

Transmission Efficiency Initiative: Host Demonstration Project

Improving Energy Efficiency of New Substation Auxiliary Systems



Substation Control

Project Objective

As part of EPRI's Transmission Efficiency Initiative, the Tennessee Valley Authority (TVA) is evaluating a possible demonstration project to assess the benefits of implementing measures to reduce energy consumption of new substation auxiliary systems.

Efficiency improvements in substation systems and its associated equipment is one area that can be reviewed for potential low-hanging fruit to reduce a utility's own electric consumption. Many approaches exist to substantively reduce consumption in substation control rooms, including optimal HVAC units, higher-efficiency fans and pumps, and better transformer efficiencies in the substation yard. The successful implementation of a number of efficiency technologies in the commercial and Industrial sectors will also help utilities to develop a more efficient substation system, as follows:

- Better building insulation and weatherization would improve the efficiency of the substation control buildings.
- High-efficiency lighting would lower the electrical usage and improve lighting in work areas inside the control buildings and outside in the substations.
- Higher-efficiency HVAC systems would increase the efficiencies of the necessary units, keeping the battery system and protective relaying at normal temperatures.

- Evaluate measures to reduce consumption of substation auxiliary system and associated equipment.
- New standard for building more energy-efficient substations.
- Benefits include reduced system energy losses and reduced carbon footprint.

TVA has proactively initiated integration of energy efficiency technologies into its substation systems in an effort to lead the way in energy efficiency and, consequently, reduce their greenhouse gas contributions and carbon footprints. TVA is interested in analyzing and defining construction and operation standards for its new substation in order to make them more energy efficient.

This project will enable EPRI, partnering with TVA, to identify, document, and implement energy efficiency measures applicable within the substation system. Although managing usage through efficiency implementations is not a new concept, many utilities have not viewed system electrical usage in the electrical substation system as a high priority.

Project Scope

This project is a field demonstration on a handful of substations, including a review the system savings for the efficiency implementations. If the savings are significant, the efficiencies could be implemented on a larger number of substations. New learning in this project will help set to the stage for larger deployments of efficient substations. The new learning in this demonstration effort will be incorporated into EPRI's R&D efforts and might be expanded to a larger effort in the future.

Expected Benefits

There might be significant potential to reduce losses and energy usage in electrical substation systems while taking advantage of efficiency technologies to manage the electrical substation systems more efficiently, which will benefit society and utilities at large. These measures can directly reduce the greenhouse gas emissions and associated carbon footprint.

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 identified 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:

- Energy savings will be determined based on energy measurements and calculations for the electric consumption at the substations being improved, before and after the implementation of the energy efficiency measures.
- A methodology will be developed to assess CO₂ emission savings and life cycle carbon footprint.

Project Approach

The main project tasks are the following:

1. Data collection. Substation data provided by TVA, based on EPRI data requests, will be collected and reviewed. Such data will include building sizes, equipment types, energy usage history, substation facilities, HVAC nameplate information, and region. This information will give EPRI a critical head start to developing efficiency options that should be implemented.
2. Review and evaluation of TVA standards for building new substations. EPRI will work with TVA staff to identify potential changes in TVA's standard and customary substation design in order to improve energy efficiency. These options to be considered might include the following:
 - HVAC
 - High-efficiency lighting and motion control
 - High-efficiency motors, pumps, and fans
 - Variable-frequency drives for fans and motors
 - High-efficiency appliances
 - Modified work practices
 - High-efficiency transformers
 - High-side reactive VAR compensation
 - Losses from loose connections
 - Programmable thermostats
 - Control building insulation and windows
 - Weatherization of the buildings
 - Other energy efficiency measures
3. Development of recommendations and guidelines for the construction of new substations with energy efficiency considerations.
4. Identification of one or more new substation projects as candidates for energy efficiency improvement: One or more projects for new substations will be selected and reviewed based on the developed construction guidelines. The projects will be modified or improved accordingly.
5. Implementation. The selected substations will be constructed according to the revised design.
6. M&V of estimated savings. Because these are new substations, measurement at the pre-implementation stage cannot be realized. Instead, baseline conditions will be determined considering the original substation design and estimating substation energy consumption accordingly.
7. Document the project results.
8. Share experience with other demonstration project participants.

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