EPRI's Innovative Sensors Detecting Vital Real-Time Status on Transmission System

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Photo Courtesy: FirstEnergy

The electric system increasingly depends on a resilient grid—a grid that can withstand or quickly recover from extreme events such as Superstorm Sandy, emerging challenges such as geomagnetic storms, and physical and cyber security attacks as well as more common events such as fires and floods. But most grids were built decades ago, and enabling them to support these diverse, dynamic new demands means utilities need real-time information about their condition. To meet that need, EPRI is developing a suite of sensors for transmission assets so maintenance can be optimized and unplanned outages avoided.

"We are developing a tool box of sensors for a variety of components, to transmit just the information utilities need to make informed decisions," said Andrew Phillips, EPRI director of Transmission and Substations.

Underway for a decade, the project is working to develop low-cost sensors, independently powered, that transmit essential information by radio frequency.

The sensors are designed to alert utilities to incipient faults and provide situational information so maintenance activities can shift from reactive to preventive. For instance, sensors can measure contamination on insulators, alerting maintenance staff to wash them so they don't fail, or can give the exact location of a power interruption to maintenance crews. Other sensors are in development or demonstration for substation components including insulators, surge arresters, and transformers. For overhead lines, sensors are being developed to detect excessive line movement, conductor breaks, lightning strikes, and geomagnetically induced currents. Other sets of sensors will detect problems in underground installations, such as excessive cable movement, and potential sabotage of transmission structures and transformers, including bullet strikes.

One challenge for all sensors is devising a reliable power source. EPRI's sensors either harvest electromagnetic current from power lines or use extended-life batteries. Phillips said the sensors require only tiny amounts of current and can be paired with very high-density advanced batteries that will last a decade or more.

The effort has resulted in many patents for EPRI, and some early sensors are already licensed for commercial use. More patents are pending. Developing sensors robust enough for electric utility operations requires multiple rounds of lab and field testing, said Phillips, noting, "There are about 30 sites now hosting either pilot or demonstration projects with hundreds of sensors installed."

Determining what types of information are meaningful for each component requires an understanding of each part's functions and failure modes. The development effort has involved collaboration with more than a dozen electric utilities, but Phillips said that the breadth of experience within EPRI has enabled researchers to draw together the precise expertise needed for each project. "Whether we need subject matter experts, sensor experts, electronics experts, transmission experts, or data integration experts, we can reach inside the organization and out to members and draw all of that together," he said.