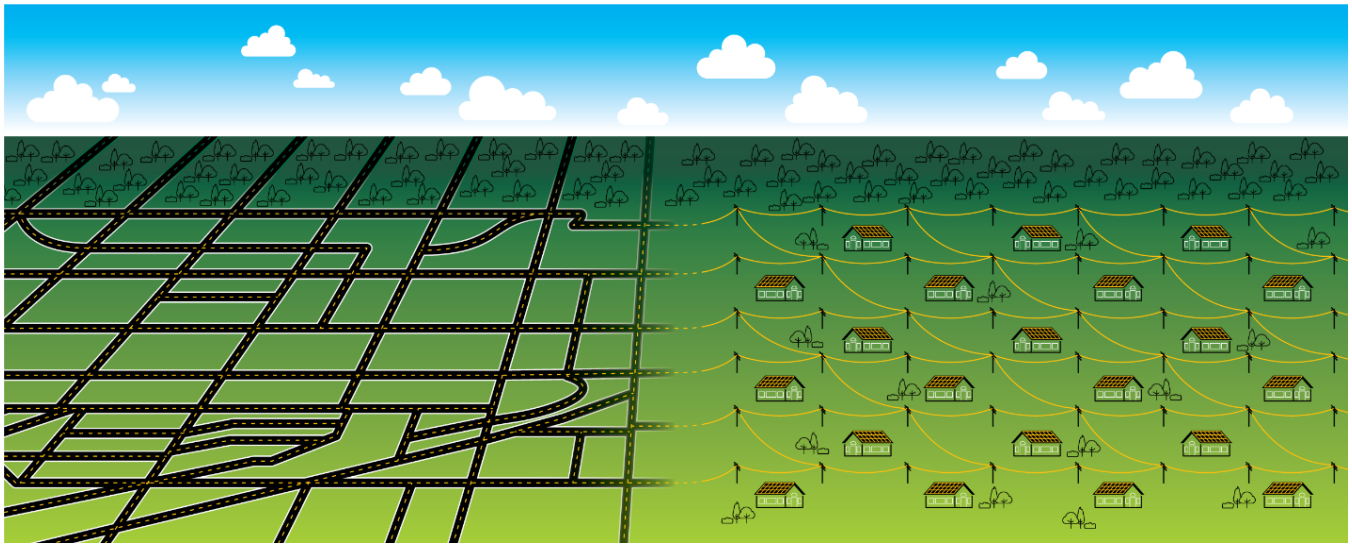
Upgrading the Grid's "Local Roads"



New Program to Help Utilities Spare Their Customers the Effects of Bad Traffic

By Sarah Stankorb

Heather Adams has a complicated job, and it's getting more so. As Director of Electric Distribution and Standards at Central Hudson Gas & Electric Corporation, she is responsible for planning the utility's distribution system. Over the past five years, customers in Central Hudson's service territory increased the system's solar power capacity from 7.3 megawatts to 60 megawatts. The queue for proposed capacity could raise the total to 725 megawatts.

The influx of distributed solar has resulted in voltage fluctuations and two-way energy flows on a system designed for one-way flow, and Central Hudson has installed automation technology equipping the system to respond. It's likely that other technologies will need to be deployed soon to make the system more flexible, resilient, and reliable.

"Deploying technology is the easy part—the challenge is in modifying processes to integrate it into operations," said Adams. "To manage the rapidly evolving system, our processes and methods must adapt so that system models are quickly updated with new information."

Meanwhile, new regulations under New York's Reforming the Energy Vision initiative require Central Hudson and other utilities in the state to step up efforts to integrate distributed energy resources (DER).

Adams' monumental undertaking—coordinating updates in many technologies, processes, and procedures while maintaining grid safety, reliability, and affordability—is shared by distribution utilities across the United States. To help them, EPRI has launched the Distribution Operations and Planning Program to equip today's grids for effectively integrating DER. The focus includes developing advanced automation and other technologies for distribution operations, along with new planning processes, models, and analytics.

Managing More "Traffic" on the Distribution Grid

The grid's high-voltage transmission system is often compared to the U.S. interstate highway system. "Both are highly interconnected and have multiple routes between destinations in case one experiences a traffic jam," explained EPRI Program Manager Jeff Smith. "The distribution system is similar to local roads that lead to individual homes. Both provide a limited number of routes to destinations, and many of these routes have limited throughput or capacity."

As more rooftop solar and other local DER are installed on distribution grids, "traffic" is increasing in many regions.

"Customers are installing significant local generation, but the grid is limited in its capacity to accommodate it," said Smith. "This can stress the grid and potentially impacts the utility's ability to serve customers reliably. It's like trying to squeeze high-speed traffic from a four-lane highway down to a two-lane residential road. The roads can't handle the traffic, making it more difficult for local residents to travel to and from their homes."

With more generation from DER, the distribution grid is becoming a dynamic system in which power flows in both directions.

"Most distribution systems were not designed for this," said Smith. "Similar to how roundabouts can be used to mitigate unnecessary backups at four-way stop-sign intersections, modernizing grid design and operations for two-way power flow can help systems accommodate high levels of DER for reliable, cost-effective service."

In systems such as those in Hawaii with extensive DER, excess energy often flows upstream into the transmission system, with adverse impacts on both distribution and transmission systems. System operators require new techniques and tools to coordinate planning and operations between distribution and transmission.

New grid infrastructure can mitigate such problems and enable more dynamic flows. In some cases, utilities deploy additional feeder ties and reconfigure the grid to increase options for power flow. Smith says this is comparable to "connecting dead-end streets in your neighborhood to provide more options for traffic flow from point A to point B."

Central Hudson is updating its distribution system by reconductoring and deploying bidirectional regulators and switched capacitors. While driven by other system needs, these projects also improve hosting capacity for DER.

Another emerging approach relies on new communications and automation technology to respond to congestion by rerouting energy flows. This could potentially enable power flow from multiple sources, help to serve demand locally, reduce power line losses, and increase the grid's hosting capacity for DER.

"Much like adjustable red lights that change traffic patterns based upon the time of day, distribution grids can be reconfigured with automation to route power flow based on changing local needs," said Smith. "This requires new technology along with advanced distribution planning tools and models to optimize its use."

State regulators are recognizing the need for new technologies, processes, and programs. Besides New York's Reforming the Energy Vision, California requires its investor-owned utilities to submit "distribution resource plans" that describe how they will integrate DER into distribution grid planning, operations, and investment. Utilities in other states may not yet face such mandates but nevertheless must address the growing need to integrate DER for continued reliability.

Technologies, Analytics, and Guidelines to Modernize the Distribution Grid

Funded by more than 30 utilities in 2017, EPRI's Distribution Planning and Operations Program comprises many efforts to integrate DER and modernize the distribution grid.

To support reliability in a dynamic grid, EPRI is developing and testing communication, protection, and control devices; distribution automation; automated restoration; monitoring equipment; advanced distribution management systems; and other technologies. Given the considerable influx of new technology, the program's research results help utilities reduce costs and increase reliability by showing how to use new capabilities effectively.

"We want to inform utilities on infrastructure investment decisions and provide information enabling them to determine how best to deploy these new technologies," said Smith.

EPRI is working on analytical tools that can help grid operators and planners extract insights from the large amounts of data produced by new technologies. For example, advanced metering infrastructure deployed in many distribution systems produces vast data sets that are used for little else than billing. Advanced tools can help utilities translate these data into actionable information to enhance distribution planning models and operators' awareness of system conditions.

"We want to advance the analytics for distribution planners and operators so that they can take full advantage of what's being deployed in the field," said Smith.

Researchers are examining how to integrate volt/VAR optimization and fault location, isolation, and service restoration into the simulation software that grid planners use to model and analyze their distribution systems. EPRI has developed methods and tools to analyze the distribution feeders' hosting capacity and is working with utilities to incorporate these into their planning software.

Generally, utility distribution management systems for modeling and controlling operations are not capable of tracking and controlling the grid impacts of DER, and EPRI has identified the key research needs to advance these systems. "EPRI is prototyping, modeling, and testing enhanced distribution management systems to provide system operators with the tools necessary to overcome the challenges of dynamic distribution systems," said EPRI Senior Technical Executive Brian Deaver.

EPRI moderates a Distribution Operations Interest Group, which provides a forum for distribution control center professionals to meet bi-annually, collaborate, and discuss current and future challenges.

"These challenges impact technologies, processes, and operator training," said Deaver, the group's moderator. "For example, distribution system operators must account for generation from DER in their manual and automated restoration procedures. If a utility restores power from an outage without factoring a region's DER, the unanticipated power demand could damage equipment. This is just one of many operating scenarios that must be defined, understood, and accounted for."

What works on electricity's superhighways—the transmission grid—may prove helpful for meeting these distribution challenges. "Many of the methods and techniques used at the transmission level can be adapted and applied for distribution," said Daniel Brooks, who manages EPRI research on transmission grid operations and planning.

As distribution-connected DER feeds more power into these systems, the challenge of integrating them becomes more relevant to transmission system operators. EPRI is investigating new ways for operators to track distribution-connected DER and developing methods for accurately valuing DER capacity and energy at the bulk transmission level.

Notwithstanding all the changes and challenges, distribution planners and operators seek to integrate DER while increasing systems' reliability, efficiency, and cost-effectiveness. This requires an integrated suite of solutions. EPRI will develop guidelines to help them incorporate technologies, analytics, and processes into the design of their future distribution systems.

"There is no single 'silver bullet' technology that addresses all of the growing needs of distribution," said Smith. "Our goal with this new program is to help utilities implement a coordinated set of technologies, analytics, tools, and more. This will help realize the full potential of the distribution grid."

Key EPRI Technical Experts

Jeff Smith, Brian Deaver