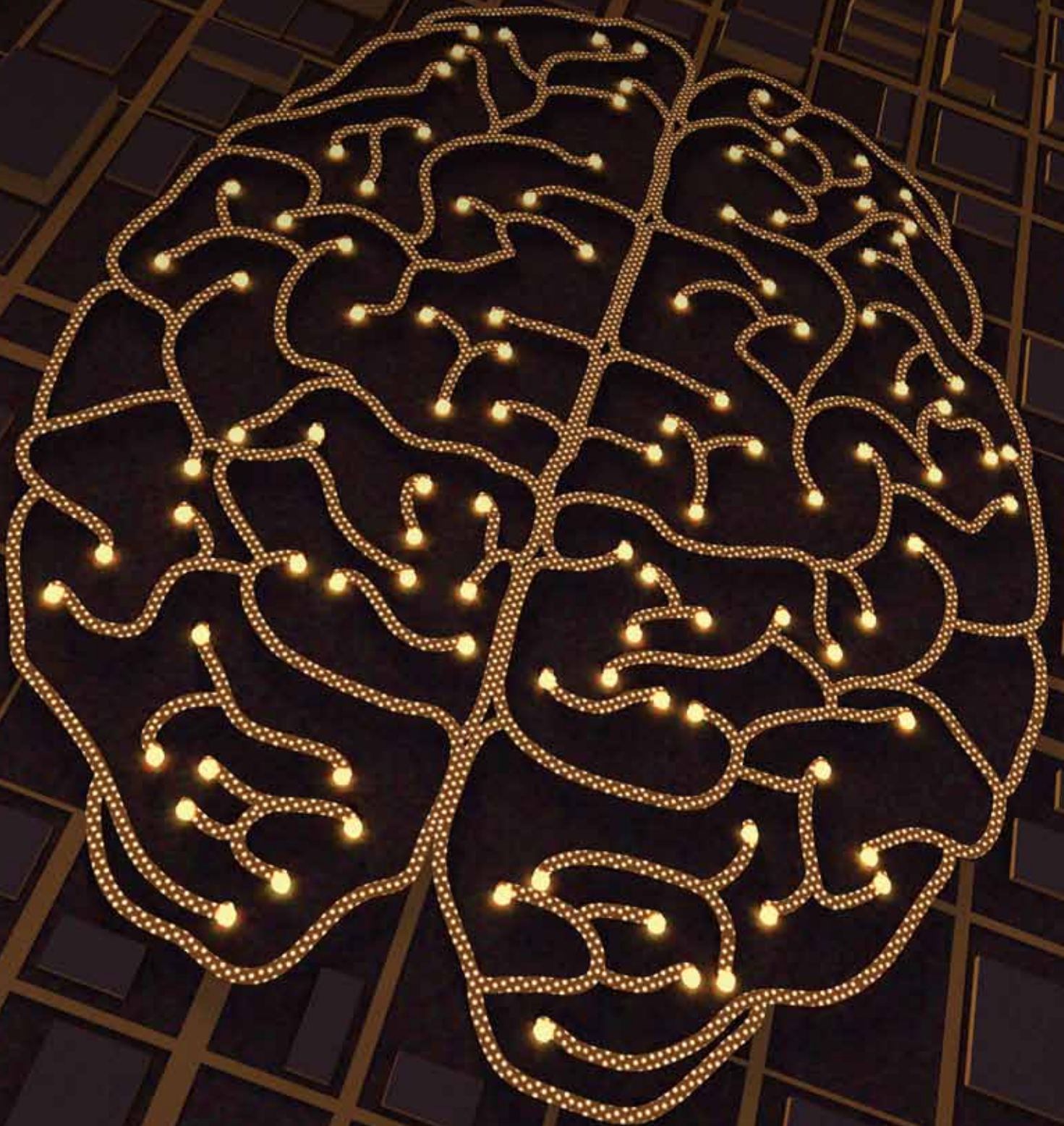


The Smart Grid: COMING OF AGE



Smart grid is no longer merely a buzzword or a vague, high-tech promise in a power company's 30-year plan. Utilities across the country are getting involved now, tapping smart grid capabilities to boost efficiency, enhance services, improve reliability, and possibly lower rates for their customers. Such improvements are driven by the complexity of the grid itself—an expansive collection of generation units, transmission and distribution lines, transformers, switches, and power-conditioning equipment, not to mention the millions of individual machines, devices, and appliances on the customer side of the meter. These many components typically operate with central coordination accomplished by control at the network's substations and power generation facilities.

Using broadly distributed sensors, microprocessors, and automated control units, smart grid technologies help coordinate the system as an efficient, integrated whole. As a result, grid operators gain improved knowledge of operating conditions and are better able to manage the system to what's actually happening throughout the system and in real time.

"We see the smart grid as a system of systems," said Don Von Dollen, manager of EPRI's IntelliGrid program. By using an open-standards-based communications architecture, utilities can not only integrate their own networks effectively but eventually monitor systems nationally to support a vastly improved power delivery system.

With EPRI's help, the National Institute of Standards and Technology is assessing and identifying interoperability standards that will make this possible, developing requirement specifications and communications protocols to help ensure that the various components of such a broad system will be compatible and able to work together seamlessly (see "The Push for Standards," p. 8).

"EPRI has been working on the smart grid for over a decade, refining the concept, developing foundational standards, and creating a methodology for utilities to use

THE STORY IN BRIEF

Having supported development of the smart grid concept for more than a decade through its IntelliGrid program, EPRI now is working directly with utilities to help implement smart technology on their transmission and distribution systems. Three forward-looking companies show how the smart grid is allowing them to break new ground in reliability, efficiency, and customer value.

when launching smart grid applications," said Von Dollen. EPRI now has shifted to working directly with utilities, helping them implement smart grid technology on their power delivery systems. "Using the IntelliGrid methodology, companies are finding that a roadmap helps make the smart grid journey much easier to navigate," said Von Dollen. The same methodology also is used for EPRI's Smart Grid Industry Demonstration project, focusing on the integration of various distributed resources into a virtual power plant.

A number of utilities have used EPRI's methodology in their smart grid deployment projects, including FirstEnergy Corp., Salt River Project (SRP), and Southern California Edison (SCE). FirstEnergy and SRP worked directly with EPRI to develop their smart grid roadmaps; SCE employed EPRI's IntelliGrid methodology to develop its own roadmap. "Each utility has a different approach to its smart grid implementation, based on its own business and regulatory drivers," said Von Dollen.

FirstEnergy completed its IntelliGrid roadmap at the end of 2007. "The roadmap helped us establish where we were, where we should go, where the gaps were in technologies, and what the order should be for our smart grid implementation strategy," said FirstEnergy's Joe Waligorski, delivery operations technical advisor. "Basically, the EPRI roadmap helped us identify which technologies would be appropriate

to evaluate for our smart grid initiatives and goals."

Waligorski noted that a guiding principle behind FirstEnergy's strategic approach to the smart grid is integrating communication and data for distributed components and their controls across all aspects of power delivery operations. "Leveraging technologies in this way allows us to benefit from economies of scale, standardized architectures, and corporate-wide sharing of information," he said.

Like FirstEnergy, SRP outlined an integrated control and data management architecture to facilitate monitoring, control, and automation functions at the transmission, distribution, and customer system levels. "We've looked closely at how we could integrate smart grid technologies into our infrastructure," said Joe Nowaczyk, SRP manager of electronic systems. "The challenge is to not oversell the smart grid—first, you have to determine whether it will be beneficial and cost-effective. We found that EPRI's IntelliGrid methodology helped us to focus our smart grid initiative on these issues and to develop internal synergy with the deployment of related technologies."

SCE used similar guidance from IntelliGrid in developing its own smart grid roadmap. According to Paul De Martini, SCE's vice president for advanced technology, "The EPRI methodology helped us zero in and understand what we wanted to

accomplish and build a timeline for the plan.”

Like Nowaczyk, De Martini recognized the need for selectivity and practical progression in developing systems unique to each utility: “We think of the smart grid as an a la carte menu.”

In choosing their early smart grid implementation projects, all three companies have focused largely on two fundamental opportunities: optimizing system operations, and engaging customers with conservation programs that will help reduce demand. Both objectives require an enhanced energy information infrastructure.

System Operations

Detailed, real-time information is key to effectively managing a system as large and dynamic as the power grid. SRP, through its extensive fiber-optic communications network, can monitor every substation and use remote distribution switches to reconfigure the network when local load grows beyond certain limits. SRP also is using synchrophasors, whose real-time information enhances the transmission operators’ ability to monitor system dynamics and take corrective action if necessary.

Such information, automation, and operational flexibility make for improved system reliability, better equipment maintenance planning, and reduced outage response times. “Ultimately, automated devices will allow SRP to increase reliability on our entire transmission and distribution system,” Nowaczyk said.

SCE has chosen an approach similar to SRP’s for system monitoring by expanding the use of sensor technology across its system and is undertaking one of the world’s largest synchrophasor deployments. The sophisticated synchrophasors on SCE’s 230- and 500-kilovolt system allow monitoring of grid dynamics 30 times a second. “Electricity is the lifeblood of our modern economy, so high system reliability is tremendously important,” said SCE’s De Martini.

But the benefits of smart grid technology go beyond just reliability. “Being able to

The Push for Standards

On June 17, 2009, EPRI submitted its *Report to NIST on the Smart Grid Interoperability Standards Roadmap*. The impetus for the report was the Energy Independence and Security Act (EISA) of 2007, which assigned the National Institute of Standards and Technology (NIST) “primary responsibility to coordinate development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems” (EISA Title XIII, Section 1305).

In early 2009, responding to President Obama’s national energy priorities, NIST acted to accelerate progress and promote stakeholder consensus on smart grid interoperability needs. On April 13, it announced a three-phase plan to expedite development of key standards.

EPRI—having engaged utilities, equipment suppliers, consumers, standards developers, and other stakeholders in a public process that identified smart grid interoperability standards, gaps in current standards, and priorities for new standardization activities—created a document that provides input for the first phase.

EPRI then developed a draft interim standards roadmap, which NIST used as the starting point for its own roadmap for interoperability standards, released September 24. NIST’s roadmap sets priorities for interoperability and cyber security requirements, identifies an initial set of standards to support early implementation, and lists plans to meet remaining standards needs. Both the NIST roadmap and the EPRI report to NIST can be downloaded at <http://www.nist.gov/smartgrid>.

measure, control, optimize, and anticipate is crucial to future system operations,” said De Martini. This is especially important now that large amounts of distributed resources such as solar and micro-wind installations are coming on to the grid. Significant improvements in system efficiency also are possible. De Martini notes that grid losses through an average system may be as great as 10%. “We estimate potential savings of 2.5% per year on distribution losses alone through integrated voltage control.”

Demand Reduction

FirstEnergy has focused much of its smart grid effort on demand reduction programs, which in turn improve system operations. In June 2009, FirstEnergy’s Jersey Central Power & Light (JCP&L) subsidiary implemented a comprehensive customer air conditioner monitoring and control program. It features direct load control of 4,000 residential air conditioners, monitoring and controlling noncritical customer electrical loads via two-way communications.

The program is part of the company’s

Integrated Distributed Energy Resource (IDER), which monitors the local distribution circuits for system reliability. The IDER platform enables JCP&L to reduce system load—especially during peak demand periods—by up to 8 megawatts, and there are plans to reduce load by an additional 30 megawatts.

“The goal of our pilot residential air conditioning monitoring program was to achieve a 5-megawatt load reduction capability,” said Waligorski. “Initial data suggest that this has been achieved during the program’s inaugural year.”

SRP also is working with customers to monitor and reduce demand. Its advanced metering initiative boasts nearly half a million smart meters that enable two-way communication between the utility and individual customers. Through this link, SRP is offering a time-of-use rate with a 3-hour peak period to reduce peak load. According to Nowaczyk, “SRP’s EZ-3 rate plan has been successful. We estimate a 1.5-kilowatt-per-customer coincident peak savings figure using the combined rate plan



SRP's time-of-use plan allows customers to monitor their on-peak electricity use (brown bars) through a secure Web page.



A technician tests the remote control interrupters on SCE's Avanti advanced distribution circuit.

and smart metering system.”

SCE has pursued a smart metering program as well, designed to arm customers with data to help them manage their energy use and their bills. “We have a variety of customer-focused programs aimed at demand and energy-use reduction, including in-home displays, Web presentations, and energy analytics. We also have voluntary programs for dynamic pricing and controlling air conditioning thermostats,” De Martini said. These customer options help SCE reduce expensive peak loads and reduce greenhouse gas emissions through conservation. “Customers will have a range of choices to improve the environment and manage their budgets,” said De Martini.

Looking to the Future

Such fundamental changes can be difficult, especially when infrastructure and substantial capital costs are involved. De Martini of SCE made the point directly: “Before you launch a program like this, you have to determine whether your organization has the capacity to manage the change involved with adopting emerging technologies.” For SRP, FirstEnergy, and SCE, the answer has been “yes,” and all three are planning to build on what they have learned.

As SRP's Nowaczyk noted, getting cross-functional management to proceed on a common roadmap is the best way to align support across the organization. As a result,

SRP continues to develop plans for integration of new metering, distribution, and transmission automation projects.

With the success of its JCP&L residential air conditioning project, FirstEnergy is evaluating additional smart grid technology for operational and demand reduction benefits, including energy storage units, load-shifting devices, line sensors, and substation device monitoring.

Meanwhile, as smart grid technology continues to evolve, innovation will help to overcome some of the inherent limitations of an aging infrastructure. According to De Martini, SCE will replace its distribution management system over the next three years. “We are preparing for the next wave of distributed resources, such as energy storage, renewables, demand response, and electric vehicles, and the new field equipment needed to enable this evolution,” he said.

The company currently has nearly 600 staff involved in smart grid technology projects totaling \$1.5 billion and involving smart metering, synchrophasors, and system controls. “These are not pilots. These are real programs that will benefit SCE's customers,” said De Martini.

Nowaczyk agreed that value is the real issue: “We were implementing smart grid technology years before it was called smart grid, and we will continue after the hype of smart grid wanes. That's because adapting smart grid technologies makes sense from

both a cost and a service perspective, and we will do the right thing for our customers.”

This article was written by Lela Katzman. For more information, contact Don Von Dollen, dvondoll@epri.com, 650.855.2210.



Don Von Dollen, a program manager in EPRI's Power Delivery and Utilization Sector, is responsible for the IntelliGrid program, which focuses on accelerating the development and deployment of smart grid capabilities in the nation's power delivery infrastructure. As part of this work, he coordinates EPRI's smart grid activities with DOE, EEL, NIST, and other government and industry organizations. Before joining EPRI in 1991, Von Dollen was a research engineer with Pacific Gas and Electric Company. He holds a B.S. degree in physics from California State University, Sacramento.

Further Reading

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