop the control strategies (such as timing and setting) of fault-current-limiting measures. The control strategies will be converted into operating guidance for system operators to use as a reference.
4. Evaluate the impact of fault-current-limiting measures on system efficiency and utilization. The project team will determine, based on transmission load flow studies and system operation simulations, the improvement in system utilization as well as the potential demand, energy, and CO_2 savings than can be achieved by implementing the identified short-circuit current limitation measures.
5. Final project report, December 2011.

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