

Transmission Efficiency Initiative: Host Demonstration Project

Improving Energy Efficiency of Existing Substation Auxiliary Systems



Substation

Project Objective

As part of EPRI's Transmission Efficiency Initiative, Kansas City Power & Light (KCP&L) is evaluating a possible demonstration project to assess the benefits of implementing measures to reduce energy consumption of existing substation auxiliary systems.

Efficiency improvements in substation systems and the 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 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.
- Refurbish or remodel existing substations to make them more energy efficient.
- Benefits include reduced system energy losses and reduced carbon footprint.

This demonstration will enable EPRI, partnering with KCP&L, 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 will evaluate energy efficiency improvement options for the following substations in KCP&L's system:

- Mid Town substation, a 50-year-old distribution substation in the heart of Kansas City, MO. It consists of four 50-MVA, 161-kV/13.2-kV power transformers, eight buses with thirty 13.2-kV feeders serving commercial and residential customers. The control house is 30 x 30 ft, concrete block construction with minimal insulation, no windows, fluorescent lighting, baseboard heaters, water heater, and air conditioner that is remotely monitored and controlled. The building is normally unstaffed. The total substation site footage is 125,000 ft².
- Troost substation, another distribution substation in the heart of Kansas City, MO. It has four 30-MVA, 161-kV/13.2-kV power transformers. Two overhead 161-kV transmission lines and sixteen 13.2-kV feeders

servicing commercial and residential customers are connected to this substation. The total site size is 40,000 ft². All transformer fans have temperature controls. The control house design characteristics are as follows: 10 x 32 ft control enclosure, prefabricated metal construction, 3-1/2 inch fiberglass insulation sandwiched between metal surfaces, no windows, phosphor lighting, vendor-selectable options for HVAC are heat pump, resistance heating, wall unit AC, and split unit AC. The building is normally unstaffed.

This is a field demonstration of two substations, including a review of system savings for the efficiency implementations. 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. Even though this project is focused on the two listed substations, project outcomes will include general recommendations and guidelines for refurbishing existing substations to improve energy efficiency.

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 Plan

The main project tasks are the following:

1. Data collection. KCP&L will provide data on Mid Town and Troost substations, based on EPRI data requests. This information will give EPRI a critical head start to developing efficiency options that should be implemented.
2. Substation audits. Substation audits will be performed to discover where energy is being consumed. An efficiency audit will be incorporated to discover the most effective efficiency upgrades that could be implemented given the critical needs in these substations.
3. Qualitative screen of potential technologies. EPRI will develop a list of best-fit options for these two substations.
4. Implementation. EPRI will work with KCP&L to choose those best-fit options that are economically feasible, and those upgrades will be implemented. Best-fit options will consider the special needs in the substation environment and the optimal savings over time.
5. Development of a calculation methodology for accounting and documenting energy savings and CO₂ emissions reduction.
6. M&V of estimated savings. KCP&L will measure and record energy consumption and other relevant variables of these substations for a predefined period before and after the efficiency upgrades have been performed. EPRI will apply M&V protocol to quantify and assess energy and CO₂ emission savings.
7. Develop recommendations and guidelines for refurbishing existing substations to improve energy efficiency: Based on the lessons learned from the actual implementation and M&V results, EPRI will work with KCP&L to draft recommendations and guidelines for refreshing substations for energy efficiency improvement.
8. Develop final project report.
9. Share experience with other demonstration project participants.

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