



Electric Energy T&D

MAGAZINE

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Publisher:
Steven Desrochers:
steven@electricenergyonline.com

Editor in Chief:
Terry Wildman:
terry@electricenergyonline.com

Contributing Editors:

- Scott Coe and Shangyou Hao, Utility Integration Solutions, Inc. (UISOL)
- William T. (Tim) Shaw, PhD, CISSP
- Maura Goldstein, Baker Botts L.L.P.

Account Executives:
Eva Nemeth: eva@electricenergyonline.com
John Baker: john@electricenergyonline.com

Art Designers:
Anick Langlois: alanglois@jaguar-media.com

Internet Programmers:
Johanne Labonte: jlabonte@jaguar-media.com
Sebastian Knap: sknap@jaguar-media.com
Tarah McCormick: tarah@jaguar-media.com

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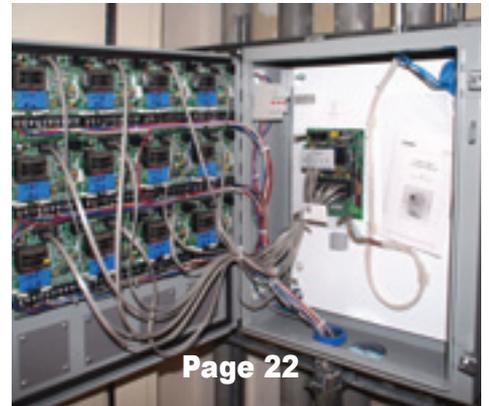
COVER PAGE IMAGE: Credit should be to Grayson Power Plant, part of Glendale Power & Water (GWP)



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A Lean, Green Fighting Machine? Part 2: Competing Objectives in the Army's Renewables Initiative

As explored in Part I of this ARTICLE (Electric Energy T&D January/February Issue 1 - Volume 17), over the past two years, the United States Army ("Army") has established a dedicated Energy Initiatives Office Task Force ("EITF"), and kicked off a novel procurement program (the "Army Renewables RFP") for a proposed \$7 billion in power purchase agreements intended to stimulate private investment in the build-out of greenfield renewable power projects at Army bases across the continental U.S.

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The term 'Smart Grid' has been used over the past decade to include a number of disparate ideas related to making the electricity grid more reliable, more economic, or more environmentally friendly.

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POWERPOINTS

The Place was Electric

I have recently returned from DistribuTECH 2013 in San Diego and I have to say, the depth and breadth of the intellect and levels of achievement on that show floor were absolutely electric. Although every major subject and topic surrounding energy was represented, a few items kept popping up in conversation and at many booths. Smart grid was everywhere as one might expect with the natural extension 'big data' being a large part of the buzz.

At first blush, the term 'big data' seemed to me a rather colloquial way to describe something so key to the success and future of the grid. But this type and sheer volume of information is something utilities have never had full use of until now. On the other hand, until now, they haven't had to face the huge task of accessing, analyzing, managing, and delivering smart grid deployed data coming at them at increasingly faster speeds. Data that is essential to optimizing business operations and enhancing customer relationships.

We are told that somewhere in this flood of data exists the way to more efficiency but vital questions are arising:

- Will access to this new information change the way utilities grow their businesses and, if so, how?
- Will predictive analytics spur operational change and improvements?

While at the show, I quizzed an expert* in big data about what they have found and this is what they told me.

- The average utility with at least one smart meter program in place has increased the frequency of its data collection by 180x – collecting data once every four hours as opposed to just once a month for those without smart meters
- Utilities with smart meter programs in place say they are somewhat prepared to manage the data deluge, rating themselves a 6.7 on a scale of one to ten where one means they are not at all prepared and ten indicates completely prepared
- Utilities are collecting critical information, such as outage (78 percent) and voltage data (73 percent), and many are using it to support business decisions, improve service reliability, and enhance customer satisfaction¹
- In the next five years, utilities plan to leverage smart grid data to improve customer service through efforts such as delivering demand response programs, forecasting demands, complying with regulatory requirements and minimizing outages²

Taking this into account, I was able to more fully understand the opportunities and challenges such data presents:

- Despite improvements, 45 percent of utilities still struggle to report information to business managers as fast as they need it and 50 percent miss opportunities to deliver useful information to customers

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- Utilities see a need to improve their ability to translate information into actionable intelligence and leverage data for strategic decision-making. Sixty-four percent say it is one of their top three priorities. Meter Data Management (MDM) systems may provide help: Seventy percent of those with an MDM system in place and who rank themselves a 7 to 10 in preparedness say they are prepared to successfully manage the data influx versus just 51 percent of those without.³ Breaking this down further shows how utilities rank their data management abilities on a scale of 1 to 10:

- a) Securing/safeguarding data – 8.4
- b) Capturing information – 7.8
- c) Putting timely information into the hands of people who need it most – 7.1
- d) Reporting on information – 7.1
- e) Translating information into actionable intelligence – 6.8
- f) Making strategic decisions based on the information – 6.6

Smart meters are bringing in a constant stream of data including outage, interval, voltage, tamper events, and diagnostic flags. In addition to smart meter information, utilities receive an influx of data from their outage/distribution management systems; customer data/feedback; alternative energy sources; and advanced sensors, controls and grid-healing elements.

I've often said to my kids that they are growing up in the most exciting time in our history and if you don't embrace the technological advantages at your fingertips, you could end up going down the road kicking stones instead of reaching for the stars. To my point, many utilities with smart meter programmes are experiencing big challenges in the shortage of skilled talent in the field of intelligence delivery, which is essential to executing data analysis. This is also creating headaches as it translates into limited, often debilitating, processing speed. Seventy-one percent of utilities claim they are being held back because there are too few available hires capable of dealing effectively with big data. This is likely part of the reason some utilities are collecting new data but are failing to use it to support business processes and decision-making. For example, 23 percent are collecting *diagnostic flag* data but not using it; 19 percent are not using their outage data; 16 percent are letting *voltage data* slip away; and of the 63 percent that are collecting *tamper event data*, only 47 percent are using it. To move forward, utilities need a better understanding of how they can extract value from data and use the information to better serve their customers.

One of the findings that I found most interesting is which department claims to own or is responsible for smart meter and/or smart grid data. This is an on-going issue that utilities are struggling with. Within the utility operations (by percentage): metering lays claim to 60; customer service – 43; IT – 43; T&D – 29; other (i.e. billing, engineering) – 20; and business analysts – 15.

At the end of the day, the take on all of this 'Big Data, Bigger Opportunities' looks like this:⁴

Use Analytics for Operational Efficiencies: With data coming in from every corner of the business, utilities must not only make data collection a priority, but invest in the systems and people needed to analyze a growing number of new data sources collected from smart meters and other smart grid components to drive operational improvements.

Tackle Ownership Issues: Data ownership resides in various organization departments. Smart meter/interval data should be considered enterprise-level data, so utilities must ensure they have an enterprise data strategy in place.

Consider MDM: Utilities with meter data management systems are better prepared to handle the data deluge. Consider MDM as a means to get the most out of smart meter data.

Remember the Customer: In addition to streamlining business operations, successful data management should greatly improve the customer experience – both through improved outage management/service reliability and stronger customer communication around smart grid changes and benefits.

According to Rodger Smith, senior vice president and general manager, Oracle Utilities, "A vast majority of utility executives are working to enhance their ability to glean real intelligence from smart grid data – to ultimately create new opportunities to improve service reliability and deliver useful information to customers. Utilities can benefit from establishing enterprise information strategies, and investing in the systems and people needed to make better business decisions."⁵

That's Big Data. Imagine what Bigger Data will bring?

*In April 2012, Oracle conducted telephone and online interviews with 151 North American senior-level utility executives (U.S. 62%/Canada 38%). All respondents have implemented at least one smart metering programme.

¹ Vespi, C. "Big Data, Bigger Opportunities: Plans and Preparedness for the Data Deluge." Oracle Utility Transformations (July 10 2012): 5

² van der Laan, C. "Utilities See Opportunities to Leverage Big Data to Improve Business Operations." Oracle Press Release (July 10 2012)

³ Vespi, C. "Big Data, Bigger Opportunities: Plans and Preparedness for the Data Deluge." Oracle Utility Transformations (July 10 2012): 5

⁴ Ibid. 15

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Progress Energy Carolinas reaches agreement with N.C. Public Staff in rate case

Raleigh, NC - Progress Energy Carolinas, a subsidiary of Duke Energy, has reached an agreement with the North Carolina Public Staff concerning the utility's request to raise base rates.

Under the terms of the settlement, the net increase to customers would be \$151.4 million the first year and \$183 million the second year, or an average increase of 5.7 percent for all customers by the second year.

The increase in year two accounts for \$31.4 million in costs associated with the ongoing construction of new natural gas combined-cycle generation at the Sutton Plant in Wilmington, N.C.

Progress Energy originally requested an average increase in retail revenues of 11 percent, or \$359 million.

Major Components

- The settlement includes a return on equity (ROE) of 10.2 percent. Progress Energy Carolinas had originally requested 11.25 percent.
- The settlement includes a capital structure of 53 percent equity and 47 percent debt. The company had requested a 55.4 percent equity component.
- PEC will contribute an additional \$20 million to help low income customers in North Carolina pay their energy bills and to provide training that improves worker access to jobs and increases the quality of the workforce. The company will be allowed to reduce its cost of removal liability by \$20 million.
- The settlement also includes support for the company's proposed nuclear levelization accounting and for a new coal inventory rider allowing the company to recover carrying costs on coal inventory levels above those included in base rates.

All issues were not settled with the Public Staff. These unresolved issues will be decided by the North Carolina Utilities Commission (NCUC). Key matters left open for commission decision include:

- The allocation of the overall rate increase among customer classes (i.e. residential, commercial and industrial)
- The company's change to a single coincident peak cost allocation factor
- The industrial economic recovery rider proposed by the company
- Resolution of the deferral request for combined cycle units at the Smith Complex in Richmond County, N.C. (currently pending in another docket)

The NCUC is conducting hearings around the state to gain public input on the rate increase proposal. On March 18, the commission will hold a hearing in Raleigh to consider the settlement and the other unresolved issues.

The company has requested that new rates go into effect June 1, 2013, for Progress Energy Carolinas customers.

"This agreement with the Public Staff is an important and positive step in this proceeding," said Paul Newton, Duke Energy's North Carolina state president. "The proposed settlement balances the needs of our customers and our investors. We understand there is never a good time to increase rates. However, we believe this settlement allows us to keep the rate increase to customers as low as we reasonably can, and still recover the investments we've made to modernize our system and to ensure safe, reliable and increasingly clean electricity for the future."

Duke Energy Carolinas, which also serves North Carolina, has a separate rate increase pending before the commission. Public hearings on that case are set for May and June.

Stem and the Sacramento Municipal Utility District Partner to Explore Sacramento's Solar Energy Future

Leading Utility to deploy Stem technology to analyze impact of PV on the grid

Sacramento, CA - Stem, a leader in energy optimization, and the Sacramento Municipal Utility District (SMUD) announced a pilot project to study the impact of high penetration solar photovoltaics (PV) on the grid.

The two-year research project will utilize Stem's unique high-resolution data collection, cloud-based power system analytics and intelligent energy storage capabilities to reduce electricity costs for customers.

During the first phase of the project, Stem and SMUD will work with residential and commercial customer volunteers from a solar-powered community to install Stem's PowerMonitor data collection and analysis solution, examining the impact of a high penetration of PV on distribution circuit power quality. The data collected by Stem will inform SMUD of the amount of PV that can be added to a distribution feeder while maintaining grid stability and power quality. These results will answer key questions including the effects of the second-by-second ramp rates of PV on SMUD's system, and how distributed storage can be used to mitigate these effects.

"We're looking forward to exploring the potential for the greater integration of solar energy into Sacramento's electric distribution system," said Mark Rawson from SMUD. "Stem's technology will enable us to both gather information and test solutions to possibly enable more clean energy in our community." Potential follow-on work may include SMUD deploying Stem's distributed storage systems to test the potential for automatic, fast-responding distributed storage to improve power quality for customers on circuits with a high penetration of PV.

"SMUD has shown admirable leadership in their commitment to better integrating renewable energy into the grid," said Stem CEO Salim Khan. "We look forward to working with their innovative R&D division to apply our core competencies in data, analytics, and power to pave the way for a sunnier energy future in Sacramento." Stem is excited about the local and national implications this research will have on integrating PV into the existing grid and the potential of distributed storage as a tool to maintain reliability.



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Sacramento Municipal Utility District's Advanced Lighting Controls program delivers significant energy savings and customer benefit

Technology utilizes smart grid's demand-response capabilities to deliver big-impact energy savings

San Francisco, CA - Pacific Gas and Electric Company (PG&E) announced that it spent more than \$2 billion with diverse suppliers in 2012—a record high for the company—accounting for 38.5 percent of its total procurement budget. The total was twice what the utility spent on diverse suppliers in 2010.

“In 2012, we reached a tremendous milestone in our commitment to the full participation of diverse businesses as suppliers to PG&E,” said Chris Johns, president of PG&E. “Through our work to deliver safe, reliable and affordable gas and electric service to our customers, we are supporting economic development, job creation and diversity in the communities where our customers live and work.”

PG&E has been committed to diversity and inclusion for more than three decades. The company has developed one of the state's leading supplier diversity programs, which culminated in a decade-long trend of consecutive year-over-year growth in diverse spending.

“PG&E truly understands the value of supplier diversity,” said Bob Mulz, chairman of the Elite SDVOB Network. “Representing the most diverse group in the nation, Elite SDVOB is delighted to partner with PG&E to further promote and support the advancement and development of diverse-owned businesses.”

“We appreciate all of PG&E's ongoing efforts to invest in the communities they serve,” said Tracy Stanhoff, president of American Indian Chamber of Commerce of California. “PG&E's Supplier Diversity Program has assisted our Native businesses with capacity building workshops and real opportunities fostering mutual success and sustainable growth.”

PG&E partners with diverse suppliers in part to generate innovation and increase competition while contributing to their revenue growth. The utility plays a significant role by providing small businesses with technical assistance training. With the emergence of new technologies in the utility industry, PG&E is also focused on helping diverse suppliers prepare to compete in a changing supply chain.

“Our work with PG&E has helped S&S Supplies and Solutions grow significantly to \$96 million in revenue with 121 full-time employees. This demonstrates not only PG&E's leadership in providing opportunities to qualified minority businesses, but also its commitment to helping foster the growth of the local economy by keeping more business and jobs in California,” said Tracy Tomkovicz, chief executive officer of S&S Supplies and Solutions, a minority- and woman-owned company in Martinez, Calif.

This national supplier and service provider specializes in technical safety, tools, maintenance, repair and operations supplies, industrial garments, technical services and contract labor services.

For information on PG&E's Supplier Diversity program or to learn how to apply to become a certified diverse supplier, visit www.pge.com/supplierdiversity/.

Smart Grid Technology Market Will Total \$494 Billion in Cumulative Revenue from 2012 to 2020, Forecasts Pike Research

Boulder, CO - The creation of the smart grid remains a colossal undertaking. Many complex smart grid programs are underway, but the scale of what remains to be done is enormous. The challenges ahead translate into strong growth for vendors of smart grid technologies – transmission upgrades, automation of substations and distribution, smart grid IT, and smart meters. According to a new report from Pike Research, a part of Navigant's Energy Practice, the market for smart grid technologies will grow from \$33 billion annually in 2012 to \$73 billion by the end of 2020, totaling \$494 billion in cumulative revenue over that period.

“The overlay of modern smart grid technologies onto existing grids promises numerous benefits to utilities, including increased reliability and capacity, reduced energy losses, and deferring or eliminating the need for new generation resources,” says senior research analyst Bob Lockhart. “These benefits reach far beyond the business of any particular utility to underlie economic growth, social well-being, and the shift to energy sources that are less damaging to the environment.”

There is no single “smart grid solution” that will work for all utilities, according to the report. Utilities are likely to take individual approaches to smart grids, some starting with smart metering while others begin with transmission upgrades. However, the number of smart meter deployments (estimated at a total of 832 million smart meters during the 2011-2020 timeframe) implies that quite a few utilities have yet to set out on an advanced metering infrastructure course but are likely to do so over the coming seven years.

The report, “Smart Grid Technologies”, examines the market dynamics and most important technology issues for smart grid technologies for the period from 2012 through 2020. The report profiles the key players in smart grid technologies, in eight categories: influential utilities, control system vendors, telecommunications vendors, smart metering vendors, application and services vendors, systems integrators, cyber security vendors, and standards associations. Analysis and forecasts are presented year-by-year and cumulatively through 2020, dissecting the market by smart grid application and by region, with further technology segmentation within each application. An Executive Summary of the report is available for free download on the Pike Research website.

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\$2 Billion To Diverse Suppliers Marks New Record For PG&E

Utility's Spending with Businesses Owned by Minorities, Women and Service-Disabled Veterans Has Doubled in Just Two Years

San Francisco, CA - Pacific Gas and Electric Company (PG&E) announced that it spent more than \$2 billion with diverse suppliers in 2012—a record high for the company—accounting for 38.5 percent of its total procurement budget. The total was twice what the utility spent on diverse suppliers in 2010.

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PG&E partners with diverse suppliers in part to generate innovation and increase competition while contributing to their revenue growth. The utility plays a significant role by providing small businesses with technical assistance training. With the emergence of new technologies in the utility industry, PG&E is also focused on helping diverse suppliers prepare to compete in a changing supply chain.

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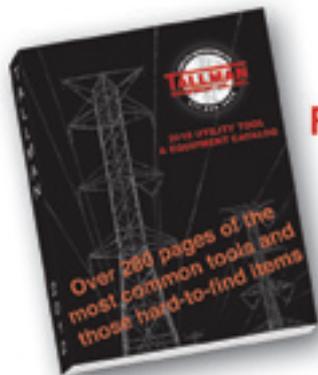
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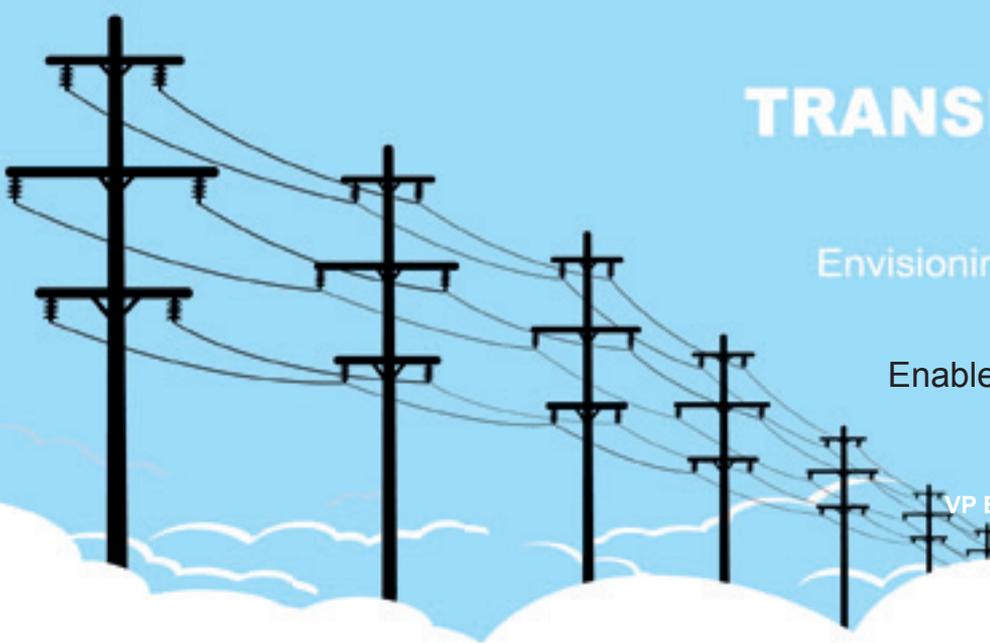
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THE GRID TRANSFORMATION FORUM

Envisioning the 21st Century Grid

How Communications Can Enable More Reliable and Efficient Electricity Distribution

We are speaking with Rob Pilgrim, VP Business Development at ABB Tropos Wireless Communication Systems

EET&D: How can a communications equipment and software business such as ABB Tropos Wireless Communication Systems contribute to making the electrical power grid more reliable and efficient?

Pilgrim: Well, the concept of a smart grid is about combining information, automation, and communications technology to create a more responsive and intelligent electric grid. So you really can't have a smart grid without communications and the software to manage it. Taking this a step further, the intelligence in the electrical infrastructure and management systems is only as good as the ability to communicate the status and control information necessary to support the specific applications. In other words you can't have a smart grid without communications and, if anything, the communications needs to be more reliable than the power grid. This is because you need visibility and control over your grid assets most when there is a fault or an outage. Communications have to remain up in these situations.

EET&D: What are the basic requirements for a smart grid communication network?

Pilgrim: Reliability is the number one requirement if you talk to the utilities. This is really a combination of survivability and availability, with availability meaning, 'Do I have access to the network resource when I need it?' both in terms of system uptime as well as system service availability. Survivability deals with how the network performs during exceptional or unplanned events, think Hurricane Sandy or a major winter storm. Utilities should be looking for communications solutions with resilient architectures that are fault-tolerant and have back-up power systems.

Other factors to consider in selecting communications include:

- Coverage – Utilities cover large areas with lots of remote assets to connect that are not always close to populated areas
- Security – This is growing in importance and is getting a lot of attention in the news and from government lately with the revelations about organized hacking from foreign nations. Smart

grids are large scale industrial control systems and the networks that connect them, whether legacy or IP-based, need to incorporate the well-tested layered security approaches utilized by enterprises.

- Performance – This is not so much about bandwidth per se. Latency is often more important, especially for applications like feeder protection. Bandwidth is important in the aggregate, however. As utilities deploy more and more applications, such as mobile workforce and substation video monitoring, bandwidth requirements will likely increase.
- Quality of Service (QoS) – Utilities can derive great value by running a mix of applications over a single network, but some applications have real-time needs that need to be prioritized appropriately
- Lifecycle – 20 plus year utility asset operating lifetimes

EET&D: What roles do wired and wireless technologies play in smart grid communication networks?

Pilgrim: When we look at the utility network and the smart grid applications being deployed, we see it arranging itself in a more or less hierarchical fashion. On one end you've got your primary substations, your high-voltage sites, and your generation facilities. These sites have demanding requirements in terms of the capacity of data, performance requirements, and reliability. They're also lower in number. Typically they're served by wired technologies, specifically fiber. On the other end you've got your metering infrastructure. Here you've got lots of devices, but lower bandwidth, reliability, and latency requirements. At least as far as the individual device connections here, you're going to find lower bandwidth, lower performance solutions. In the middle, what's inbetween these two ends, we have the distribution network. Here we're talking about hundreds or even thousands of devices and applications with varying requirements, although as we just discussed the individual applications can be demanding and so can the requirements in the aggregate. There's some debate on the specific solutions and technologies to be employed here, but a consensus seems to be forming around private (utility-owned) wireless solutions. This is because in terms of coverage, total cost to the utility, and a desire to control matters of performance and security, private network solutions end up meeting the needs of utilities best.

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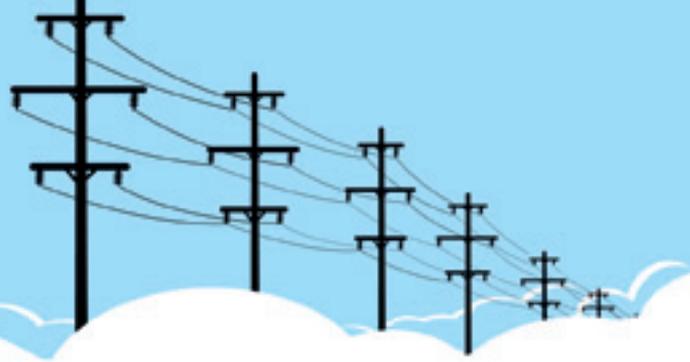
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EET&D: How can communications make electricity distribution more reliable and efficient?

Pilgrim: One example is with outage management. A dramatic instance of this was recently seen during Hurricane Sandy, but whether it's a catastrophic failure or something more mundane like a tree falling on a power line, utilities are measured by their regulators on both the number and the duration of outages and can face penalties for poor performance. While some outages can't be avoided, the length of the outage and its scope – the number of affected customers – can be minimized.

For decades, utilities have relied on customer phone calls and dispatching crews to the field to identify outage areas. They often received delayed and imprecise outage information, slowing power restoration. This reactive response process and associated long outage durations have often been viewed negatively by customers and regulators.

Utilities can improve customer satisfaction by deploying software, intelligent devices, and network communications to implement a state-of-the-art outage management system. These technologies can minimize the scope and duration of outages and enable proactive engagement with affected customers.

A key element enabling proactive outage management is real-time, bidirectional communication with utility devices in the field. Communications permit outage management systems (OMS) and other utility software systems to collect up-to-the-second information from the distribution system, adjust system operation, and provide information to customer service systems and personnel for proactive customer engagement. Even better, the OMS could predict pending failures, enabling scheduled preventative maintenance and reducing unscheduled maintenance under outage conditions.

EET&D: What are the barriers to integrated smart grid system implementation and how can utilities overcome them?

Pilgrim: There are a couple of different dimensions to this notion of breaking down barriers. The first is in terms of breaking down organizational silos within the utilities and fostering information and operational systems convergence. As a communications vendor selling into utilities, we've frequently seen these organizational barriers come into play and influence technology decisions in ways that weren't beneficial to the overall organization. A prime example of this would be a utility's billing organization evaluating solutions based solely on the requirements of supporting their advanced metering infrastructure. By considering their own requirements in isolation from those of say, the distribution engineering or substation engineering groups within the

utility, they end up with a solution that might not support the overall application requirements of the 'smart grid.' Many utilities are starting to take a more systematic and strategic approach to defining their 'smart grid' network requirements, but the former situation, and similar siloed decision making still occurs.

This is unfortunate because there are real advantages to using a shared infrastructure. It lowers the costs of network deployment and network operation, because you're deploying once, and you have one network to manage. At the same time however it opens up possibilities in terms of tying data together from previous disparate systems, and then utilizing that data to achieve greater efficiencies. An example of this would be in the case of outage management where data from customer meters, pole-top sensors, and protective relays can be brought together to gain a more effective view of what's actually going on out in the field. Going a step further, the data from OMS, SCADA, and DMS systems can be more quickly coordinated and the right repair resources identified and directed to the right locations more efficiently.

More efficient operation of the grid through more integrated communication and management systems can also help overcome another barrier to implementation – funding it. For regulated utilities any large investment in infrastructure, especially if it's tied to a potential rate increase, is going to come under scrutiny by the relevant utility commission. However if there are tangible end benefits such as improved reliability of the grid, shorter outage times, and more responsive support for things like distributed generation, electric vehicle charging, and better voltage management, utilities may find they have an easier case to sell. What's more some of these applications like CVR, for example, will likely have relatively short payback periods after which they've paid for themselves and may help offset the cost of other applications as well. Finally, one silver lining in the devastation of events like Hurricane Sandy is that they've driven home the need for grid modernization to regulators and made available federal investment dollars for the affected areas. With any luck, and hopefully with some early successful deployment examples, this may spur regulators in areas that weren't affected to approve similar projects.

EET&D: Are industry interoperability standards important to smart grid communication networks? Why or why not?

Pilgrim: For communications, standards are vital. Deploying networks based on interoperability standards from the IEEE – Ethernet and 802.11, for example – and the IETF's family of IP-related standards allow the network to be a platform that connects a variety of devices from a wide range of vendors and that supports a diverse set of applications. Using standards-based components and software lowers operating costs for utilities and allows them to take advantage of innovation from a larger pool of vendors.



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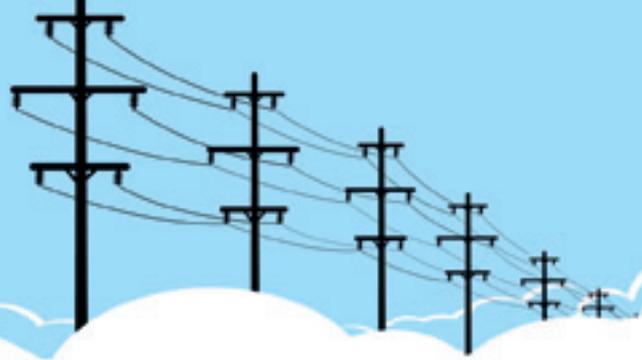
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It's also important for vendors and utilities to support utility-specific standards. This means support for newer standards such as IEC 61850 and DNP 3 as well as legacy standards such as Modbus, which is important to avoid stranded assets with migrating to an IP-based grid communication solution.

EET&D: What is the appropriate role of compliance standards – whether mandated by regulators, politicians or industry associations – in smart grid communication networks?

Pilgrim: I think that while some utilities are taking cybersecurity seriously, others are being too passive in their approach, and are waiting for regulators to tell them what to do. Utilities and their customers would be better served if utilities aggressively adopted the existing interoperability standards for internet security – standards such as IPsec virtual private networks, AES for encryption, and RADIUS for authentication and accounting – and look to enterprise security for best practices in applying these technologies. Rather than mandate compliance standards, which often become a ceiling rather than a floor, regulators and politicians can best contribute by encouraging utilities to be transparent about cybersecurity issues. Transparency about

security is not something that comes naturally but it's vital so that utilities benefit from the vast knowledge and manpower of the internet security community.

EET&D: Thanks, Rob, for speaking with us. We look forward to keeping in touch as the smart grid and smart grid communications evolve.



About the Interviewee: Rob Pilgrim is responsible for corporate business development and strategy for ABB Tropos Wireless Communication Systems including global strategic partnerships, alliances, marketing, M&A assessment, and technology licensing. He built the Tropos solutions ecosystem and spearheaded the Tropos' GridCom initiative, shifting the company into smart grid communications. Prior to joining Tropos in 2005, Rob was Director of Product Management and Business Development at early DSL pioneer Covad Communications, and spent over 10 years in various management roles in network communications including Sigma Networks and Fluor Corporation working on network programs for Level 3 Communications and T-Mobile. Pilgrim started his career at Georgia Power Company, an operating unit of the Southern Company. Rob holds a bachelor's degree in engineering from Georgia Institute of Technology.

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GREEN OVATIONS

Innovations in Green Technologies

Energize Your Conservation and Energy Efficiency Measures with Submeters

By Dave Bovankovich, VP Engineering



Since their introduction to the market in the 1980s, submeters have dramatically evolved in terms of functionality and usefulness, and have proven themselves valuable ‘front-line’ energy data gathering tools in an era of rising utility costs and tightening budgets. Submeters not only help operators to improve the facility bottom line, but facilitate implementation of building retro-commissioning projects and other energy initiatives while also encouraging facility occupants to become stakeholders in the energy management and conservation process through real-time and historical data presentation.

The level of sophisticated energy profiling needed by high-volume consumers is unobtainable using the standard utility meter found at the facility’s main electrical service entrance. In response to the need for greater granularity in terms of the energy intelligence needed to optimize today’s facility operations, electric submeters continue to provide a cost-effective way to help identify literally thousands of dollars in previously hidden energy savings opportunities.

Submeters can reveal operational inefficiencies, demand spikes and other bottom-line impacting events, while increasing facility operational effectiveness. As metering devices with monitoring

capability that are installed on the facility side of the master meter (Figure 1), submeters provide any or all of the following:

- Usage analysis and peak demand identification
- Time-of-use metering of electricity, gas, water, steam, BTUs and other energy sources
- Cost allocation for tenant billing
- Measurement, verification, and benchmarking for energy initiatives like BOMA BEST (BOMA Canada’s Green Globes-based commercial building certification program), LEED energy and water efficiency credits, and others.
- Load comparisons
- Threshold alarming and notification;
- Multi-site load aggregation and real-time historical monitoring of energy consumption patterns for negotiating lower energy rates, and more.

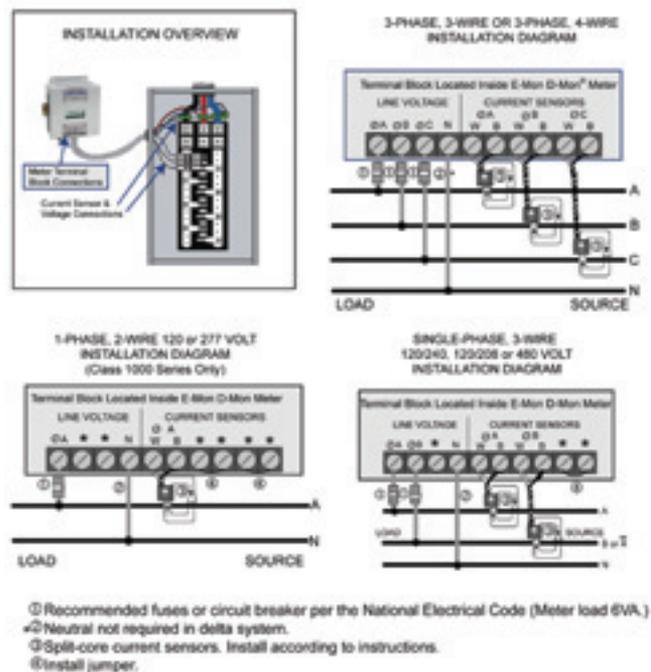


Figure 1. Submeters are used to measure energy consumption from the enterprise level all the way down to a single device or circuit panel, as shown above. Sold through distribution, electric submeters are easily integrated with water, gas and other pulse-output utility meters, energy intelligence software and Building Management Systems (BMS), to provide a total facility energy snapshot.

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Of the three main submeter types shown in Table 1, the first two – feed-through and current transformer (CT)-based – are socket-type meters. CT-style socket meters are used with loads of 400A and above. However, socket-type meters are not UL listed, a disadvantage in many jurisdictions. The third type is the solid-state electronic submeter, a non-socket device that provides clear advantages over the previous two.

SPECIFICATIONS	SUBMETER TYPE		
	Socket Type Electromechanical/Solid State		Electronic Non-socket Type
	Feed-thru Type	Current Xlnr Type	
INSTALLATION			
Installed Cost (estimated)			
Stand alone, up to 320A, 3Ø	\$1,000	Not Applicable	\$700
Stand alone, over 320A, 3Ø	Not Applicable	\$2000 - \$5000	\$800
8-Meter Unit, 200A, 3Ø	\$16,000	Not Applicable	\$5,500
Installation Time	2-3 Hours	6-8 Hours	1 Hour
Power Interruption	2-3 Hours	6-8 Hours	None
Amperage Limitations	320 Amp, Max.	None	None
Space Requirements	2 Square Ft	11.7 Square Ft	0.25 Square FT
Installation Location	Utility Room	Utility Room	Anywhere
FEATURES			
Multiple Meter Units (MMU)	Yes	Yes	Yes
Size of 8-Unit Cabinet	18.1 Square Ft	18.1 Square Ft	2 Square Ft
Digital Readouts	Optional/Yes	Optional/Yes	Standard
Reset Capabilities	No/Yes	No/Yes	Standard
Multiple Load Monitoring	No	No	Yes
Subtractive Load Monitoring	No	No	Yes
Monitor Specific In-Panel Circuits	No	No	Yes
Amperage Modification in Field	No	w/CT Change	Yes
Meter UL listed	No	No	Yes
ENHANCEMENTS			
Digital-to-Analog Profiles	Yes	Yes	Yes
Pulse Outputs	Yes	Yes	Yes
Timed Metering	Yes	Yes	Yes
Software Monitoring	Yes	Yes	Yes
Upgradable in the Field	No	No	Yes
Power Quality Functions	Available	Available	Yes
Net-Metering Capability	Yes	Yes	Yes
Form C Control Relay Output	No	No	Yes

Source: E-Mon

Table 1. Non-socket-type electronic submeters are less expensive initially, quicker and easier to install and offer superior performance and options compared to other types, making them a cost-effective means for measuring and verifying facility energy retrofit program goals.

Submetering Applications Overview

Submeters are useful for a number of energy monitoring needs, including but not limited to:

Aggregation – commercial property management companies, large multi-site industrial facilities, school districts and other mutual interest groups based on volume energy use are likely candidates for aggregating their combined energy consumption in deregulated jurisdictions. Submeters provide the advanced profiling needed for aggregating energy purchases.

Billing – revenue-grade-accuracy submeters provide the raw data needed by property managers to provide complete, accurate accounts of submetered tenant spaces, common areas and other metered entities (Figure 2). Energy intelligence software seamlessly converts the raw data into user-defined billing

statements that provide all the necessary detail to eliminate tenant disputes through fair and accurate billing of actual consumption.

Cost Allocation – individually metering common areas provides the data needed to recover and allocate costs to event sponsors, tenants, departments or other budgetary entities. In the manufacturing setting, monitoring energy use of production, as well as non-production departments, allows businesses to drill down to find how, when and where energy is being used. In the educational setting, metering each department lets users take advantage of energy-saving opportunities which may be as simple as turning off lights or computers when rooms are not in use. Monitoring energy usage by individual department allows the tenant to allocate energy costs to specific departments within their own business, ensuring accurate budgeting and increased energy efficiency.

Demand Side Management – designed to reduce electrical demand and/or use, DSM strategies include load management, load profiling and load shedding to shift usage and demand to off-peak periods.



Figure 2. Installable in any convenient location, electric submeters are commercially available in a variety of configurations from single, stand-alone devices to multiple-meter units (shown) housing up to two dozen meters. Applications include benchmarking, measuring and verifying energy conservation and ROI goals in connection with existing building retrofit initiatives gaining momentum around the country.

The key to avoiding higher charges is to identify usage peaks and take steps to reduce them. Submeters can be used to profile individual or aggregated loads to pinpoint peak usage areas or equipment that is performing outside normal limits. This allows manufacturers to employ load controlling devices to set high/low thresholds, control loads and reduce energy costs. Large commercial and industrial users that purchase power by the hour using either forecast or time-of-use (TOU) pricing will find TOU-capable meters and interval data recorders (IDR) useful for profiling demand and consumption at user-specified time intervals.

Energy Analysis and Load Control – plant operators require accurate, real-time status feedback to evaluate the performance of pumps, compressors, heaters, chillers, conveyors and other electrically powered equipment. However, many commercial and industrial customers do not have the resources to manage a full-scale load-management system. Advanced electronic submeters provide this capability via selectable high/low setpoints. The ‘high’ set point allows users to shave electrical demand peaks by activating a local generator or shedding loads to off-peak hours when energy is cheaper. The ‘low’ kW limit allows the load to be returned to normal operating power as pre-set parameters are met. A programmable timing feature allows delayed activation to eliminate ‘nuisances’ like short-term motor starts. Other functions are designed to prevent short-time cycling, as can occur in HVAC compressor control applications.

Measurement & Verification (M&V) – individual submeters can be installed at the point of load to monitor chillers, HVAC, air handlers, pumps and so forth. Operational inefficiencies may thus be identified to reveal, for example, if two or more large loads are coming on at the same time, causing demand spikes. Diagnostic functions also include the ability to identify equipment that may be close to failure, as indicated by a larger than normal current draw with no corresponding productivity output. Early identification of a potential problem allows facility engineers to schedule preventative maintenance before a costly failure occurs.



Figure 3. Energy intelligence software allows generation of graphs and profiles of kWh and kW for demand analysis and usage reduction. Converted meter data is presented in both historical and real-time slices for trending and reporting.

Energy Intelligence Software

Energy monitoring software allows users to read and monitor energy consumption and demand via on-site or remote, non-dedicated computer. Software allows generation of graphs and profiles of kWh and kW for demand analysis and usage reduction (Figure 3). Itemized bills may also be generated for tenant and/or department allocation and usage verification. Other key characteristics include:

- Remote or on-site meter communications via modem, Ethernet, Internet and wireless
- Reads multiple time periods for time-of-use (TOU) monitoring
- Operates on Windows 2000, XP or Vista operating systems
- Exportable, user-configurable data to spreadsheets, MV-90, etc.

Submeters Help Utility Service Center Earn ‘LEED Gold’

Wildomar, California, is the site of the first of ten new high-performance customer service centers that Southern California Edison (SCE) will be building over the next few years. Electric submeters are an integral part of the Wildomar facility’s energy monitoring system that tracks consumption (kWh) and demand (kW), a key performance requirement for obtaining Leadership in Energy and Environmental Design (LEED) certification.

With two multi-level main buildings and a single-story structure in the service yard, the 97,553-square-foot, \$38M facility is almost 40 percent more energy efficient than similar buildings. Featuring solar panels (Figures 1 & 3) and energy-efficient lighting that automatically adjusts lumen levels to augment available natural lighting during daylight hours, these and other energy-efficiency features and water conservation measures helped the facility qualify for certification at the Gold level under the U.S. Green Building Council’s LEED high-performance building assessment system.

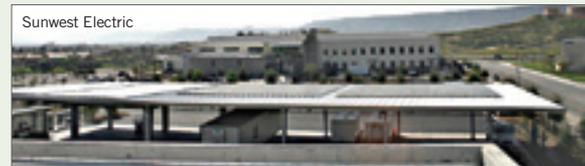


Figure 1: Photovoltaic panels installed on the canopy over the utility service yard convert solar energy to electricity for the fuel dock, overhead lights and other circuits, earning a LEED credit for onsite renewable power.

The energy data acquisition front end of the Wildomar center’s building automation system (BAS) is provided by electric submeters from Langhorne, PA-based E-Mon, an energy monitoring hardware and software solutions provider. Sunwest Electric (www.sunwestelectric.net) of Anaheim, CA, the submetering system installer at Wildomar, specified 277/480V 3-phase/4-wire E-Mon D-Mon meters to monitor electrical consumption (kWh) and demand (kW) on two 200A and one each 1600A and 3200A circuits (Figure 2) in the three main buildings and the main switch board.

Communicating the raw energy data every 15 minutes to the energy manager’s PC via the facility’s Ethernet local area network, “the E-Mon D-Mons were installed to see how much power is being consumed in each building and to compare this usage to similar non-green buildings,” said Sunwest Project Foreman John Richards. “Benchmarking the energy-efficiency measures that were implemented in this facility will serve as a prototype for other service centers in the near future.”



Figure 2: Four 277/480V submeters were installed next to a main switchgear cabinet outside one of the buildings.

From an operations standpoint, “Our new service center in Wildomar is a model of energy efficiency, environmentally friendly and vital to providing optimum service to our customers in southern Riverside County,” said Cecil House, SCE senior vice president, safety, operations support and chief procurement officer.



Figure 3: A ground-level view of the yard at SCE’s Wildomar, CA service center showing the photovoltaic panels and overhead lights monitored by electric submeters.

Integrating Meters with the BMS

Submeter communications are typically achieved through (1) proprietary energy analysis software and protocols or (2) via pulse output into an energy management system. In both cases, the software resides on the user's PC and communications are accomplished through a "hard-wired" system or a phone modem.

Hard-wired systems work through dedicated RS-485 cabling or through an Ethernet connection that uses an existing network. Ethernet communications do require an optional module and an Internet Protocol (IP) address. Using the RS-485 approach allows up to 4,000 feet of cabling to be run in the building. Available software is able to either method simultaneously and is easily set up to do this. One important thing to remember is that pulse-output electric, water, gas, steam and other similar meter types have to be used with an IDR (Interval Data Recorder) to provide communications.

Unlike meters which continuously read energy usage as it occurs, IDRs collect and store consumption (kWh) and demand (kW) meter information at user-specified time periods from five to 60 minutes, allowing for profiling of energy data and more detailed comparative analysis for billing and other uses. Stored IDR data can be accessed via telephone modem, Ethernet, ModBus, BACnet, Internet Protocol (IP), LonWorks TP or MV-90. Data can be used to interface with Automatic Meter Reading (AMR) and billing software, Building Management Systems or other energy software.

Ethernet – may be used with both intranet and Internet systems. When tied to the Internet, for example, meters anywhere in the world can be read without bearing long distance charges, as would be the case using a telephone modem. Moreover, Internet access time is very quick, which is especially valuable if 'real-time' access to the meter data is desired.

Modbus – data is exported from the meter on request and the automation or control system processes the raw data for its use. If the IDR is used through Modbus, the data is typically limited to kWh (consumption) and kW (demand). Modbus-compatible meters usually come in the form of (1) Modbus RTU which communicates through RS-485 cabling, and (2) Modbus TCP which is used when Ethernet is the form of communication required by the user.

BACnet – as with Modbus, BACnet-compatible meters communicate over an RS-485 cable system or utilize Ethernet cabling. When used with RS-485, the BACnet MS/TP protocol is utilized. When Ethernet is the choice of communication, BACnet IP is the protocol.

LonWorks – open-protocol LonWorks has its own specialized form of communication and uses neither RS-485 nor Ethernet cabling. Lon TP (twisted pair) is used with this meter and communicates over a twisted-pair of wires, making it somewhat unique in its application and installation.

Energy Data Presentment

Submeters are useful for a number of energy monitoring needs. By importing data from electric submeters and other metering devices into Web-based communications, interval data may be cost-effectively collected, analyzed and displayed in near real-time (Figure 4):

- View resource use in hourly, daily, weekly, monthly or yearly increments
- Compare historical data with current consumption patterns
- Translate savings into monetary results
- Visualize what sustainable efforts are in place
- Show how being efficient saves money, tax dollars and helps the environment



Figure 4. Carbon footprint dashboard of an 800A main distribution panel. The meter data provided by an E-Mon D-Mon Class 3000 submeter is converted by energy intelligence software into real-time and historical kWh statistics, along with generated CO₂, NO_x, SO₂ and other measurements and calculations.

Bottom Line Considerations

As first-level energy data acquisition tools, electric submeters – in conjunction with automatic meter reading (AMR) software solutions, web-enabled meter dashboards and other energy monitoring and management solutions – can help facility operators to measure, verify and report compliance with whatever requirements they may encounter. The old energy adage – 'you can't manage what you don't measure' and its implied corollary 'you can't save what you don't manage' – was never more valid than in today's increasingly energy-minded facility environment. To that end, submeters offer the using facility an accurate, cost-effective tool for doing exactly that, while providing the flexibility and scalability to respond to evolving operational requirements.

About the Author

David Bovankovich, Vice President of Engineering for E-Mon, has more than 30 years of electrical engineering, facility management, design, and metering expertise. As a utility industry liaison, Bovankovich participated in the U.S. Energy Association's Energy Efficiency Forum and was a member of the Publisher's Roundtable for NEC Digest. He has participated in deregulation hearings of both California and Pennsylvania. Dave can be contacted at dbovankovich@emon.com



Advancing Customer Relationships with Advanced Metering

DNV KEMA and Glendale Water & Power's Smart Grid Grant

By Terry McDonald, PMP –
Executive Consultant,
DNV KEMA

Keeping on track, on time, and on budget with smart grid projects

The 2009 American Recovery and Reinvestment Act (ARRA) issued a broad range of grants totaling \$787 billion. The money was to save and create jobs, and increase investments in infrastructure, including smart grids and 'green' energy.

Glendale Water & Power (GWP) won a grant from the ARRA which turned out to be one of the most high profile ARRA projects in the utility industry. DNV KEMA Energy and Sustainability was a key implementation partner for GWP, and partnered with GWP from the start of the grant application process, through RFP development and execution, vendor evaluation and selection, and the first two years of implementation. GWP was one of the first utilities to receive ARRA funds for smart grid projects and its ARRA work has been wide-ranging.

In the later phases of the two year (2010 to 2012) implementation, one of the goals was to ensure GWP had arrived at the point where DNV KEMA's services were no longer needed. As soon as this knowledge transfer was completed and GWP was able to independently carry on its wide-ranging smart grid capabilities on an ongoing basis, the utility was on its own. GWP then continued with the final phases of administering, monitoring, and demonstrating the long term benefits of its smart grid capabilities.

GWP has emerged as an ideal prototype of utility industry smart grid projects and ARRA grants, successfully managing the project and gaining step-by-step approvals to spend all of the funds as planned, on schedule and within the highly constrained and monitored milestones required of these programs.

It may sound trivial to have been able to spend all planned money in an ARRA grant project successfully, but it is no small matter. As has been highly publicized recently, it is unclear whether all recipients of ARRA grants will be able to spend the entirety of their grant funds on schedule and also complete their projects before the September 2013 deadline as planned. As a non-utility example, according to the U.S. Department of Education, although all 50 states received ARRA Title I

education grants, only six of them have succeeded in using every single one of their ARRA Title I dollars as planned by January 13, 2012.

In any industry, unspent grant funds may, at minimum, represent plans that did not account for the realities of the marketplace. They could also involve the additional difficulties associated with implementing major new initiatives that involve technological as well as cultural changes, both within the implementing companies and their larger customer, contractor and stakeholder communities.

Everything old is new again: Advanced metering and deeper utility relationships with customers

Three of DNV KEMA's core values during its 80 year history are risk reduction, listening to its customers, and being trusted by clients as objective, independent evaluators. Similarly, over its 100 years of service, GWP's primary purpose has coalesced around similar values, as described in its Mission Statement: *To be your trusted community utility.*

These values and missions were reflected in the way the joint GWP/DNV KEMA team devoted much of its initial efforts to the cultural aspects of strengthening relationships with Glendale's electric and water customers.

Everything old is new again. Closer relationships between a utility and its customers mirror the core values of the utility industry's early history. Early on in the development of the modern electric utility industry, part of receiving electric service involved interacting with meter readers and utility sales personnel, who encouraged homeowners to buy new electric appliances directly from the utility. At the utility industry's inception in the 1880s to early 1900s, customers paid not by the kilowatt-hour, but by the number of light bulbs in their home or office. Utility personnel would provide on-site service when light bulbs went out. As meter installations occurred and electricity use expanded from lighting to other appliances in the home, utilities sold these appliances as well. For example, in 1923, U.S. electrical utilities sold 31 to 41 percent of all electrical appliances by dollar volume and had the largest market share of heavy appliance retail sales.¹

Advancing Customer Relationships with Advanced Metering

Regulatory changes after the onset of the Great Depression led to an invisible wall between utilities and their customers, banning the sale by utilities of any equipment or services on the customer's side of the meter.

Although municipal utilities have not entirely lost this culture of relationships with customers, they have, like other utilities, gradually tended to move away from having such close relationships with their customers. The sad truth is that by the time smart grid opportunities started to rise in prominence, our electricity-dependent modern culture had, for decades, already become habituated to taking electric utility service for granted. For many people, invisibility is almost part of the definition of the word 'utility' itself – something useful that stays behind the scenes and runs on its own.

Now, the deep customer involvement associated with smart grid opportunities is introducing something new to people's minds about their utility and potentially represents a shift back to prior generation's close relationships with its utilities. As a result, utilities need to start learning a lot more about their customers than they needed to know in the last 75 years.

Fundamentally, not only do utilities need to learn more about their customers, customers also need to learn more about their utilities, as only a deeper understanding will help motivate customers to make changes. Society cannot enjoy the important potential benefits of smart grids unless there is a huge increase in the frequency and depth of information exchanged between utilities and their end-users. This increase in the use of real-time data about customer usage and utility supply is at the heart of many of the benefits associated with advanced metering and the smart grid.

In much the same way that the introduction of electric appliances helped customers save time in getting work done around the home, the new drive for smart grids will also help customers be more efficient. Improved efficiency will help customers reduce their overall contribution to expensive peaks in electricity demand and help promote distributed energy resources such as solar and electric vehicles. Not only do these initiatives help customers save money, they also help to ensure increasingly economical and reliable electric service as well as preserve environmental resources and quality of life.

From a customer-facing perspective, the interactions are mainly between smart grids and home area networks (HANs), with advanced metering infrastructure (AMI) as the key linkage between the two.

Along with identifying key groups and how to reach them, the DNV KEMA/GWP team built a detailed matrix that represents the entire Glendale community and asks several questions about each key group:

- What impact will the project have on them – positive or negative?
- What impact will they have on our work with this project?

- If we are to engage with each of these customer segments, what info will they need?
- When will they need it?
- What modality for conveying this information is the best and how can we ensure we make it as much of a two-way conversation as possible?

This initial work at the front end of the project guided the team through our efforts and taught everyone how to vary communications methods for the best reach. For example, we found that our large and long-standing Armenian community generally prefers to get their information through Armenian TV, radio and church venues. Ethnic festivals are focal points for this and numerous other communities and in some cases, we reached many customers by taking a booth at community events.

We were able to gather information regarding the different needs of each of our major constituent groups. We also had strong participation of team members at town halls for the general public, as well as speaking engagements for Homeowners Associations. GWP also set up weekend booths in parks calling their outreach 'Coffee's in the Park' in order to bring the concept of the smart grid into the community.

Advertising programs also helped get the message across that GWP was moving toward smart grid capabilities in order to provide benefits to our customers, and that customer participation was a key element of maximizing benefits to them and to the overall community.

Customers learned the amount of cost savings that smart grid improvements could provide them by cycling the operation of major appliances such as air conditioners, refrigerators, and pool pumps in order to smooth out peaks in electricity demand while increasing reliability and providing environmental benefits. As part of this outreach, the team also taught consumers about additional cost savings by using AMI to maximize their efficiency and keep track of their own power usage to stabilize their power bills. Positive momentum was built in anticipation of the program as customers also learned about how they would now be able to get quicker feedback about where a problem impacting electric service may have originated, with sensors that help crews know exactly where to go to restore power, making continuation of service more reliable and efficient.

Prototyping to set the stage for the full advanced metering rollout

Installation of the meters required extensive work to ensure development of good meter provisioning processes and to avoid problem areas. In this process, our team made a catalogue of use cases. The typical model for prototype installations was too labor-intensive as it involved a three person team going to a person's home to do the meter installation and pairing it with the Home Area Network.

Advancing Customer Relationships with Advanced Metering

Instead of a screen displaying only usage data, as part of the prototype, GWP included piloting a new type of in-home display that incorporate digital picture frames inside customers' homes, making the displayed metering information customizable alongside family slideshow photographs that can be sent from the cloud (e.g. Facebook, cellphones, email etc.). This prototyping work, which was part of the initial project roll-out, has made the in home displays more popular.

The company making the digital picture frames, Ceiva, stores pictures in the digital cloud format. This system uses the same ZigBee chip that manages communications that run from the customers' meter to the real-time display, allowing for the incorporation of their energy information alongside their private photos on the digital frame. Provisioning the HAN and meter installation for these prototype installations involved the team engaging in one-on-one advising with the customers on how to use the frame. The lessons learned during this HAN prototyping phase were invaluable, although it is not a sustainable model for doing the tens of thousands of meter installations required. Rather, we created a new web portal to give the customer access to a wide range of services, one of which is doing HAN provisioning.

It is of vital importance to maintain security while being customer friendly. This security involves a set of criteria that requires striking a delicate balance, since it is easy if the customer interactions are not designed well on the portal for the security aspects to make it feel like an unfriendly process.

The customer will be able to configure the digital frame or any Zigbee device they wish. Each device has to be provisioned with the meter or it will not be part of the network. This integration involves a wide range of activity which requires workflow and system designs to automate customer interactions with the portal, given the impossibility of having customer service or technical personnel directly interfacing with each of GWP's customers. The team found that there was nothing off the shelf for this type of portal and built it to allow single sign-on.

Continuing with this model, portals are being installed with different tabs to allow the customer to pay their bill and access information on a range of conservation tips, try out different rates and see what would be most beneficial based on 'what-if' scenarios related usage. In addition, the system will allow GWP to provision the HAN device or shut it off if the customer at that location moves, in order to prevent it from being a security risk.

The process of the build-out to full scale has been a teaching experience to deal with challenges. For example, if you have multi-family dwellings, in some cases, the meter bank is in a remote location away from the dwellings. To align each home's Zigbee, you have to develop certain processes for pairing to the right meter with the right home's HAN.

Trying to take Ben Franklin's advice; how do you 'make haste slowly'?

Achieving the benefits of these technologies involves interactions between numerous systems. In order to avoid major problems we were fortunate to have found the right balance between slow and deliberate execution of pilot elements and a desire for quick rollout of the full scale installations. The initial pilot had to be carried out in widespread fashion for our teams to have gathered all the experiences and information we needed, to then carefully reviewing and structuring the lessons learned from this 'slow' phase, before hastening to the full rollout.

GWP's smart grid implementation includes smart metering and installations of advanced metering infrastructure to support all customers. Over the course of the implementation, the DNV KEMA/GWP joint team installed smart meters for both electric and water service. The detailed plans, which were executed successfully in accordance with the original schedule, also included installation of customer Web portals, smart water communication modules, and meter data management system, as well as leak-detection systems.

Aside from making the prototyping installation phase big enough for everyone to gather a sufficiently wide range of experiences, another important part of our plan was having a major process check point with all team members and contractors before going into the full scale rollout. At a large learning session teams focused on ways to make their part of the process smarter to improve the efficiency, safety, and effectiveness of the work.

By discovering the issues between the prototype and full production phases, it became imperative to devise processes to vet all meters in the field. Meter readers, for example, photographed each meter and compared that information against the existing SQL meter database. Data accuracy went from 70 to 99.5 percent. The difference this made in the installation process was enormous. Verification of data took place in different neighborhoods and across commercial, industrial and residential customers. The resulting quality control should yield a good payback in terms of reduced costs and faster implementation times.

Realities of running the new system

The AMI system is up and running with 120,000 meters now being serviced. In parallel with its implementation, the team commenced programs for demand response and electric vehicles as well as development of key operational reporting capabilities required for managing the system.

Implementing this infrastructure within 24 months was a major accomplishment for the entire team. The project went from concept, to design and pilot, to full-scale implementation and included the installation of a dedicated WIFI. An additional set of capabilities for disaster recovery was also completed.

Management of the ‘tsunami’ of smart grid data proved to be an important area for key lessons learned. Operations still need to be optimized based on non-financial constraints, even when the extra funding from a grant award yields a larger set of options.

The threat of data overload is very real. Pulling in a more wide-ranging set of interval data with smart meters does not automatically mean a company should overload its IT systems with more frequent and more detailed metering measurements than will optimally yield a proper allocation of its resources. An important lesson learned is to not mix different firmware and software. During system upgrades, for instance, it is better to stick with one set rather than creating a hybrid environment since the resulting data loses value.

On the electric side, intervals are useful for resolving high bill complaints. Using the accumulated data, the customer can be shown a detailed breakdown of their usage to determine if, and by which side, an error has been made.

The large amount of meter data to be accommodated for backup and storage or for server activity purposes was a bit of surprise. Initial estimates for the storage area network lasting three years lasted only six months. The lesson learned here was the need to implement strict discipline for controlling the types and amounts of data collected from each meter during programming. Just because you can collect it does not mean you should collect it. Much of the data gushing in like a fire hose typically cannot be used. On top of this, storing massive quantities of data is not cheap. In a Storage Area Network, adding another terabyte is many times more than a typical utility would be willing to pay and the data volume makes it that much more difficult to find the necessary data.

Possessing good people with the right intelligence and data analytics tools is an essential part of the equation and in some cases a new skill set is required – simply being able to think in terms of large data – when an AMI system goes operational. How data is visualized and analyzed is much more a question of a statistical methodology as opposed to raw computation. One needs to be able to algorithmically look at a set of data and translate it into actionable information.

Bundling multiple utilities’ future AMI and smart metering projects

The level of effort and the nature of the challenges do not change much with the size of the project. The difference between one meter and one million meters is the number of servers. Aside

from this fact, a small utility will have about the same amount of work to implement AMI as a much larger utility. At GWP, the job was sufficiently large to have been worthwhile in spite of these ‘fixed cost’ aspects of the work. Obviously, the larger a utility is, the greater benefits it can enjoy in terms of the ability to spread these fixed costs over a larger job, potentially driving greater efficiencies and cost savings, all other things being equal. To get around this issue, the economies of scale appear strong for bundling future projects on the basis of a consortium of utilities being served as a single customer (e.g. involving statewide municipal electric associations or rural electric cooperatives associated with one another through their statewide associations or related G&Ts).

In addition, it is interesting to consider that culturally, there are a lot of potential advantages for smaller utilities. The culture at municipal and cooperative utilities has, from their inception, tended to be more community oriented than the large investor-owned energy providers. Personnel tend to specialize less in smaller organizations and thereby develop an interesting breadth of skills that can help in the issues identification process described earlier between the prototype and full roll-out phases.

Scaling several smaller utilities together into a large project is a great opportunity to extend smart grid benefits in areas where the costs savings can be a great boost to the local economies. These projects scale very well, and the hosting option increases the prospects of collaborations between utilities for the server infrastructures involved. As a result, they could enjoy smart grid benefits more widely without having to incur the large fixed cost that is somewhat irreducible.

About the author



Terry McDonald is president of T.S. McDonald Associates, a firm specializing in assisting utilities with design, development and execution of smart grid projects. Terry has 40 Years of professional experience as a corporate executive, management consultant, program manager, project Manager and U.S. Navy officer. He has a BA in psychology from Villanova University and Masters in applied project management and business process management from Villanova and the University of San Francisco. Terry can be contacted at Terry@tsmcdonald.com

¹ Tobey, Ronald C. Technology as Freedom: The New Deal and the Electrical Modernization of the American Home. Berkeley: University of California Press, 1996 p20

Standby Power System at Florida VA Hospital Covers All Electrical Loads

By Ben McKelway,
Norris & Company

Few if any hospitals have a better power system than the James A. Haley Veterans' Hospital in Tampa, Florida, thanks to its recently renovated power plant. Completed at a cost of \$47 million, it includes SCADA and a backup system capable of covering all electrical loads for 120 hours (without refueling) in the event of an outage.

A teaching hospital affiliated with the adjacent University of South Florida College of Medicine, Haley Hospital provides a full range of patient services with state-of-the-art technology and research. It has 548 beds, plus another 118 beds in an on-site long-term care and rehabilitation facility – the Haley's Cove Community Living Center. The busiest of four U.S. Veterans Administration (VA) polytrauma facilities in the nation, Haley serves a four-county area in which it also runs four outpatient clinics.



James A. Haley Veterans' Hospital in Tampa, Florida, boasts one of the most advanced emergency backup power control systems of any hospital in the United States.

After Hurricane Katrina hit New Orleans in 2005, the VA called for bids to upgrade emergency/backup power systems at VA hospitals in hurricane zones – upgrades that could ensure continuous air conditioning, not just the operation of life-safety and other critical equipment.

For Haley Hospital, the winning bid for power control switchgear, transfer switches, and SCADA was from Russelectric, a well-known power control firm based in Hingham, Massachusetts.

Extra Layer of Confidence

The hospital's administration is pleased with the new power system, which provides many more capabilities than the previous one. Although there has not been an unexpected utility outage since the system became fully operational in May 2010, Byron Taylor, the hospital's Lead Power Plant Operator, appreciates the extra layer of confidence. At Taylor's side to oversee the system, as they were throughout the planning and installation process, are Engine Technician Kyle Graley and Electrical Shop Supervisor Bill Hagen.



One of two rooms housing the medium voltage generator/utility switchgear

"We've had some storms come through, and it has been really nice because we do not have to worry," says Taylor. "One time, we saw the storms coming and Tampa Electric Company (TECO) asked us to drop off the grid. We fired up our generators, and operated on our own power for 17 hours, while TECO concentrated on restoring power to its residential customers. That sort of thing has happened several other times for shorter periods, and there has never been a problem."

Hagen particularly appreciates the quality of the power from the backup system. "We get more blips from TECO than we do from our system," he quips. "It is exceptionally smooth."

Standby Power System at Florida VA Hospital Covers All Electrical Loads

The hospital's former backup power system included nine on-site generators, yet it could only cover life-safety loads – 45 percent of the hospital's total load – in the event of a utility outage. Hagen has no fond memories of the old system, which he calls 'a major headache,' least of all for the system's dynamic matrix control. "We had nothing but problems with it," he recalls. "We never got it to work in parallel. It couldn't even generate a monthly testing report."

In contrast, the new backup system covers everything – every load for nine buildings, 15 trailers that make up an on-campus clinic, and a parking garage – with just seven new 13,200-VAC Caterpillar diesel generators that produce 2,200 kW each.

Another improvement is the hospital's renovated fuel system. The former system had a capacity of 22,000 gallons, and the storage tanks were spread out over several locations. Today, a new tank farm has four 12,000-gallon tanks. With another 6,000-gallon tank under each generator, the system has a capacity of 90,000 gallons.

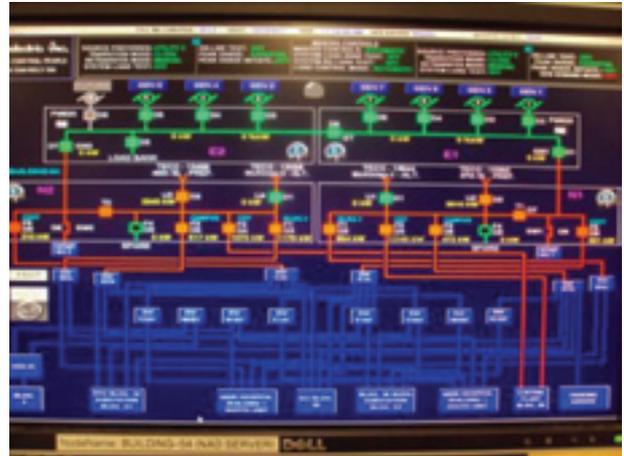


With full tanks, the hospital has enough fuel for 120 hours of backup power if utility feeds are lost. The 2-MW load bank in the foreground facilitates testing of generators.

More improvements are in the works. As of now, Haley Hospital receives no rebates or preferred rates from TECO, and the agreement between the entities does not allow the hospital to feed power back to the grid. But that agreement could change someday. On the roof of a parking garage, the hospital will be installing photovoltaic (PV) cells expected to generate another 500 kW of power. Newly installed solar panels in the adjacent parking lot near the long-term care facility (Haley's Cove) will supplement that building's utility feed by up to 500 kW. The new cells will boost Haley's photoelectric output to a total of 1 MW, enough to illuminate two parking lots. Although feeds from the solar panels are lost when the hospital's generators take over, under everyday conditions the new panels might provide surplus power that would enable the hospital to sell some power back to TECO. A peak-shaving arrangement with the utility is also likely in the near future, according to Taylor.

The Power of Information

Very important to the power control system upgrade is the new state-of-the-art SCADA system, which includes software and screen displays customized for the hospital's needs. It provides interactive monitoring, real-time and historical trending, distributed networking, alarm management, and comprehensive reports around the clock for every detail of the entire power system, not just for the backup components.



SCADA screen displaying a one-line diagram of the state-of-the-art power system



One of two panel boards in the control room at the hospital's power plant. The boards include a custom SCADA system that allows remote monitoring and control of all aspects of the hospital's power system and provides extensive information for analysis and planning. Operators normally access the system through desktop workstations.

In addition to monitoring power quality, the SCADA system's many functions include continuous monitoring of fuel consumption by each generator and the level of fuel in every tank. An operator can easily monitor and control the facility's entire power system using full-color 'point and click' interactive computer-screen displays at the system console. For example, the operator can access and change the system's PLC setpoints, display any of the analog or digital readouts on switchgear front panels, run a system test, or view the alarm history. A dynamic one-line diagram display uses color to indicate the status of the entire power system, including the positions of all power switching devices.

Standby Power System at Florida VA Hospital Covers All Electrical Loads

Operating parameters are displayed and updated in real time; flashing lights on the switchgear annunciator panel also flash on the SCADA screen. Event logging, alarm locking, and help screens are standard.

“The SCADA is so sensitive that it detects and explains even the slightest anomaly, including those in the utility feed,” says Taylor. “A number of times we’ve called TECO because we saw something happening, and they had no idea they even had a problem yet! The stuff the system does is phenomenal. It gives us more data than we ever need for an average day, but it’s tremendous that we have it when we do need it.”

Freedom to Test the System

In accordance with state and federal regulations, the backup generators are tested every month. Thanks to the new system’s capability for closed-transition transfer, the tests inconvenience no one. Because there is no interference with hospital loads, there is no ‘blip’ (power interruption).

The system allows Taylor and Graley to carry out the tests in two different ways. They can parallel the output of all seven generators to the utility feed, or they can test one generator at a time up to its full output, by way of a special 2-MW load bank that has an independent control panel. Testing can be initiated manually or through SCADA. “It’s so much easier now,” says Hagen. “We’ll never again have to pay a testing firm to come out and test an engine to make sure it meets all the requirements.”

Unlike most hospitals, Haley has the advantage of four utility feeds. On a normal day, it draws from two of these (primary) feeds. This means that, except for testing, Haley does not have to start its generators until it loses three or more utility feeds.

With advance notice from the utility that an outage is likely, Haley’s power plant personnel can now parallel the utility feeds with their own generators, then switch to on-site power seamlessly (closed-transition transfer). But if there is an unexpected outage (and when the automatic transfer switches are tested), there will be a ‘blip’ of 1 to 10 seconds, depending on the load. For life-safety and other critical loads, the ‘blip’ is only 1 to 3 seconds. ‘Blips’ for other loads are adjustable; most are set for 8 to 10 seconds.

High-Integrity Power Control Systems

By John A. Meuleman

As with the installation at the James A. Haley VA Hospital, Russelectric custom designs and builds high-integrity power control systems to meet the stringent performance and reliability requirements of data centers, airports, hotels, communication hubs, banks, defense installations, and other mission-critical facilities.

Designed to maximize uptime during normal source disruptions or aberrations, these systems provide emergency generator control, synchronizing, and distribution. They can accommodate open- or closed-transition transfer in sophisticated control schemes such as utility paralleling, peak shaving, and load curtailment. Prime power and cogeneration systems are also available.

Custom SCADA provides system integration and remote supervisory control through highly detailed, full-color monitoring screens. Simulation software is available for diagnostic testing, system verification, and off-line operator training. Russelectric also offers a full line of automatic transfer switches and bypass/isolation switches, including the industry’s most comprehensive line of UL tested (per UL 1008), listed, and labeled 30-cycle-rated switches, which dramatically simplify selective coordination of overcurrent devices. Switches have the industry’s highest UL 3-cycle close and withstand ratings.

All transfer switches and bypass/isolation switches are controlled by the advanced RPTCS controller, the industry’s most powerful, most versatile microprocessor-based transfer control system.

The company’s single-source approach is based on pre-specification support and assistance; individual project engineer responsibility/supervision from system design through installation; and totally integrated manufacturing for quality assurance and continuous parts availability. Strategically located throughout the United States, knowledgeable factory-trained Russelectric field-service engineers are on call 24 hours a day, 7 days a week.

Founded in 1955, the company has been employee-owned since 2010. While Russelectric will never compromise on quality, the company will go out of its way to provide exactly what customers want.

About the author



John Meuleman is Vice President of Russelectric Inc. Mr. Meuleman has over 30 years of experience in emergency/backup power systems for mission critical facilities. He holds a degree in electrical engineering and is a member of the IEEE, AEE, 7x24 Exchange, and NFPA. Contact <http://www.russelectric.com/>

Standby Power System at Florida VA Hospital Covers All Electrical Loads

Technical Support

Taylor and Hagen have high praise for the supplier's field support services. They recall working hand-in-hand with Jim Bourgoin, the company's local Field Service Engineer, for seven months.

"During installation, Jim helped the contractors interpret the design whenever they were puzzled," Hagen says. "Afterwards, he stuck around to help us get things up and running. It took a lot just to understand everything this system can do. I already had a background in this, but it took quite a bit of training to really get up to speed."

Taylor recalls, "There has not been one time when I have called Jim for an alarm or with questions about the system – whether at midnight or later – that he didn't answer the phone and help me. And on two occasions, he drove here at 3 or 4 in the morning to correct something that

had gone wrong. But it's not just his responsiveness that's impressed us. The service he provides is exceptional, and it has been that way since day one. To me, that's worth just as much as the system itself."

Taylor adds that Tom Crider, the local sales representative, was also deeply involved throughout the project, answering questions, facilitating the installation, and training Taylor's staff. Recently, with Taylor's cooperation, Crider has led personnel from two other Tampa hospitals on tours of Haley's power system. One of those hospitals is installing a similar system. The other is considering such an installation.

Onward and Upward

The fact that the system is designed to allow for modifications as the hospital continues to grow has Taylor thinking. "With this new power system, we have seen what is possible," he notes. "It provides us with the information we need to analyze our power usage and consider new possibilities – opportunities we never would have considered before."

About the author



Ben McKelway writes for Norris & Company, a specialized industrial advertising and public relations agency with a clientele of manufacturers whose wide-ranging product lines include adhesives and materials-handling equipment in addition to electrical switches, switchgear, and emergency/backup power systems.

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Bulk System Reliability Assessment and the Smart Grid

Insights and Recommendations from Exploratory Workshops on Evaluating Potential Reliability Impacts of Smart Grid Deployments

By Jason Taylor, Senior Project Engineer/Scientist, EPRI

Part I (Electric Energy T&D January/February 2013) looked at R&D challenges, exploratory workshop purpose, reliability assessment concerns and gaps, and reliability and performance indices. Pinpointed subjects included:

- Model and Data Limitations
- Variable and Intermittent Resource Integration
- Protection Coordination
- Distributed Energy Resource Integration
- Information Technology Dependence
- Control System Architecture Interaction and Design
- Education and Training

Future Research Framework

The ultimate goal of this effort is the development of metrics, models, and methods required to assess reliability and plan the future smart grid. A significant takeaway from the workshops, however, is the array of potential reliability assessment areas requiring further R&D.

An initial phase will provide a complete evaluation of current reliability assessment practices of smart grid technologies to qualitatively determine the criticality of potential reliability impacts, identifying the current state-of-the-art. This will be achieved by reviewing the existing body of work in this area and through periodic forums to facilitate the sharing of industry experiences and solutions.

In parallel, characteristics of key smart grid technologies will be clarified and examined along with potential data needs required to effectively model the devices and systems. These findings will be compiled to qualitatively determine the criticality of particular reliability assessment areas.

The second phase will focus on critical gaps through case studies designed to demonstrate new reliability assessment functions. A collaborative case study-driven framework is proposed, which will develop a collection of directed studies and analyses targeting various smart grid applications. As illustrated in Figure 1, the case study framework will not only provide system-specific findings, but more importantly will serve as the catalyst for developing the models, methods, and metrics needed in the industry.

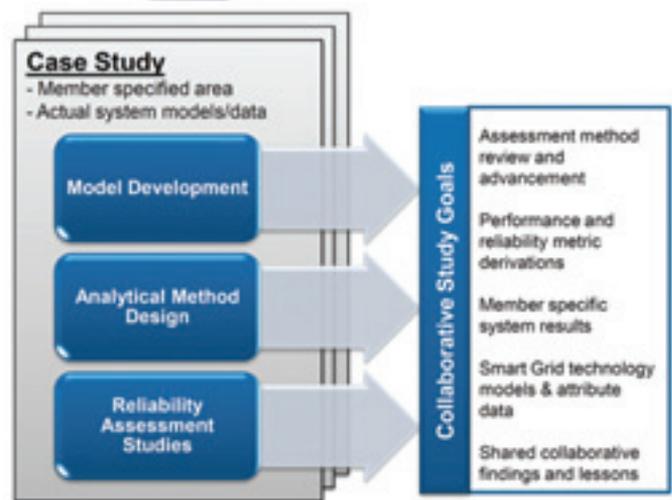


Figure 1: Collaborative Case Study-Driven Research and Development Framework

Using actual system models and data in these case studies, the developed tools will be designed and tested in real-world applications. Finally, the collaborative research framework will enhance the existing body of knowledge on reliability assessment and smart grid characteristics through the sharing of findings and derived tools.

Example Case Study and Assessment Areas

The table below outlines potential case study areas. Many of these research areas are interrelated and will provide insights into the targeted issue as well as related assessment areas. The findings can be further leveraged as part of the larger collaborative effort through the aggregation and review of multiple case study results. In addition, cross-cutting case studies can examine potential interactions and interference by combining different technologies and applications.

Reliability Issue	Study Area	Assessment Gaps
DER Ancillary Service Participation	Identify constraints on demand response and other DER's ability to provide ancillary services	<ul style="list-style-type: none"> Aggregate DER performance and reliability Market influence and constraints
Characterizing System Flexibility	System flexibility assessment and potential utilization of DER to accommodate variable generation	<ul style="list-style-type: none"> Flexibility requirements System and resource flexibility metrics
Protection Coordination	Impact to UFLS and UVLS schemes from distribution smart grid applications	<ul style="list-style-type: none"> Visibility requirements Aggregate DER characteristics Evaluation of end-user based load shedding schemes
Increased System Complexity	Communication and control failure impacts to bulk system security and adequacy	<ul style="list-style-type: none"> Cyber-physical infrastructure mapping Contingency and risk assessment Co-simulation event analysis
Monitoring, Control, and Visibility	Evaluate reliability benefits of distribution level visibility and potentially adverse automated control system interactions	<ul style="list-style-type: none"> DER visibility requirements Automated control design and evaluation tools
System Frequency Response	Calculate the system stability and frequency impacts from changing system inertia and high penetration of DER	<ul style="list-style-type: none"> Equivalent dynamic models Application of advanced inertia response
Reactive Power Support	Assessment of volt/var interactions and voltage stability issues from high penetration of DER	<ul style="list-style-type: none"> DER reactive power capabilities Distribution deliverability constraints DMS coordination
Incorporating Customer Behavior	Evaluate impacts from increasing reliance upon dispatched and non-dispatched demand response	<ul style="list-style-type: none"> Customer Participation models EV charging patterns Market and DER co-simulation
Dealing with Contingencies	Assessment of system impacts of wide-spread disconnects of DER due to bulk system events	<ul style="list-style-type: none"> DER visibility and models Probabilistic risk assessments DER operations during system restoration

ACRONYMS
 DER – distributed energy resources
 UFLS – under-frequency load shedding

UVLS – under-voltage load shedding
 DMS – distribution management systems
 EV – electric vehicle

APPENDIX NERC Smart Grid Task Force

The North American Electric Reliability Corporation (NERC) mission is to ensure the reliability of the North American bulk power system. NERC develops and enforces reliability standards; assesses adequacy annually via a 10-year forecast, and summer and winter forecasts; monitors the bulk power system; and educates, trains, and certifies industry personnel.

The Smart Grid Task Force (SGTF) was set up by NERC to *identify and explain any issues and/or concerns of the smart grid with respect to bulk power system reliability and to assess smart grid reliability characteristics and how they may affect bulk power system planning, design, and operational processes and the tools that may be needed to maintain reliability.* This task force is part of the Critical Infrastructure Strategic Roadmap and the Coordinated Action Plan. The SGTF released a report stating *successful integration of smart grid devices can improve reliability* but also recognized smart grid integration *may result in substantial changes to the bulk power system.*¹ In response, the task force developed a work plan (Figure 2), identifying issues and next steps towards successful integration of smart grid devices and systems. Issues included the development of new planning tools as well as the need to account for changing distribution system characteristics.

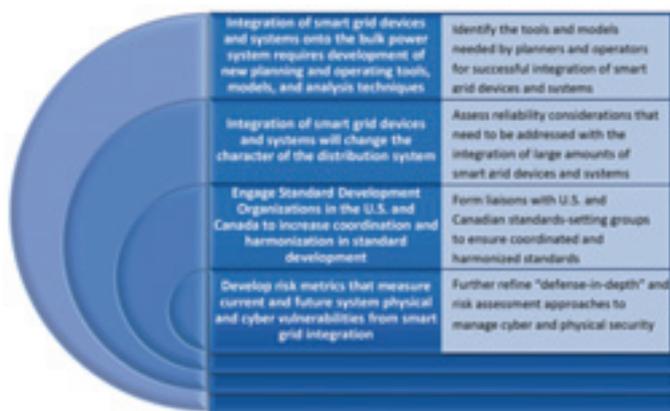


Figure 2: NERC Smart Grid Task Force Recommended Work Plan ²

ENTSO-E

The European Network of Transmission System Operators for Electricity (ENTSO-E) speaks for all electric transmission system operators (TSOs) in the EU and others connected to their networks, with one voice for all regions, and for all of their technical and market issues. The European TSOs agree and have founded ENTSO-E intending to play an active and important role in the European rule setting process and to push network codes and pan-European network planning forward urgently.

ENTSO-E and the EDSO-SG (European Distribution System Operators for Smart Grids) released the European Electricity Grid Initiative (EEGI), which is one of the European Industrial Initiatives under the Strategic Energy Technology Plan (SET-Plan).² The EEGI proposes a 9-year European research, development, and demonstration (RD&D) program to accelerate innovation and the development of the electricity networks of the future in Europe. This program outlines a set of Functional Projects organized by clusters and Smart Grid function levels from the New Generation Technologies (Level 0) to the Smart Customers (Level 5). Transmission network activities organized according to four clusters corresponding to the four basic activities of a network operator (planning, investments, operations, and power markets) are shown in Figure 3. Transmission and distribution networks will increasingly need to coordinate their operations and exchange data in real time. Functional RD&D activities including increased visibility of electric network for system management and control, the integration of demand side management in TSO operations, and ancillary services provided by DSOs were also proposed.



Figure 3: EEGI Transmission Level Activities³

EPRI Grid Transformation

In general, 'Smart Grid' refers to a modernization of the electricity delivery system so that it monitors, protects, and automatically optimizes the operation of its interconnected elements – from the central and distributed generator through the high-voltage transmission network and distribution system, to industrial users and building automation systems, to energy storage installations, and to consumers and their thermostats, electric vehicles, appliances, and other household devices.³

In 2011, EPRI identified three technology pillars to facilitate the transformation to a smarter transmission system: Grid Development and Operation, Asset Life-Cycle Management, and Information and Communication Technologies.³ A fundamental component in realizing the Grid Development and Operations pillar is to craft reliability assessment tools to address future challenges in this new era of power transmission. These tools will be necessary for planners and operators to successfully integrate an evolving array of new

technologies, renewable generation, and demand-side resources. In addition, these tools are fundamental in formulating long term regional, inter-regional, and interconnection wide transmission plans.

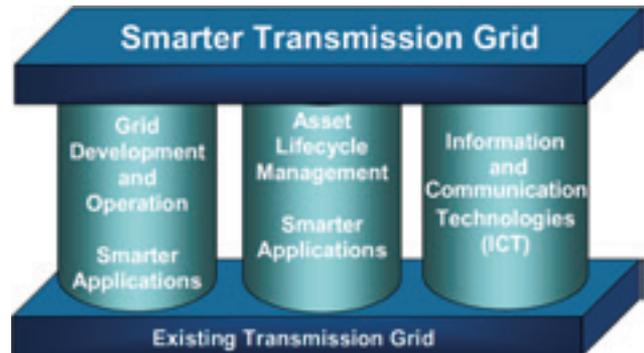


Figure 4: Technology Pillars for a Smarter Transmission Grid³

A significant portion of smart grid activities in the industry have been focused at the distribution and customer levels given the significant opportunities increased visibility and controllability can provide at these levels. Accordingly, a vast array of smart grid devices and applications have been proposed and demonstrated. These activities have already initiated advancements in distribution system analysis tools to support distributed resource integration and grid modernization; for example, EPRI's electric power Distribution System Simulator (OpenDSS). Advancements in bulk system assessment tools to address the changing distribution system characteristics due to smart grid applications continue to be relatively minimal. This is especially troublesome considering many long-term visions for integrating large amounts of distributed resources with bulk system operations. Nonetheless, new distribution analysis tools represent an important resource towards understanding and portraying potential distribution characteristics at the bulk system level.

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About the author

Jason Taylor is a Senior Project Engineer in the Power System Studies Group at EPRI. Dr. Taylor has worked in the industry for over a decade and holds a doctorate from Auburn University. His current research targets the advancement of reliability assessment metrics, models, and methods needed to evaluate and design a 'smarter' power system. He is a member of the NERC Smart Grid Task Force and a chair of the CIGRE committee on Planning and Optimization Methods for Active Distribution Systems. Dr. Taylor can be reached at jtaylor@epri.com

THE BIGGER PICTURE

BY MAURA GOLDSTEIN BAKER BOTTS L.L.P.



A Lean, Green Fighting Machine? Part 2: Competing Objectives in the Army's Renewables Initiative

As explored in Part I of this Article (*Electric Energy T&D* January-February 2013, Issue 1, Volume 17), over the past two years, the United States Army ("Army") has established a dedicated Energy Initiatives Office Task Force ("EITF"), and kicked off a novel procurement program (the "Army Renewables RFP") for a proposed \$7 billion in power purchase agreements intended to stimulate private investment in the build-out of greenfield renewable power projects at Army bases across the continental U.S. These actions have attracted capacity crowds of interested bidders at Army conferences on renewable power project development opportunities. This Article explores some of the details underlying the Army Renewables RFP and sounds a cautionary note regarding certain legal and policy risks that are unique to it. Part I of this Article explains the unprecedented nature of the power purchase agreement ("PPA") procurement approach adopted by the Army to attract private capital investment in renewable energy projects and the regulatory risks that arise in connection with that approach. This Part II examines the policies that underlie the Army's renewables program and identifies challenging open questions that will need to be addressed in its implementation.

The EITF and the Army Renewables RFP are the Army's solution to the looming set of requirements imposed by the various renewable energy mandates the Army faces in coming years. The Army has determined that very large capital expenditures will be necessary if the Army is to satisfy these mandates, and that the PPA approach embodied in the Army Renewables RFP will attract an infusion of private-sector investment to fund these expenditures. The somewhat idiosyncratic renewables mandates and policy objectives to which the Army is subject help to explain the shape and form of the Army Renewables Program that has emerged in response. However, they also give rise to questions critical to its implementation. One issue relates to how the Army can possibly reconcile its security objectives with its allegiance to renewable resources. Another goes to the fact that the mandates impose an expensive approach to the adoption of renewable resources by the Army, and it is not clear that the Army is prepared to pay for it. This then leads to the next issue, which is whether the Army Renewables Program offers a viable means of resolving the Army's budget constraints relative to its renewables mandates. These core issues must be addressed before

private investors can be expected to devote substantial resources to partnering with the Army to help it to meet its renewable energy goals.

The pressure on the Army to meet renewable energy standards comes from a number of sources, including the Energy Policy Act of 2005 ("EPAAct 2005"), Executive Order 13423 ("EO 13423"), and the 2007 National Defense Authorization Act. Under the EPAAct 2005, the federal government is required to procure an increasing proportion of its total energy needs from renewable energy sources, culminating in the requirement that 7.5 percent of its electricity come from renewable sources by 2013. EO 13423 requires that at least half of the statutorily required renewable energy consumed by a federal agency in a fiscal year comes from 'new renewable sources' (placed in service after January 1, 1999) and, to the extent feasible, from renewable energy on agency property. The 2007 National Defense Authorization Act codifies the voluntary goal of the U.S. Department of Defense ("DOD") to ensure that at least 25 percent of the electric energy consumed by DOD at its facilities beginning in 2025 comes from renewable energy sources. Finally, on April 11, 2012, the President set a goal for the Army to use one gigawatt of renewable energy by 2025 in a release entitled 'Obama Administration Announces Additional Steps to Increase Energy Security.'

The reference to energy security in the President's April 2012 statement is illustrative of another theme underlying the Army's renewable energy program. The Army consistently describes its actions to increase its renewable energy consumption as critical to achieving the larger goal of improving 'energy security,' meaning the availability of energy to allow the Army to carry out its mission uninterrupted, even if the civilian power grid is unavailable. The EITF 'will help the Army build resilience through renewable energy...,' according to Secretary of the Army John McHugh.¹ As explained by Katherine Hammack, Assistant Secretary of the Army for Installations, Energy and Environment, renewable energy will ensure Army bases are able to operate and the military is able to serve and protect the community should power grids go down.²



The proposition that renewable energy is the solution to the Army's exposure to grid events, asserted as though renewable energy were synonymous with distributed generation, is a reflection of a senior level policy choice to equate the two. For example, the 2009 Army Energy Security Implementation Strategy, which was intended to address the challenges facing the Army with respect to its energy usage and, in particular, its need for assured access to power, specifically identifies renewables as the Army's chosen form of distributed generation by establishing – as one of the Army's five strategic energy security goals – 'accessing alternative and renewable energy sources available on installations.'

There seems to be some dissonance in the Army's promotion of intermittent resources at Army bases while citing as the rationale the urgent need to enable installations to 'island' with reliable power upon a failure of the grid. Under the EAct 2005, 'renewable energy' is defined as 'electric energy generated from solar, wind, biomass, landfill gas, ocean (including tidal, wave, current, and thermal) geothermal, municipal solid waste; or new hydroelectric generation capacity achieved from increased efficiency or addition of new capacity at an existing hydroelectric project.' EO 13423 has a similar definition, though not limited to electricity. As a practical matter, this means that the on-base choices for Army installations will largely be confined to the clean energy resources of solar and wind, or the generation of electricity by burning biomass and waste. The obvious problem with reliance upon solar panels and wind turbines, however, is that, even assuming that a large number of bases benefit from significant sun and wind, not even the Army can control when the sun will shine or the wind will blow.

The Army has provided the explanation that renewable energy, as 'an intermittent resource... means that we are looking for energy to help reduce our peak power and give us the ability to operate longer should power disruptions occur...' ¹³ Implicit in this statement is the idea that the intermittent resource in question will work in tandem (and at moments of peak load) with another, more reliable, form of back-up power that is independent of the grid, perhaps 'some sort of storage mechanism,' ¹⁴ as suggested by Assistant Secretary Hammock. However, upon questioning at Army Renewables RFP-related conferences, Army representatives have clearly stated that large-scale energy storage technology is not sufficiently proven or commercially viable in the Army's view. Still, in a further sign that the Army continues to grapple with the renewables vs. reliability trade-off, the Army Renewables RFP indicates that 'grid isolation technology will likely be required' as an optional price component of individual proposed projects 'so that a continuously operating plant will self-isolate and remain functional upon external grid power failure.'

Arguably, the choice to combine the Army's energy security objective with its renewables goals will result in additional cost in the implementation of its Renewables Program. A similar conclusion may be drawn from other idiosyncratic requirements of the Army's

renewables mandates. For example, the bias in favor of the development of facilities on-base and the requirement for resources placed in service after January 1, 1999 lead to demand for new-build facilities to be dedicated to Army consumption on a smaller scale than would be possible for facilities that are utility-owned or have utility power purchasers. To appreciate the impact on cost that results, consider the finding by the Pacific Northwest National Laboratory, in relation to the cost of small scale wind projects, that 'bids to install a single large turbine were two times the average cost quoted by industry for a wind farm of 60 MW or larger.' ¹⁴

Another restriction on Army flexibility to embrace renewables in the most cost effective manner relates to the DOD's 25 percent renewables by 2025 goal in combination with the Army's Policy on Renewable Energy Credits ("Army REC Policy"). ⁶ Federal agencies have fairly widely used the acquisition of renewable energy credits ("RECs"), representing the non-energy environmental attributes of the energy generated from renewable sources, in lieu of direct purchases of renewable energy as a means of meeting renewables mandates. This practice is expressly permitted pursuant to EO 13423 and the EAct 2005. The Army REC Policy, however, establishes that the Army may not comply with its renewables mandates in this way. Instead, measurement of Army compliance with renewables mandates will be based on the actual production or purchase of the renewable energy itself.

In a reversal of the well-established notion of a REC as disaggregated from the energy output of a renewables facility, the Army REC Policy indicates that there must be a direct link between the RECs the Army purchases and the energy the Army consumes by providing that the Army's renewables mandates can be met only with the purchase and retention of RECs created by projects in which the Army will:

1. Construct, convert or renovate a renewable energy generating asset owned by the Army
2. Purchase, under an agreement, energy output from a system under (1) or output from another system
3. Grant use, under an agreement, of Army land for the purpose of generating renewable energy

In other words, a REC generated by a non-Army-owned facility must be bought by the Army directly from a renewable energy generating asset and in connection with the purchase of the energy output of that renewable energy generating asset or from a renewable project that happens to be located on Army land (apparently, in this narrow instance, without regard to whether the Army will purchase the associated energy output). No wonder there is an urgent need for capital expenditures on new renewables facilities. Even if the Army could buy RECs independent of energy output at a lower price or support the development of renewable power through voluntary green power or similar programs offered by the utilities that currently provide service to Army installations, these activities will not fit into the narrow parameters of the Army's renewables mandates.



This then leads to the question of what the Army is willing to pay for the bespoke renewable power production infrastructure it is asking the private sector to build. Knowing what we now know, it seems quite predictable that the Army Renewables Program represents a more costly form of procurement than the Army's current approach to energy procurement at retail rates through utility service contracts. After all, the Army is seeking small-scale, dedicated, new-build plants using all new renewable technology, likely requiring grid-free back-up, unable to monetize carbon credits and subject to high financing costs if open regulatory and government contracting risks are left unresolved (as suggested in Part I of this Article). And yet, the Army led the initiative by indicating that bases would not pay more for renewable energy than the rates they were paying to utilities. Bowing to reality, the Army has since acknowledged that its lowest-cost energy objective may not be compatible with its renewables goals and has said that it will buy renewable energy project output at a 'fair and reasonable premium' over the retail utility rates it would otherwise be paying.⁷ Most recently, however, Assistant Secretary Hammock explained, "we are not looking to pay more for electricity, we are looking for parity, or the price point with the private sector that will enable us to have reliable resources for the long term within our current budget..."⁸

The reference to the Army's current budget relates to another area of uncertainty at the core of the Army's Renewables Program: namely, how to treat a PPA for federal budget purposes. The appeal of a PPA approach as a means of renewable energy procurement is that it will attract private capital expenditure to fill in the Army's budget gap relative to its renewables mandates. The Army would like to be able to expense the cost of renewable power plants over time by paying a tariff that, effectively, repays the capital cost of new projects over the life of a long-term PPA. From a budgeting perspective, however, this would require that the Army's future year payment obligations under a PPA will not be 'scored,' or characterized, by the Office of Management and Budget ("OMB") as a current year expense.

The rules relating to 'scoring' an agency's payment commitments consistent with statutory requirements relating to the federal budget are exceedingly complex, but OMB's past treatment of federal government Energy Savings Performance Contracts ("ESPCs") offers a worrying precedent. An ESPC is a form of contract in which an agency undertakes to pay a private party over time for the energy savings that result from the private party's capital investment in energy conservation measures. According to a Congressional Research Service report on potential Army PPAs, 'these long-term contracts proposed for purchasing power from renewable energy projects potentially represent future unfunded commitments if funded through annual appropriations (much the same way that ESPCs do),' and, if so, arguably should be 'scored' as a current year expenditure in respect of all future payment obligations.⁹

Although agencies have been able to avoid this result for multi-year power and natural gas supply contracts and other similar arrangements, this has been achieved by means of 'explicit

termination and damages provisions that limit the government's financial risk to the difference between the contract rate and prevailing ... prices.' Such provisions may be acceptable to private counterparties to commodity contracts or utility service agreements, but they will almost certainly pose a deterrent to equity investment and debt financing for the construction of dedicated power generation facilities. The essential problem is that, if all of the future payment obligations of the Army under a PPA are determined to represent a current year expense, then the Army will be unable to enter into \$7 billion of PPAs.

In sum, it seems that the issues of budgeting, pricing and security are bound to impinge on the momentum of the Army's Renewables Program. The Army's roll-out of the EITF and its framework for \$7 billion in procurement of renewable energy herald an exciting opportunity for renewable power project developers and investors. However, the uncertainties discussed in this Article can be expected to cause reluctance on the part of private parties to commit the resources the Army hopes to attract. If the Army is to turn this opportunity into a reality, it will need to build confidence by addressing such issues head-on. Only then will it be possible for the Army to inspire a mutually beneficial public-private partnership that will have a meaningful impact on the achievement of the Army's renewables goals.

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ABOUT THE AUTHOR

Maura Goldstein, a Partner in the Global Projects Group of the law firm of Baker Botts L.L.P., represents developers, equity investors and lenders in connection with major infrastructure projects, including power projects, worldwide. Maura has extensive experience structuring gas and coal-fired, solar, wind, energy storage, and biomass power projects, and negotiating power purchase agreements, project site leases, construction contracts, technology procurement, and project financing arrangements for power projects. Baker Botts' energy and transactional associates Katrina Smith, Yuefan Wang, and Kyle Wamstad, provided valuable assistance in the research and development of this article. Maura can be contacted at Maura.Goldstein@bakerbotts.com



With William T. (Tim) Shaw
PhD, CISSP / CIEH / CPT

SECURITY SESSIONS

What's a nice guy like you doing in my computer?

As I reviewed the recent Presidential directive on cyber security I was pondering the evolving cyber threats to our national infrastructure and institutions from both domestic and international sources. Shortly after the events of 9/11 the Department of Homeland Security (DHS) was formed and tasked with protecting everything. Eventually that mandate was focused onto a set of key industrial and financial sectors with DHS required to develop and promote security best practices. Some industry segments, such as Electric Power and Interstate Natural Gas pipelines, have stepped up (sorta) and made an effort to improve their cyber security. Others continue to ignore the issue and hope it will go away. There is a cyber war going on all around us every day, and you ignore it at your peril.

If you keep track of cyber incidents and hacking-related news events as I do (ok, you probably don't – but I am old and have no life, so I do) you can't have failed to notice that they no longer nearly exclusively target US interests. A few years back most cyber attacks were aimed at getting into our government (and military) systems along with financial institutions and business systems containing personal and financial information. Sure, some Russian hackers attacked some infrastructure assets in former Soviet-block countries and turned their lights off and you occasionally saw some 'hacktivist' organization deface an evil corporate website or release embarrassing emails. But mostly it was the Chinese trying to steal our technology and the Russian and US mobs trying to steal all your savings and pathetic middle-eastern terrorist 'wannabe' groups putting up web sites promising to send all of us evil Americans (and the Israelis) to Islamic hell. Ah, the good old days.

Lately you hear about a hacking exchange between Pakistani and Indian groups, you see Chinese hackers and Pilipino hackers going after each other, we discover hackers launching specifically tailored trojans against specifically selected Japanese banks, and the Government of Myanmar hacking into Gmail accounts of some of its citizens. There are Syrian hacker groups going after targets in Saudi Arabia, Korean hackers going after targets in China

and Taiwan, and the list goes on and on. In this age of universal Internet access and computer literacy the only country without a home-grown hacker community may be Pago Pago (and I might be wrong about that.)

The world today seems to be filled with crafty and cunning folks who are constantly looking for new ways to attack and break into the computers of others. And the threats and attack methods are shifting. More of the recently identified malware is customized and targeted for specifically identified targets rather than for general dispersion. Defensive mechanisms can't be limited to scanning for known malware 'signatures' any more. The most dangerous stuff is all zero-day and may only be identified and blocked *after* it has gotten past your security perimeter and starts performing its intended malicious functions. If you have a company with a web site and email server (and who doesn't these days) you are probably 'scanned' several times every day from sources located all over the world. Almost makes you want to throw up your hands and take an axe to the router connecting you to the Internet. But there are things that can be reasonably done to erect a pretty sturdy cyber barrier and defensive boundary between the computers and networks you depend on and all of those folks who would like to break in and trash the place (from a cyber-perspective). We have discussed many of them in this column of the past few years.

To date each organization that sets out to establish some cyber peace of mind has had to rely on the skills and experience of their respective IT/Engineering staffs, recommendations published by various industry groups, books on the topic, vendors who insist that their product is a cyber panacea and consultants who will reveal the truth and solve all their cyber ills for enough money. Wouldn't it be nice if there was a really smart group of folks who could establish a clearinghouse and bring all of this together and issue (and update) industry-segment-specific recommendations based on the funny little differences that make generic and universal approaches untenable? And do it really, really soon? Like yesterday?

SECURITY SESSIONS

By Presidential directive the National Institute of Standards and Technology (NIST) has just kicked off an effort to establish a set of best practices for protecting the networks and computers that run the country's critical infrastructure. The 'Cyber-security Framework,' as it is being called, was initiated at the behest of the President after several recent attempts to pass cyber security bills (and pretty much everything else) failed to make it through Congress. This executive order calls for the development of a common core of standards and procedures aimed at keeping critical computer and communication systems from falling prey to a wide range of cyber threats. NIST claims that the project will allow government agencies and private firms to be reasonably sure that security measures implemented based on the framework will be effective and provide the best bang for the buck.

I personally have a lot of respect for the work done by NIST. Their 800-series special publications are excellent references for IT best practices and a good technical reference on many IT and cyber topics (although some are very Government issues specific – not many plant automation systems contain classified, Top Secret information). I regularly quote the NIST SP-800 documents in various courses I teach. But my concern is that drawing *exclusively* on NIST, or *any* of the major national labs, will not result in the promised results. I have already seen attempts by various groups to force-fit NIST IT cyber security recommendations (from, for example, SP 800-53) into industrial automation applications with no regard to the rather significant differences between business IT and industrial plant automation. When you hear people talking about applying security patches to smart panel indicators or running virus scanning software on a PLC or installing a firewall on a digital chart recorder you realize that there is a basic lack of industry segment understanding.

I have also personally witnessed that one government entity/agency may not have any awareness of the rules and regulations put in place by another. So requiring that updates and patches be installed as soon as they are available may seem like a good practice to an IT cyber person from NIST, but the pharmaceutical company faced with FDA 'validation' strictures or the nuclear plant operator with NRC design change procedural hoops to jump through, may see this as a very unworkable practice. A 'one size fits all' approach to best cyber practices isn't going to be all that helpful. I am not saying that some cyber security practices might work well across the board. But many will not. And the best 'bang for the buck' would come from recommendations and best practices that are aligned with industry segment regulations and automation technologies. Recognize that an RTU or PLC has to be treated differently than a PC running a Windows O.S.

Again, let me express my admiration for a lot of the great work that has come out of NIST. My sincere hope is that NIST gathers industry segment automation and digital instrumentation experts from each of the major DHS-defined infrastructure segments/sectors and includes their knowledge in the development of the cybersecurity framework. NIST did team-up with the ISA (International Society for Automation – formerly the Instrument Society of America) a couple of years back to develop a more plant/process-friendly set of recommended general cyber practices. It was a step in the right direction. Some of these experts might need to come from the vendor community. I always get a bit nervous about having vendors on a standards committee as they almost invariably tend to try and guide the standards in favor of their products. Naturally they think that their products are the best. Sometimes they may even be right on that score. Frankly issuing recommended practices and standards without taking into account the current state of commercially available technology is just dumb. But many a standards committee has bogged down and failed due to squabbling members who refuse to look objectively at the competition and find a middle ground that serves everyone fairly (you know – just like Congress.)

I will be anxiously watching the work of NIST and their development of a cybersecurity framework. I really hope they do a bang-up job because, as I said at the beginning of this column, there is a cyber war going on out there and we need to protect ourselves. I hope that if they actually do a good job, and the results are designed around the specific needs of each industry segment, that the industry will voluntarily adopt and implement them. Of course when I was a kid I also hoped to get a go-kart. But hey, sometimes wishes and hopes do come true. But that will have to be the subject matter for a future column.

ABOUT THE AUTHOR

Dr. Shaw is a Certified Information Systems Security Professional (CISSP), a Certified Ethical Hacker (CIEH) a Certified Penetration Tester (CPT) and has been active in designing and installing industrial automation for more than 35 years. He is the author of [Computer Control of BATCH Processes](#) and [CYBERSECURITY for SCADA Systems](#). Shaw is a prolific writer of papers and articles on a wide range of technical topics and has also contributed to several other books. He has also developed, and is an instructor for, a number of ISA courses. Dr. Shaw is currently Principal & Senior Consultant for Cyber SECURITY Consulting, a consultancy practice focused on industrial automation security and technologies. Inquiries, comments or questions regarding the contents of this column and/or other security-related topics can be emailed to timshaw4@verizon.net

Active and Passive Customers in a World with Flexible Electricity Demand

Technical advances and the role of responsive devices in supporting our electricity grid

By Scott Coe and Shangyou Hao,
Utility Integration Solutions, Inc. (UISOL)



Figure 1. Key benefits of smart grid and demand response include a more reliable, more economic, and more environmentally friendly grid.

The term ‘Smart Grid’ has been used over the past decade to include a number of disparate ideas related to making the electricity grid more reliable, more economic, or more environmentally friendly. One of these ideas is that end-use customers should move from flat or time-of-use electricity rates to real-time pricing models that change based in part on what is happening to real-time electricity rates at the wholesale level. One can make arguments that if executed properly, more accurate pricing would lower costs, support more renewable resources, and ultimately balance load to improve overall grid reliability (Figure 1). But when these long-term gains require that customers spend money, invest time, and even experience lower levels of comfort, what objectives should future responsive demand programs achieve so that customers will make these short-term sacrifices?

Most electricity consumers fall into a group which can be called ‘passive customers.’ Passive customers, as the name implies, do not actively participate in understanding the complexities of electricity. Rather, they simply plug in their devices and get a bill, and occasionally call the local utility if there is a disruption in service. A good parallel to the passive electricity customer is an employee with a 401k plan who contributes a percentage of his salary into a mutual fund and rarely (or perhaps never) adjusts the financial portfolio.

The other case which has become fashionable to discuss in recent years is the ‘active customer.’ Enabled by an increasingly networked life, the active electricity consumer can monitor conditions in the home, view status information of household devices, and follow the trends of, and the predictions for, the price of electricity. The active customer then optimizes this information into a plan for devices, be that cycling an air conditioner, delaying a dishwasher load, or dimming the lights. The parallel here is the employee who frequently examines his investment portfolio, researches market trends, and trades stocks in an attempt to optimize the financial outcomes.

The Internet has enabled individual consumers to play more active roles than ever before in managing both their financial portfolios and electric devices. But easy access to information is only part of the solution; it is important that the information be standardized to make it easier to understand and to enable software developers to build tools to effectively leverage it. Like common financial industry terminology and standard data feeds, a consistent model and information delivery framework is necessary for electricity grid information. The investment portfolio analogy provides half the picture; the other half is access to near real-time electrical usage data as well as historical trends and behaviors.

This information about the consumer and his electrical devices must be captured in a standard format with proper safeguards to protect the customer’s privacy.

Incentive to Become Active

So when the information does become available in a standard and secure format, what is the incentive for a passive electricity customer to become an active electricity customer? The incentive for the active portfolio management is clear; there is the potential for substantial financial gains to be realized by putting more effort into the process. Is the incentive the same for the electricity customer?

Consider a customer with a 10 kilowatt air conditioning compressor equipped with a device which can operate the unit at a 50 percent duty cycle for the most expensive 100 hours of the year, a net reduction of 500 kWh. If this customer lives in the PJM territory and was buying power at wholesale prices in 2011, the average rate of energy costs in those peaks hours would have been 17 cents per kWh, yielding an annual net savings of \$85.

The customer could add more devices into the scheme such as a water heater and a pool pump, even a refrigerator or a space heater, but all of these loads are generally smaller and in some configurations the discomfort for customers will clearly outweigh the financial incentive. The catch is the more people who implement demand response in this way, the more the peak prices are suppressed by the aggregate load reduction, and lower the effective individual savings becomes over time. So other factors held constant, this example of the above annual savings can be viewed as a best case scenario.

For loads which can change their level of electricity consumption quickly, providing ancillary services can add even more value. Ancillary services include making small increases or decreases in electricity consumption to keep electricity supply and demand in balance (regulation service) and being able to provide larger reductions in the event of short-term supply deficiency (reserve service). PJM members paid \$234 million in 2011 for regulation services and another \$579 million for operating reserves. Using a simple average load ratio share^{1,2}, every residential customer's contribution in the territory was approximately \$12. So even if every customer could cover his own portion of these support service costs, the individual savings here too are small.

If cost savings is not the answer, what is?

Technology Enablers

Energy efficiency of residential refrigerators has steadily and drastically improved over the years – a phenomenon which is largely invisible to the public. While the average refrigerator size has increased, energy usage today is approximately five times more efficient compared to levels just three decades ago.³ Why has efficiency improved? The simple answer is technology: better insulation, new refrigerants, and more efficient compressors with improved cooling cycles. But customers didn't demand these technologies directly; public awareness through consistent energy efficiency labeling and ever-improving Federal efficiency standards along with tax rebates and purchase incentives meant that manufacturers needed to use these technologies to be competitive in the marketplace.

This is a success story where passive customers are involved: buy a refrigerator with a good rating and the role of the customer is essentially complete. And, in fact, it represents a success for all three of the benefit areas: less power consumption means reduced energy cost, plus a less stressed and more environmentally friendly grid. There are many things that both consumers and policy makers can do – with help from new technologies – that will bring more benefits. Most importantly, the simplest things do not require all of us to become active customers, nor to invest our time, to spend our money, or to sacrifice our comfort in any meaningful way.

Today, devices are relatively ignorant of electricity grid conditions. But there are signals that could be broadcast to augment any conditions which can be monitored locally to facilitate future devices to help our grid and our bottom line at the same time. For example, consider a freezer which is capable of processing the following rudimentary signals (Table 1). These actions would barely be noticed by the typical consumer, and the aggregate load benefits could be significant when implemented in scale.

Signals & Sensors	Automatic Actions
<ul style="list-style-type: none"> Local disturbance sensed Electricity grid emergency signal received Elevated price signal received 	Reduce temperature setting a small amount for a small period of time and delay defrost cycle several hours.
<ul style="list-style-type: none"> Reduced price signal received 	Increase temperature setting a small amount for a small period of time and perform defrost cycle if required.

Table 1. Smart Freezer: Processes Signals and Takes Automatic Actions

Other response schemes could be automatically programmed into devices. If one considers air conditioning compressors, hot water heaters, pool pumps, resistive heating, clothes dryers, dishwashers, and electric vehicle charging, it is conceivable that these new smart loads could supply some or all of the reserve requirements for the bulk power system, and perhaps even a major portion of the regulation and frequency support functions. The costs for these types of functions might very well be covered by reduced system support costs well before the life of the device runs out.

Grid price signals may come from multiple sources and have different levels of granularity. Electricity prices may be stable over large areas or zones or vary down to the nodal level. The prices may also have components from different sources too, including core information from the wholesale markets, overriding or supplemental components from a load serving entity, and adders from the distribution operator.

Grid health signals could also come from multiple sources. The transmission system operator could warn of low reserve margins and a distribution operator could warn of a feeder overload. With large scale renewables on the transmission system with unpredictable generation levels and with distributed generation on the rise, the chances for these types of problems will increase. There are also unique scenarios where transmission and distribution health signals can oppose each other or at times the health signals move load opposite in direction to the effects from price signals.

Putting all of this together, the need for sophisticated software to properly process these data – in a standard format – becomes obvious.

Making It Happen

Standard Signals: First and foremost, the industry must quickly converge on a set of common signals for communicating the value of electricity along with an indication of the health status of the grid. These messages should be very small, very simple, and identical across all regions.

It may be useful to publish multiple forms of the information, for example zonal or local nodal prices as well as qualitative prices such as high/medium/low relative to historical norms. System health should also be communicated, akin to the Department of Homeland Security Advisory System – simple levels for well-defined conditions. Giving the device manufacturers multiple options will help them to innovate. The flip-side is that these standards will need to be extendable and be allowed to be improved over time as experience increases.

Incentivize Adoption: As noted, the cost savings alone to customers may not be enough to create this mindset change. If demand response providers and load-serving entities don't see a play to scale up the proceeds and push it forward, we might consider either a carrot approach (a reduced electricity rate or a discount on the purchase of an enabled appliance purchase) or a stick approach (an opt-out fee or an increased electricity rate) can be used. Government action can help solve part of the problem, nudging manufacturers to enable their devices – just as we have seen with the refrigerator efficiency standards. For example, it is not unreasonable for the owner of a plug-in electric vehicle who now stresses the grid more than the average customer to use his vehicle to help support that grid with some level of regulation and reserve service.

Public Awareness: Every consumer has his or her own personal spin on which component is most important: cost, reliability, or environmental responsibility. Regardless of that preference, the goals are not mutually exclusive. Public awareness campaigns that focus on all three points over time are essential, for example:

- Buy this grid-enabled device today, and the investment will pay for itself
- Buy this grid-enabled device today, and you are helping to reduce the chances of a power outage and you will helping restore power when it does go out
- Buy this grid-enabled device today, and you will be helping to balance wind turbines when the wind dies down and solar panels when clouds pass overhead

In the end, some people are excited to become active electricity customers. The good news is that none of these ideas are inconsistent with someone who wants to increase the responsiveness of the devices in the home. In fact, having a common set of signals, extra financial incentives, increased public awareness and, more importantly, devices which are smart enough to go beyond 'plug it in and walk away,' means that becoming that active electricity customer is a much easier job.

But many of us will not want to choose this path. We should all understand that as a society we have become much more demanding of our electricity grid and the signs point to our demands rising in the future. If we do not become active electricity customers, perhaps it is our obligation to actively push to become a new kind of passive electricity customer: one with responsive devices which support our electricity grid in simple but very meaningful ways.

A Future View of Responsive Load Signals

Signals for controlling electrical loads fall into two major groups:

1. Command-and-control style signals used for traditional demand response
2. Broadcast style signals used to publish information about the grid.

While the latter signals are integral to the success of responsive loads, the former are the most highly evolved today.

Demand response has developed organically over many years. Without central oversight, programs were designed with bespoke control signals; in other words one program's control signals were generally independent from every other program's signals. Today, there are options which can be utilized instead of creating yet another protocol from scratch. The first is OpenADR, a protocol with several practical implementations and heavy backing from a number of important industry players through the recently formed OpenADR Alliance.

The Independent System Operators (ISOs) and Regional Transmission Organizations (RTOs) in North America took a slightly different approach from Open Automated Demand Response (OpenADR) and developed a second option in recent years. Utilizing the standards development processes at the North American Energy Standards Board (NAESB), an initial model for demand response signals was developed and published in 2010. The ISOs and RTOs took another step forward as they evolved that standard into an International Electrotechnical Commission (IEC)-based model in late 2012, building upon the existing, widely used IEC standards. Currently, working groups at the IEC are bringing this standard into the core IEC models for electrical power systems.

As we embark on developing those broadcast style signals for responsive loads, there are several influences which should be considered: there are components within the aforementioned IEC models which can be leveraged and there is also a base model available from NAESB on the topic. A sure-fire recipe for successful responsive load signals should include a solid analysis of these sources including input from grid operators, device manufacturers, and consumer advocacy groups, an open process for public comment, and a liberal amount of experimentation and testing.

¹ Annual load in PJM is approximately 778,000 GWh (PJM 2011 Annual Report)

² Annual residential utility customer usage is 11.5 MWh (U.S. Energy Information Administration <http://www.eia.gov/tools/faqs/faq.cfm?id=97&t=3>)

³ http://www.appliance-standards.org/sites/default/files/Refrigerator_Fact_Sheet_Aug_25_2011.pdf

ABOUT THE AUTHORS



Dr. Scott Coe is a Vice President at UISOL and manages UISOL's Markets & Demand Response practice. His industry contributions include co-chairing the NIST working group for the Wholesale Demand Response Communication Protocol and facilitating the ISO/RTO Council's development of the NAESB DR measurement and verification standard. Scott holds an MS in Engineering Physics and a PhD in Physics. He can be reached at scoe@uisol.com.



Dr. Shangyou Hao is a Director at UISOL. He has over 25 years of experience in power system engineering, economics, computer applications and systems integration services in the utility industry. Shangyou received a PhD in Electrical Engineering and can be reached at shao@uisol.com.

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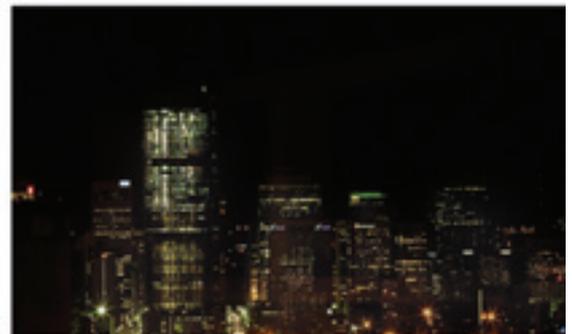
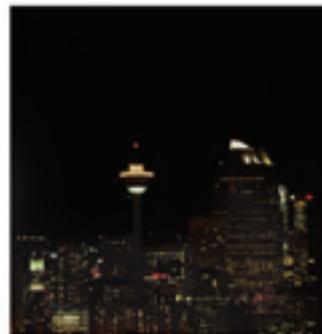
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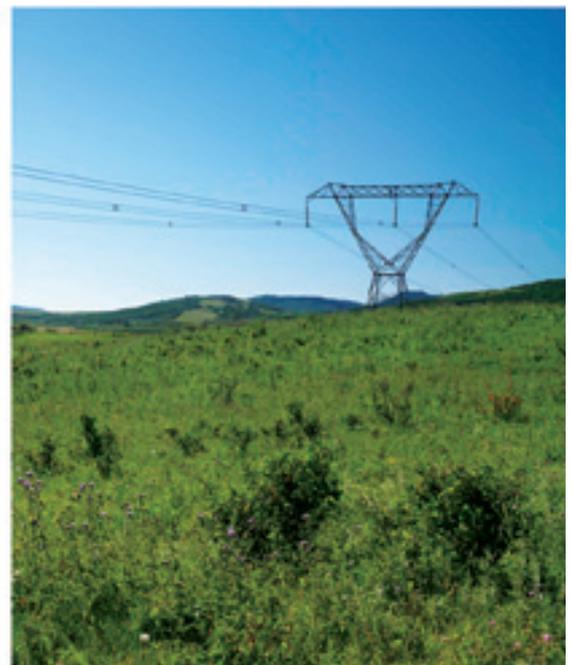
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