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Publisher:
Steven Desrochers:
steven@electricenergyonline.com

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

Account Executive:
Eva Nemeth:
eva@electricenergyonline.com

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

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

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As a longtime utility 'insider,' I know first-hand the trials and tribulations of deploying and managing a smart grid. Now, with the added perspective of being a technology provider to the industry, I can share my experiences and lessons learned.

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Over the past few decades, changes in weather patterns due to climate change or global warming have led to more extreme, frequent, and costly weather events that have included intense rains, ice storms, tornadoes, floods, hurricanes, heat waves, droughts, and wildfires.

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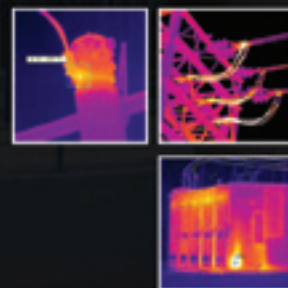
Since the earliest installation of electrical power lines, the need to develop comprehensive construction and maintenance work rules was recognized as essential to ensuring lineman safety.

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POWERPOINTS

Smart Harvesting

By the time you read this column, I will have already spent ten days tent camping at Algonquin Park in Central Ontario with my son and 13-year-old grandson. This is one of the most pristine and jaw-droppingly beautiful parts of this planet. I know because I camped with my family there every summer for over ten years.

In those days, before online reservations became the norm, you would drive to one of 13 or 14 individual campgrounds accessible from the single highway that runs through one corner of the park travelling some 56 kilometres gate to gate. Once at the chosen campground, we would drive around looking for empty campsites. When one was found, one of us three kids or my mum would hop out of the car and prepare to 'repel all borders' by sitting on the supplied picnic table. This would happen throughout the campground until we ran out of family members, which also included our springer spaniel. Once the best site was determined my Dad would drive around and fetch us if he could remember where each of us was. I don't think we ever lost anyone for more than half-an-hour. Sometimes we had to knock on outhouse doors because it had been a long drive from Toronto.

Before we could set up the big cottage tent, Dad had us make rakes out of twigs and branches and amidst some grumbling we swept the site to collect any trash that may have been left behind. After camp was struck two or three weeks later, we all three of us kids took up our arsenal of gear and again swept the plot clean. In his words, we could always find the means to take out of the bush every single thing that we took in. That is one of those 'fondest memories' I have of him and how he constantly instilled in us an absolute and unequivocal love and respect for family and friends and for the natural world and the life it gives us.

One of the amazing aspects of Algonquin Park is the nature trails. One would lead you to a huge beaver dam, one to a long-since abandoned logging camp, and another would take you up a steep escarpment to look out over an incredible natural landscape or the mirror surface of a quiet lake. The smell of countless campfires from the valley below was intoxicating. On the nature hikes in those days, dogs could be let off the leash once you were a certain distance from the highway. We let our spaniel off her tether and she ran like the wind through the undergrowth. At one point as we made our way up a steep part of the path we heard a lot of commotion and crashing through the bush over the rise and several people were yelling, "Bear, bear, it's a bear!" We immediately thought it would get the dog or us and we too ran into the bush. As it turned out there was no bear – just our black-and-white mutt nosing through the ground clutter. She was as surprised as we with the carry-on.

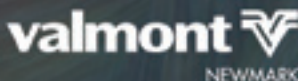
Once nestled safely in our sleeping bags at day's end, we often heard the timber wolves howling in the blackness of the night. By the way their sound carried and from the chill running down our spines we swore the pack was gathering just on the other side of the tent flap.

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I'm sure we all know someone, if not ourselves, who have succeeded in maximizing living as close to nature as possible. I have friends who winterized their 24 foot by 36 foot cottage located about 190 kilometres north of Toronto right on the shores of a beautiful quiet river to make a permanent home. When the couple decided to increase their living space, they lifted the entire structure ten feet in the air on house-jacks, poured an eight-inch-thick floating concrete slab below it and constructed a natural log structure under the full dimension. They dovetailed each 12 inch by 12 inch pine timber and chinked every void by hand, learning as they went along. The entire new first floor was kept cosy in even the severest winter weather by a closed wood-fired heat stove. A wood-burning fireplace did the same for what became the second level. They invested in a government-controlled wood lot not far from home, which meant their heat bill every winter was a pittance and no fossil fuels per se were burned. Solar panels provided much of the joy to the house. The other beauty is that they could cut and/or remove only naturally felled trees and ones designated as sustainable by the Ministry of Natural Resources. Most things in their home were hand-made – cupboards with stained-glass fronts, backs and sides; chairs with huge soft inviting pillows; book cases; bed frames – you get the picture. As a hobby, employing ancient methods, my friends made a birch-bark canoe. To my surprise, the damned thing actually floated and we spent many lazy hours on the river in it.

They were both Scandinavian, right down to their Siberian Husky, and I'll not soon forget visiting in the early winter and being greeted by the scent emanating from a cauldron full of soup-fixins' gently bubbling away on the heat stove. At some point during each day we would sweat it out in their sauna. Then, red hot skin and all we would walk out five metres to the river's edge and plunge naked into the frigid water. What luxury!

My son has close friends who design and build houses from bales of straw, which is the waste product from wheat/grain. It is a totally renewable agricultural by-product that has a positive impact on the environment as well as farming communities. These houses require half as much timber and can be heated and cooled for 25 percent to 50 percent less than other conventional methods meaning the atmosphere doesn't have to absorb so much fossil fuel exhaust. Unlike manufactured insulation, straw bales are natural and do not emit toxic gases that can lead to health problems. The walls actually breathe for real therefore condensation becomes negligible reducing the chance of mould forming. On top of that, straw actually has a better fire rating than foam insulation – foam will quickly burst into flames while straw simply smolders thereby allowing more time for escape and far less toxic smoke filling the space.

My son-in-law is a registered trapper with the government of Canada. He is often called in to clean up messes created by non-thinking people that overhunt or destroy the habitat of a particular animal species. This makes room for alien species to move in and totally disrupt the natural balance. He was recently sent to British Columbia for the unpleasant task of culling hundreds of exotic ducks from an area that were preventing the native ducks from re-emerging once they were declared endangered. I must say that he would rather not have to perform such tasks.

What I'm driving at is why so many people want to enjoy the very world that gives them pleasure yet continue to put nature's head on the chopping block by contributing to, or who are loath to accept, global warming and climate change. I don't know for sure where it comes from. All I know is that it's here and the clock is ticking. I often think of the words of the character Andy Dufresne from the movie *Shawshank Redemption* – 'are we really that obtuse?'

We seem to think there's plenty of time to deal with problems and I'm going to finish with the words of Tom Rand, fellow Torontonians and author, climate advocate, senior advisor at the MaRS Discovery District as well as managing partner of the privately-backed \$30-million MaRS CleanTech Fund. He is also the developer of Planet Traveler, a low-carbon hotel project in our fair city:

The battle to save the planet started out well enough. When U.K. prime minister Margaret Thatcher addressed the United Nations General Assembly in November 1989, there could not have been a much more credible advocate for strong action on climate disruption. The world seemed poised to act, and leading the charge was none other than the Iron Lady herself – champion of the free market, military hawk, and good friend of U.S. president Ronald Reagan. Fast-forward twenty years. Today, an outpouring of climate scepticism is required to establish bona fide conservative credentials. From former U.S. Governor Mitt Romney (Massachusetts) to former governor and vice presidential candidate Sarah Palin (Alaska) and from Fox News to the American Enterprise Institute, neoconservatives have somehow positioned a scientifically illiterate denial of climate disruption into the national debate. Even when the problem is acknowledged, it's played down as more of a nuisance than a threat. What on earth happened?¹

¹ Rand, Tom. *Waking the Frog: Solutions for our Climate Change Paralysis*. Toronto: ECW Press, 2014



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Siemens successfully installs third HVDC platform in the North Sea for TenneT

Major milestone for German offshore grid expansion

Siemens has completed installation of the offshore platform for the direct-current connection HelWin2. Working under contract from the German-Dutch grid operator TenneT, Siemens has thus achieved a decisive milestone of the German grid connection projects. 'We have now installed three high-tech platforms for TenneT in the North Sea. The HelWin2 project is now in the homestretch to begin operation in the coming year,' says Jan Mrosik, CEO of the Power Transmission and Smart Grid Divisions of Siemens AG. 'We have achieved one more major interim milestone, and are step by step accomplishing the German government's offshore expansion goals', says Lex Hartman, member of TenneT's executive board.

The newly installed HelWin2 platform lies 35 km north of the island after which it was named, Heligoland, directly adjacent to the HelWin1 platform Siemens successfully erected earlier in August 2013. Earlier this year in April Siemens already erected the BorWin2 platform off the coast of Borkum.

All told, Siemens builds five North Sea grid connections for TenneT. The first four are to begin commercial operation successively over the second half of 2014 and the first half of 2015, and in sum total provide transmission capacity of over 2.9 gigawatts. The fifth connection recently ordered this year, BorWin3, is to be ready for operation in 2019.

Using the Siemens technology installed on the platforms, the alternating current power generated by the wind turbines is transformed into direct current for efficient transmission to the mainland. At the associated land-based stations, the electricity generated by the connected wind farms is converted back into the alternating current power required for feeding into the transmission grid. Thanks to Siemens' low-loss high-voltage direct current (HVDC) technology, transmission losses are less than four percent. The platforms are designed to operate for decades in the rough North Sea conditions, and are fully automated.

The HelWin2 platform was constructed and installed by Heerema. The marine and land-based cabling were supplied and laid by the cable specialist Prysmian Group.

HVDC solutions and the associated service activities are part of Siemens' Environmental Portfolio. Around 43 percent of the company's revenues are generated by green products and solutions. That makes Siemens one of the world's leading providers of eco-friendly technology.

BC Hydro smart meters help customers save via MyHydro

At \$100 M under budget, smart meters enable new conservation tools for customers

Using MyHydro electricity tracking tools online, Guy Lynch discovered that washing and drying a load of towels and a load of jeans doubled the daily electrical use at his home.

So Lynch started drying much of his laundry on a drying rack and, along with other changes, he has reduced his electricity use by more than 30%.

Elizabeth Morse had a similar experience, discovering via MyHydro's home comparison feature that her home was using roughly twice the electricity of similar homes in her area. After a few do-it-yourself changes to the way her family uses electricity, she cut her electricity costs by 41% in a month.

The installation of smart meters at homes and businesses across B.C., an initiative that is about \$100 million under budget, enabled the development of MyHydro. And MyHydro has inspired a new wave of Power Smart British Columbians.

Ninety-nine per cent of BC Hydro customers now have a new, modern meter installed on their property. And as a direct result, there are now more than 720,000 British Columbians who actively use MyHydro to track their electricity use and find new ways to save energy and money.

This past winter, BC Hydro customers logged in to view MyHydro tracking tool pages on bchydro.com more than 1.2 million times, including over 100,000 who checked to see how their home electricity usage compared to that at similar homes in the area.

"Facing up to our wasteful energy usage was a humbling experience, but at least we were closer to a happy ending," wrote Morse in a blog post on bchydro.com.

That happy ending could include lower monthly bills, plus a \$75 Team Power Smart reward cheque from BC Hydro if her family can deliver savings of 10% or more over a 12-month period.

Smart meters not just about energy savings

Once completed, a modernized BC Hydro electricity grid will not only provide new tools to help customers, including businesses, to save money. Smart meters will also:

- Help lower costs and improve service
- Identify and help us reduce electricity loss across the system, including from theft of power
- Automatically detect power outages

More than 99 per cent of customers have smart meters and are enjoying benefits such as access to MyHydro electricity tracking.



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PG&E Signs On to New White House Initiative, Announces Actions to Help Small Business Partners Grow and Prosper

Pacific Gas and Electric Company (PG&E) has pledged to help small business suppliers grow by taking active steps to speed up payments for goods and services and promote better access to financing. The company's commitment came as it signed on to a new White House effort known as the Small Business Supplier Financing Initiative. President Barack Obama announced the initiative at a White House meeting which included PG&E Senior Vice President and Chief Customer Officer Helen Burt.

Companies participating in the Small Business Supplier Financing Initiative are committing to help small businesses succeed in three ways:

1. Providing a Working Capital Solution to Small Business Suppliers Companies will take active steps to lower the working capital cost of small business suppliers by paying them faster to reduce their capital needs or facilitating access to financing at a lower cost.
2. Sharing Best Practices Companies will highlight tangible outcomes from their own efforts, provide visibility into their actions and promote key learnings and results.
3. Implementing a Win-Win Solution Companies will carry out this pledge while minimizing new administrative or operational burdens.

"We rely on our partnerships with small businesses to help us provide safe, reliable and affordable energy for our customers," said PG&E Chairman and CEO Tony Earley. "Small businesses are the economic engines of our service area. Their growth not only helps us be successful, but also creates more local employment opportunities. We're excited to commit our support for President Obama's Small Business Supplier Financing Initiative."

The commitment is the latest step in PG&E's ongoing efforts to help small businesses and local economies thrive in its service area. Over the past year, the company has created a special economic development rate aimed at helping businesses stay local, continued to provide assistance through its extensive energy efficiency programs and achieved record results in its supplier diversity spending, much of which goes to small and mid-size firms.

"The backbone of our supplier diversity program has been our relationships with small business suppliers," said PG&E Senior Vice President of Safety and Shared Services Desmond Bell. "Our commitment to promoting a diverse and robust supply chain has made our program one of best in the country. These partnerships have helped us achieve our goals. President Obama's Small Business Supplier Financing Initiative will help strengthen our supply chain and invigorate the economy." An example of a PG&E supplier that stands to benefit from the utility's new commitment is Agile Sourcing Partners, Inc. - a Southern California-based enterprise with offices in the San Francisco suburb of Benicia. Agile supports utilities, suppliers and manufacturers in the gas and electric industry by providing sourcing and material supply solutions. Agile was founded in 2006 by a Hispanic woman.

"PG&E has understood paying smaller suppliers quickly allows them to operate more efficiently and deliver the best value and service," said Agile Founder and CEO Maria Bastian Thompson,

who accompanied Burt to the White House. "In Agile's first engagement with PG&E, they extended 15-day payment terms to ensure there was no cash gap with our sub-suppliers. As a result, we hired an administrator to manage the engagement and were able to offer similar payment terms to our 70 sub-suppliers, most of whom are small businesses themselves that also greatly need quick payment for their services.

"The Small Business Supplier Financing Initiative will allow small enterprises to work more autonomously and rely less on traditional mechanisms such as bank loans and lines of credit," added Thompson. "Alleviating some of the challenges and expenses of gaining access to capital allows small businesses to better serve their large customers."

PG&E's commitment to supplier diversity has resulted in an 11-year trend of consecutive year-over-year growth in diverse spending. In 2013, PG&E spent \$2.3 billion with diverse suppliers, accounting for 42.1 percent of its total procurement budget and an increase of \$265.2 million from 2012.

PG&E's Supplier Diversity program has received additional honors in 2014:

- On May 21, PG&E Director of Supplier Diversity and Sustainability Joan Kerr received the first Corporate Trailblazer Award from the National Minority Supplier Development Council.
- In April, PG&E was named as the top utility in the nation for diversity by DiversityInc.
- In March, PG&E was selected as one of 2014's "Top-50 Organizations for Multicultural Business Opportunities" by DiversityBusiness.com. The company also made the Women's Business Enterprise National Council's 2013 list of "America's Top Corporations for Women's Business Enterprises."

PG&E's Supplier Diversity website contains more information about the program. The site also provides details on how to become a certified diverse supplier.

MidAmerican Energy Takes Steps to Combat Copper Wire Theft

MidAmerican Energy Company has launched a program designed to combat copper wire theft in the Fort Dodge area.

To deter thieves from cutting perimeter fencing at its facilities and stealing copper grounding wire, every MidAmerican Energy substation in the area has painted the wire a bright yellow color. Metal recyclers are being asked to contact local law enforcement immediately if they suspect an unauthorized attempt to sell the yellow-painted copper wire.

"This criminal activity results in thousands of dollars in damage to our facilities and can potentially disrupt electrical service and cause severe injury to MidAmerican Energy personnel," said David Hempen, manager of business continuity and security investigations. "The bright yellow color will help recyclers and law enforcement officials quickly and easily identify copper wire that belongs to MidAmerican Energy."

To help protect all customers and personnel from the negative effects of copper theft, MidAmerican Energy plans to expand the deterrence program throughout its service territory.

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Investment in Plainview-Area Power Facilities Surging

New Xcel Energy substations, power lines being constructed for \$106.7 million

Strong agricultural demand and general economic growth in the Texas South Plains region centered on Plainview, Texas, has triggered a series of high-value capital improvement projects on the Xcel Energy system that will boost the reliability and capacity of the regional power grid.

As part of its Power for the Plains capital expansion, Xcel Energy is investing \$106.7 million in new substations and high-voltage transmission lines in Hale, Castro, Parmer, Swisher, Bailey and Lamb counties that should be mostly completed by year's end.

'We continue to see strong agricultural demand as farmers and ranchers demand more electric power for irrigation purposes in this area,' said David Hudson, president and CEO of Southwestern Public Service Company, an Xcel Energy company. 'Our transmission and distribution system is much like our system of highways and city streets. As traffic increases - in our case, electricity demand - we have to update and expand the lines that transport power to a growing customer base.'

The Plainview-area growth follows the trend of growth Xcel Energy is experiencing in almost all of its Texas-New Mexico service area, which covers most of the Panhandle-South Plains regions in Texas and the eastern and southeastern counties of New Mexico. In that area, Xcel Energy is investing more than \$3 billion to build or upgrade power plants, power lines and substations.

'This is a historic growth cycle for us and our communities, and the investments we make today will help build the economies of our communities for years to come,' Hudson said.

In the Plainview area, Xcel Energy has built two new substations and has completed or is constructing several new transmission lines. These projects include:

- The new Newhart Substation five miles northeast of Hart, Texas
A new 115-kilovolt line 18 miles in length connecting Newhart Substation to Kress Substation near Kress, Texas
- A new 115-kilovolt line 24 miles in length connecting Newhart Substation to Castro Substation, located about five miles southwest of Dimmitt, Texas
- The new Kiser Substation northeast of Plainview
- A new 115-kilovolt line 8.7 miles in length connecting Kiser Substation to Cox Substation, located east of Plainview

Projects now under construction or being planned include:

- A new 115-kilovolt transmission line from Newhart to the Hart Industrial and Lamton substations in Castro and Lamb counties, respectively
- A new 230-kilovolt transmission line from Newhart to Swisher County Substation
- A new 115-kilovolt transmission line connecting Kiser Substation to Kress Substation

In addition to these substation and transmission investments, Xcel Energy is investing in new and upgraded distribution lines that deliver power directly to homes, farms and businesses in the region.

All the Plainview-area projects were identified as critical improvements in studies by the Southwest Power Pool, the regional transmission organization responsible for grid reliability across portions of eight south-central states, including the Xcel Energy Texas-New Mexico service area.

Western Administrator Approves Regional Transmission Organization Membership

Upper Great Plains Region approved to join Southwest Power Pool

Western's Administrator Mark Gabriel approved and directed Western's Upper Great Plains Region to take the necessary actions to accomplish full membership with the Southwest Power Pool.

In signing the decision Gabriel said, 'Western manages our assets, \$4 billion strong, to ensure they are deployed wisely for our customers and for the nation to keep the power flowing safely and reliably to more than 40 million Americans. Effectively managing our resources is central to our success. Our comprehensive and rigorous Alternative Operations Study showed joining the Southwest Power Pool supports our Mission to market and deliver clean, renewable, reliable, cost-based federal hydroelectric power and related services yielding significant economic benefits under the unique circumstances in the Upper Great Plains. This business-based decision is in concert with our Vision and our Strategic Roadmap 2024, helping us keep costs low and efficiently serving our customers in the Upper Great Plains Region. We are extremely pleased with the process, spirit of cooperation and consideration by all of the SPP staff and members in helping us make this decision.'

Western's Upper Great Plains Regional Manager Robert Harris added, 'Due to the unique marketing and transmission footprint and the growth of organized markets around Western's Upper Great Plains Region, we have faced increasing constraints and costs to reliably deliver low-cost, cost-based, hydro power to our firm power customers. We particularly appreciate the involvement and support of our customers in the process to reach this decision as well as the significant work by SPP, its members, committees and staff. SPP's dedication and tenacity to find solutions benefiting all members is apparent. We look forward to being full and active participants in SPP.'

The approval is contingent upon Federal Energy Regulatory Commission approval of the SPP tariff changes without significant modification to the negotiated provisions that allow Western to ensure compliance with statutory and regulatory requirements and continue to provide reliable, cost-based hydropower to its customers consistent with sound business principles. SPP's tariff changes are expected to be filed in early August. Implementation will begin on a concurrent track, with full membership anticipated by October 2015.

The Upper Great Plains Region markets Pick-Sloan Missouri Basin-Eastern Division power and energy to preference customers in Montana east of the Continental Divide, North Dakota, South Dakota, western Minnesota and Iowa and eastern Nebraska. Western operates the Integrated Transmission System, which is owned by Western, Basin Electric Power Cooperative, and Heartland Consumers Power District.

The Upper Great Plains Region and the other IS owners have studied several forms of potential regional transmission organization participation since the 1990s. Beginning in 2001, the IS participants began to evaluate potential options of joining SPP, joining the Midcontinent Independent System Operator, or continuing operations on a stand-alone basis. These studies identified the option to join SPP as having the most benefit and the least risk.



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Selecting an Online Substation Inspection System

We are in discussion with **Dr. Nand Singh** the founder of MinMax Technologies a Texas-based software company delivering software-based productivity tools for substation operations for utilities with two or more substations. Joining Dr. Singh is **Doug Evans**, electrical engineer with the Texas City of Weatherford. He is highly experienced and knowledgeable about substation assets and their operation.

EET&D: How can a utility manager know if they are getting a quality inspection system?

Singh: As a substation manager who is researching and considering the implementation of an on-line substation inspection system and asset manager for his utility operation, you need to know what differentiates an adequate system from a superior one. The following tips will guide and help in the selection of an on-line substation maintenance system for your utility.

First and foremost, any quality substation asset management system *must* be inspector friendly. The system must allow the users to operate in a logical and intuitive fashion; otherwise most of its benefits will go unrealized.

Evans: As a duly nominated and accredited D.O.U.G. (Dumb Old Utility Guy) I can recall the many trade magazine articles and discussions of a few years ago which promoted R.C.M.

(Reliability Centered Maintenance) and C.B.M. (Condition Based Management) schemes. We don't see these terms bandied about much anymore, but we yet tend to feel some guilt and lack of thrift if we haven't implemented these systems.

It was always apparent, even to us unsophisticated DOUGs that for acronym-based maintenance to be effective, one would incur a large data handling and computational overhead, as well as a need for very sophisticated help to analyze the accumulated data. There also seems to be some truth to the DOUG suspicion that the complex and highly interacting and circumstantial upstream and downstream environments in which substation equipment lives and dies makes recognizable precursors to failure less recognizable and predictive than in the industries that fostered RCM and CBM.

The fundamental realization that seems to have negated the need to employ such needlessly sophisticated tools stems from the requirement for regular, in-depth, and consistent inspections of the substation equipment for the RCM and CBM programs to work. It has been observed that the inspection component alone seems to work as well as the full-blown system. I suggest that this is because the human brain is a pattern recognition machine far superior to any present-day silicon system. There is a growing recognition that effective man-machine interaction occurs when each half of the overall process is focused on what it does best.

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EET&D: Do you suggest a particular method when selecting a system?

Singh: The utility should always consider the following:

- How was the system created?
- Who played the key roles in the design and development of the system?

The system should be a complete substation-centric asset management system, not just an *add-on* or a *distilled down sub-system of some larger application*. Further, it should not be piggy-backed onto an existing product by the vendor.

Substation engineers along with software developers with extensive knowledge in the field of electric power delivery are truly the professionals most qualified to design a system that meets the needs of the substation inspectors and managers. The most reliable and efficient system would be the one that is jointly designed and developed by experienced software engineers, electrical utility managers, and experienced technical inspectors.

Evans: For the human, that skill set is multi-mode sensing and pattern recognition; for the computer it lies in recording, storing, retrieving, and presenting the information needed to support the human half. If we create a computer tool that facilitates the above data handling tasks to allow the human end of the partnership to practice its unconscious pattern recognition wizardry, we can then easily implement a periodic inspection program. This can simply, cheaply, and nonetheless effectively guide people to deploy the full array of senses to equipment specifics at appropriate times to feel out the underlying patterns that suggest problems.

A software tool that enables an enlightened and human-centric inspection plan thus allows an easily implementable means to assuage any guilt we might be feeling as a DOUG in being unable to have what we might have previously been led to believe is best practice for substation maintenance planning. If we are able, using easily-administered routine inspections to achieve credible results without the need for NASA-level resources, there is no rationale for guilt in opting for the simple over the arcane.

Even more significantly, the availability of a simple and easily administered software tool to organize and guide personnel through a competent inspection process allows DOUGs to shed another prominent source of guilt. A Utility that does not perform any type

of proactive inspection and pre-failure maintenance is often viewed poorly by insurers, regulators, its customers, and by the public, and creates discomfort for said DOUGs. The lack of a systematic program to make itself aware of the status of substation equipment and facilities can be seen as irresponsible and can drive liability and judgment issues for that utility.

EET&D: Do you need to seek out a particular type of system?

Singh: You should determine if the system was developed specifically for the Electric Power Delivery Industry.

Creating a software solution for one industry based on a design pattern from another industry often misses the mark. For example, a system that was originally developed for the Oil & Gas industry may not accommodate the different terminologies, inspection questions, frequency of inspections, types of work orders, NERC and other regulatory requirements, cyber security, and proper nameplate data fields for T&D types of equipment. Further, to fit your operation, the software should be user configurable and customizable without vendor participation. If the system advertises to work equally well for multiple industries, be *skeptical*.

EET&D: How in-depth must the utility's investigation be?

Singh: The major question to ask is, "Does the system fit your substation and distribution operations?"

The purpose of performing substation inspections is to increase asset reliability, reduce cost of repairs, and improve safety of personnel and property. The system should allow users to realize such benefits by performing prompted, scheduled, unscheduled, and Work Order-based maintenance in both energized and de-energized states. Both supervisors and inspectors should be able to easily retrieve desired inspection records for any of their substations, inspectors, and time periods using pre-defined reports or dashboards that can be used to support regulatory audits, substation health, and other operational metrics.

The system must maintain a high degree of integrity by keeping all its data, inspection records, test information, manuals, drawings, and pertinent notes at one location, which is accessible from anywhere, at any time from a device that is easy to use by inspectors.



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EET&D: There must be explicit questions to ask.

Singh: Certainly one of the first parameters to determine is if the system is scalable and extensible for your size operation?

Every utility is different, each with its own unique policies, schedules, and asset management terminologies, and regulatory requirements. There are no one-size-that-fits-all systems. Make sure the inspection software will scale to accommodate your utility's specific requirements and terminologies without additional costs.

Depending on the geographic area of your operation, you may not have internet accessibility at or near some of the substations. To avoid any paper-based dual data collection, make sure the inspection system can operate in off-line mode and sync up instantly with the main data when the inspector returns to an internet zone.

EET&D: Given the desirability to have software to guide people through substation (or any other equipment or facilities, for that matter) inspections, what core attributes should that software possess?

Evans: I would suggest that the inspection tool should:

- Be capable of displaying the specific questions that are to be answered for a given type and or instance of equipment
- Allow different inspection frequencies and offsets to be able to spread out less common and or more time-consuming tasks over several inspection cycles
- Be editable so that questions can be customized for specific equipment instances
- Explicitly list each location, equipment item, and question to be inspected
- Provide a verification of when and who each question was answered, and to create an indelible and attestable record of the inspection results which can be supplied to regulators or litigators if so required
- Provide a standardized but nonetheless editable list of answers to ease sorting and finding results
- Permit recording specific answers, numbers, or comments as needed
- Be easily modified as equipment is added or changed
- Provide adequate question specificity to allow non-specialists to understand and answer questions
- Provide a checklist for all inspection items that are to be examined in a given interval, and provide visual feedback to the user as to which substations, equipment items, or detail questions remain to be addressed

- Be able to automatically create inspection plans for a given instance that include all inspections needed in that interval
- Run on hand-held devices within the substation to eliminate paper notes and subsequent transfer to file
- Provide data sorting, viewing, displaying, reporting, and exporting facilities so that generated records are widely available and usable
- Provide the inspector ready access to previous recorded results to facilitate on-site pattern-recognition

EET&D: Your job doesn't end after the initial sale and installation are made. Where do you go from there?

Singh: Next to determining what system will suit your needs best, the most important thing to know is what type of customer support the software vendor can provide.

The vendor must offer customer support during the hours of your operation. Make sure that support team has software professionals who have the domain knowledge of substation inspections, regulatory requirements, and its major maintenance operations.

Be sure to ask for references and ask how many utilities are currently using the vendor's system. Check multiple references to see how satisfied others are with the product and with the customer service. If there is any hesitation about providing references, look elsewhere.

Evans: Many other desirable features can be added to this list; it would be nice to be able to store equipment-related documents and photos, to be able to back up the questions with explanations or instructions where needed, to be able to create follow-up work ticklers, or to automatically send e-mails for worrisome results, and so on.

These basic needs define a software tool that can be organized to prompt inspectors to perform inspections of specified locations and equipment, and to answer defined questions when doing so. The tool must be infinitely flexible, but yet must present inspection tasks and result in a standardized way. As an example, power transformers may be an equipment type that offers a list of a couple of dozen questions; not all will apply to all units however. If a standard question asks the inspector to look over the oil pump, and the particular unit doesn't have one, we would be in jeopardy of our field inspectors accusing us of being DOUGs. So we need to be able to start with a comprehensive question list, and whittle down to those appropriate to the given instance.

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The inspection plan must be detailed enough that any item which is to be inspected is explicitly listed; to be able to attest that an item was in fact inspected it must be named along with the questions asked about that item. There are obviously many items that make up a substation, but because many of these items can be included in the equipment types, it isn't necessary to laboriously enumerate each item. Going back to our power transformer example, if we want the high and low side bushing oil levels to be checked, we can include it as a specific question for the power transformer equipment type, and every time a transformer is listed, the bushing oil level question will follow.

EET&D: Are there any pitfalls to watch out for?

Evans: One constant constraint in attempting to sort any human-derived data set is that different people answer the same question with different terminology. If one asks about the condition of a transformer control cabinet, one may say 'OK,' the next 'Good,' and the next 'Okay.' These answers are difficult to parse and compare. The software tool described should have a standardized answer list from which selected answers to a specific question are in a drop-down list. The control cabinet answers may thus be constrained to 'Good,' 'Bad,' or 'Out of Service.' Comments can amplify the meaning of answers, but the answers will nonetheless be sortable.

Singh: Editing questions and answers to become specific and direct provides a profound corollary benefit: Once the question is clearly written out, it becomes understandable enough that workers other than trained and specialized substation folks can understand and reliably answer the inspection questions. Utilities that make use of non-specialized personnel to perform substation inspections will find that the explicit questions and the comprehensive list of targets to inspect allow the inspection software tool to perform much of the guidance and training needed to obtain a competent inspection. It is important to understand that the forced brevity required of printed inspection forms and checklists precludes the level of detail needed to provide this guidance.

EET&D: Once installed, how complex do inspections become?

Singh: Not every component of a substation requires the same frequency of inspection. Equipment with a major impact on customer service such as line relays or high capital cost such as transformers warrant more frequent checks than do relatively slow deteriorating items such as paint on junction boxes or cabinets. Public responsibility items like walking the fence line looking for

gaps for kids to crawl under or for detached ground wires are not generally an every-session inspection, but nonetheless it is vital to ensure that this task does get done. The software tool must be capable of having selectable inspection frequencies so that it doesn't become expedient to inspect every single thing every single time just to ensure that the low-frequency items don't get skipped.

Evans: Without prompting, humans fall into a routine. An individual sent out to perform a substation inspection without effective on-site guidance will sense a few things, record a few things, and then move on. To make use of the innate pattern-recognition abilities of the human processing system, the inspector needs to be reminded to look at and become aware of as much of the environment as possible. We may no longer (or at least usually) be using this talent to look for sabre-toothed tigers in the weeds, but it is the same set of abilities at work. By using a software tool to prompt the user to look at the many and varied inspection points we've noted, we hope to more fully engage the inspector with the environment of that substation, and better sense the sabre-toothed LTC failures lurking therein.

Because innate pattern-recognition is subconscious and inexplicable to the conscious mind, the awareness that something isn't quite right arrives as a feeling, not as a self-evident fact. For this reason, the ability to display equipment historical records is important. If we feel that something is odd, the impulse is to seek information that supports or refutes that interpretation. If it is difficult or awkward to back up that gut feeling we tend to ignore the feeling, thus possibly missing the opportunity to avoid a major failure. This is the downfall of all paper-based inspection systems; it is too unwieldy to gain any benefit from on-site pattern-recognition. It may be possible to later find what was missed, but it is unlikely to help identify the issue in advance.

I came into the substation engineering field with an expectation that to be truly professional and responsible I would need to implement a comprehensive RCM system. I've since then come to believe that comparable results are obtainable with a vastly simpler, less costly, and more easily managed periodic inspection program. And guess what... I feel no guilt about it.

EET&D: Having both of you in the same spot at the same time has been extraordinary and I know our readers are going to benefit from the wisdom of each of you. On behalf of the magazine I thank you for finding the time in, what I'm sure is, a crazy schedule to share such in-depth knowledge combined with a little 'tongue-in-cheek' on such a key area of the electric utility industry.



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About the Author



Dr. Nand Singh has more than 30 years of experience in executive management and serial entrepreneurship in information technology industry. Prior to founding MinMax Technologies in 2007, he co-founded BEST Systems in 1994. The company was cited in several case studies

from Microsoft for building multiple specialized custom software solutions on the Microsoft platform for key industry leaders.

From 1985 to 1994, he was the director of Technology Transfer for Power Computing Company where he directed commercialization, distribution, and support of more than 150 electric utility software products to serve over 500 electric utilities globally. He was responsible for the operation of Electric Power Software Center (EPSC) for EPRI where he supervised the EPRI technology transfer to its member utilities. A champion of best practices based on ISO 9001 and CMM methodologies, Dr. Singh helped EPRI promote a uniform process called SIMPLE (Software Implementation for EPRI) among its software vendors. While working with the leading power delivery consultants to EPRI, he was the principal investigator and designer for the first Substation Inspection and Maintenance Software initiated by EPRI for all its member utilities.

Dr. Singh is also an adjunct faculty member at the Southern Methodist University (SMU) in Dallas, Texas where he teaches Strategy Engineering, Decision Support Systems, and Program & Project Management. He serves on the Distinguished Advisory Council of the Engineering Management and Information Systems at SMU and the Advisory Board of the Asian Studies at SMU Dedman College of Humanities and Science.

An alumnus of IIT-Bombay, Dr. Singh received his MS in Aerospace Engineering from the University of Cincinnati, and his MS, MBA, and Doctorate of Engineering from the SMU. He can be reached at nand.singh@minmaxtech.com

Doug Evans is the electrical engineer with the City of Weatherford and has been instrumental in helping MinMax launch SMART. He brings with him a wealth of experience and knowledge about substation assets and their operation. His organization is the early adopter of SMART and has been using it for well over 2 years now. Reach him at devans@weatherfordtx.gov

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GREEN OVATIONS

Innovations in Green Technologies

Green Button Implementation Gains Momentum

By Patrick Gannon



Two big announcements in recent weeks highlight the increased acceptance and implementation of Green Button across the energy sector. Smart Grid Interoperability Panel (SGIP) and its members continue to make important contributions to the effort. SGIP members have been very active in advancing Green Button Initiatives from many different perspectives, including Green Button Download My Data, which allows consumers to easily download their energy data, and Green Button Connect My Data, which uses a new, Business-to-Business Paradigm for the energy sector.

As described in this March 2012 article, *SGIP Plays Key Role in White House's Green Button Initiative*, SGIP's PAP-10: Standard Energy Usage Information was instrumental in laying the groundwork for this highly visible and successful initiative. SGIP's involvement continues with PAP-20: Green Button ESPI Evolution. As organizations in SGIP's stakeholder community – from utilities and manufacturers to government agencies and energy service providers – move Green Button into the marketplace, consumers are starting to reap the benefits.

One of the first groups seeing benefits will be American taxpayers, because the Federal Government is embracing Green Button technology as a key element of its plans to improve energy efficiency and sustainability.

On May 28, at a White House-sponsored 'Datapalooza' event, Secretary of Energy Ernest Moniz and OSTP Director John Holdren announced a successful federal pilot applying Green Button to help building managers achieve greater efficiencies. General Services Administration (GSA) Administrator Dan Tangherlini said, "Creating a more sustainable government is vital to our mission and drives the agency's priorities. As one of the largest real estate managers in the country, adopting Green Button technology across our real estate portfolio allows us to improve building performance and save taxpayer dollars."

Green Button Initiative

A recent White House call-to-action has spurred the Green Button initiative. It is an industry-led effort to provide utility customers with easy and secure access to their energy usage information in a consumer-friendly and computer-friendly format. Customers are able to securely download their own detailed energy usage with a simple click of a literal 'Green Button' on electric utilities' websites.

All consumers want to save on their energy bills and now, with their own data in hand they can take advantage of a growing array of online services to help them manage energy use. Voluntary adoption of a consensus industry standard by utilities and companies across the country both enables and incentivizes software developers and other entrepreneurs to build innovative applications, products and services which will help consumers manage energy use. For example users can program their home energy management devices, determine the size and financing of rooftop solar panels, and help contractors verify their home energy savings in a more cost-effective manner.

Adoption of the Green Button data standard will also benefit utilities that receive numerous requests for data, are administering energy efficiency programs, are looking for avenues for greater customer engagement, and in many other ways.

What has been the success and progress on the initiative to date?

The Green Button initiative was officially launched in January 2012. To date, a total of 35 utilities and electricity suppliers have signed on. In total, these commitments ensure that at least 36 million homes and businesses will be able to securely access their own energy information in a standard format. This number will continue to grow as utilities across the continent voluntarily make energy data more available to their customers in this common, machine-readable format.



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What is the Green Button data standard?

Green Button is based on the Energy Services Provider Interface (ESPI) data standard released by the North American Energy Standards Board (NAESB) in the fall of 2011. The data standards development process was facilitated by the Smart Grid Interoperability Panel (SGIP), a public private partnership that is facilitated by the National Institute of Standards and Technology (NIST).

The ESPI standard consists of two components:

1. A common XML format for energy usage information
2. A data exchange protocol which allows for the automatic transfer of data from a utility to a third party based on customer authorization.

All of the utilities that have committed to Green Button will implement the common XML data format in an easy to download manner.

What does Green Button data include?

The Green Button data standard is flexible enough to handle different types of energy data and time interval usage. Applications are being developed for both residential and commercial customers. The data can be provided in 15-minute, hourly, daily, or monthly intervals depending on what a utility decides to make available and what level of detail they are able to provide. The Green Button Initiative is not limited to utilities that have deployed smart meters that produce very detailed information about energy consumption, but also includes utilities that are able to provide only monthly billing data. In the future, the ESPI data standard is being explored with a view to supporting natural gas and water usage information amongst other uses.

What is Green Button Connect My Data?

Many utilities are implementing:

- a) *Green Button Download My Data* which means that the utility customer can download their own energy consumption data directly to their own computer, and if they so choose, upload their own data to a third party application
- b) *Green Button Connect My Data* is a new capability which allows utility customers to automate the secure transfer their own energy usage data to authorized third parties, based on affirmative (opt-in) customer consent and control.

What about data access, privacy, and security issues?

Green Button is consistent with current privacy and security practices, since customers have to first authenticate themselves on a utility portal with a login and password before they see and download their own information. If they want, customers can share their own data that they have downloaded, by independent choice and action, with those they trust. As some utilities deploy *Green Button Connect My Data* (the full ESPI standard) in the future, automated transfers of Green Button data from a utility to a third party service will be allowed. Such transfers will happen only if a customer has granted explicit permission. Ed.

For this pilot project, the GSA, with the support of the National Institute of Standards and Technology (NIST) and the Department of Energy (DoE), worked with private-sector partners Schneider Electric, Pepco Holdings and FirstFuel Software to demonstrate the opportunity for building managers to use innovative tools to manage energy usage and reduce greenhouse gas emissions.

The DoE's Federal Energy Management Program will use the results of this pilot to develop government-wide guidance, and the EPA is working to integrate the Green Button standard into its ENERGY STAR® benchmarking tool. With these strong endorsements of the Federal Government on its behalf, Green Button implementations in the marketplace are likely to accelerate in the coming months.

Green Button's second major announcement came on June 20, when a public-private partnership unveiled a Green Button Test and Certification Program, which will help ensure interoperability of the broad range of Green Button deployments across the nation. The partnership members include UCA International Users Group (UCAIug), Underwriters Laboratories (UL), The American National Standards Institute (ANSI), NIST, and the DoE.

UCAIug stated that it will certify Green Button in two categories:

1. Service providers such as public, municipal and co-operative utilities cws and energy efficiency organizations who provide data to energy consumers
2. Product vendors that provide Green Button software solutions to service providers Service providers require certification even if they use a vendor's product offering that has been separately certified

In an important first step for the new program, UCAIug announced that it has completed a trial run for the Green Button Download My Data Certification. Two implementations of the UCAIug Green Button Test and Certification process for Download My Data have now been completed and one is pending:

- Seattle City Light is the first Electric Utility to receive certification.
- The Schneider-Electric Energy Profiler Online (EPO) product is the first commercial software product to receive certification.
- Wake Electric is working with UCAIug to certify its Green Button program.

The design of Green Button Connect My Data Certification is currently under way, with target Certification of Green Button machine-to-machine Connect My Data to occur in late 2014.

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Green Button Certification is an essential underpinning of the national Green Button initiative. In the certification's absence, non-interoperable implementations will result in customer and vendor frustration and additional support costs for parties exchanging data, making data use difficult.

Additionally, a reliable certification mark will allow a robust ecosystem of data providers and users to grow, which will help consumers optimize the efficiency of their energy usage and better manage their energy cost.

SGIP will be hosting panel sessions at its Annual Conference in September in Nashville TN, to learn more visit <http://www.sqip.org/SGIP2014-Annual-Conference>.

For more information on Green Button, visit <http://www.greenbuttondata.org/>

For more information on the White House's Datapalooza announcements, visit <http://www.whitehouse.gov/the-press-office/2014/05/28/fact-sheet-harnessing-power-data-clean-secure-and-reliable-energy-future>.

For more information on the Green Button testing and certification program, visit <http://www.gbitca.org>.



About the Author

Mr. Gannon is Executive Director and President of SGIP 2.0, Inc., the international non-profit Smart Grid Interoperability Panel. SGIP is driving the collaboration, coordination and promotion of smart grid standards interoperability for the energy sector on a global basis. He served as President of Warning Systems, Inc. from 2008 to 2013, and as President and CEO of OASIS Open from 2001 to 2008. Mr. Gannon was appointed in 2006 as a high-level Advisor to the United Nations Global Alliance for ICT and Development (UN GAID). He also served from 2000 to 2005 with the United Nations Economic Commission for Europe (UNECE), as Chairman of the Team of Specialists for Internet Enterprise Development, which advised governments in transitional economies on best practices for electronic business. Gannon served as a member of the US Election Assistance Commission (EAC) Technical Guidelines Development Committee (TGDC) from 2004 to 2006 where he worked closely with the NIST Director and staff. He served as Vice President of Strategic Programs for the CommerceNet Consortium in Palo Alto, California, directing research and development efforts in new Internet commerce standards such as XML in the mid-1990s. While at CommerceNet, he became the first Project Leader for RosettaNet and served as Executive Director for the Open Buying on the Internet (OBI) initiative. Mr. Gannon is co-author of the book: Building Database-Driven Web Catalogs, and is an international speaker on electronic business and Internet software standards.

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From Research to Action

Data Analytics and the 'Little Data' Challenge

By Matt Wakefield, Director, EPRI and Thomas O'Brien, Vice President – Information & Technology Services, PJM Interconnection

According to INSIGHTSQUARED's infographic¹ on data quality, poor data and lack of visibility into data quality is the No. 1 reason for project cost overruns, and the cost of 'dirty' data for US businesses exceeds \$600 billion dollars annually.

The term 'Big Data' has a lot of buzz in the electric industry, but is this a primary issue for utilities? One basic definition of 'Big Data' is when the amount of data available or received is greater than one's ability to process or manage it. IBM has described data in terms of the 'four V's'² – volume, variety, velocity and veracity. Large data sets certainly fall into the volume category, but these other characteristics also present big data challenges.

As EPRI enters its second year of transmission and distribution modernization demonstrations (TMD & DMD) on data analytics, its one-year update on findings³ identifies the general data analytics priorities of 14 utilities, and the volume of data is not the biggest challenge. Although a number of specific data analytics applications are being identified and prioritized, clearly a more significant challenge is what has been called 'Little Data' as shown in Error! Reference source not found. A simple definition of 'Little Data' is when the number of data sets is greater than one's ability to integrate and process the associated data.

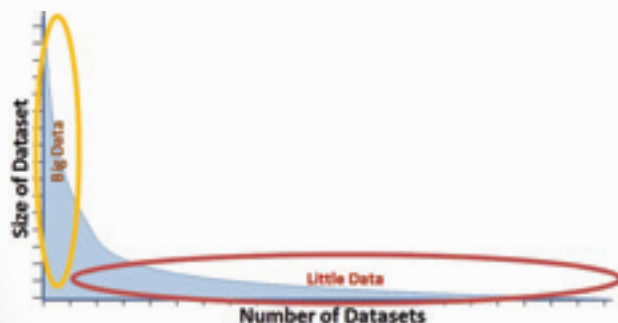


Figure 1: Little Data vs Big Data

A major element of the challenge is that common information may exist in separate datasets that represent the same asset, system, or grid model information, but these datasets are managed independently in their own silos. These silos in themselves can result in data inaccuracies or inconsistencies. Creating ways to integrate, improve, and maintain data quality

across different systems can have a positive impact on the bottom line. Of the four Vs, both variety (different forms of data) and veracity (uncertainty of data) apply. The combination of opportunities and challenges caused by 'Little Data' indicates that data becomes an increasingly valuable asset when there is one accurate 'source of truth.'

The Little Data Challenge

Electric utilities have the potential to gain access to more data from an increasing number of sensors and systems, both internal and external with new sources continuing to evolve. Grid operations are increasingly dependent on data that cuts across multiple business functional areas in which data representation is very diverse in character or content (i.e., heterogeneous). One basic example is meter data. Historically, meter data has been used exclusively for billing – the utility cash register. But as advanced metering systems have evolved to provide significantly more data such as voltage and other power quality information, the meter data has become a valuable asset to distribution operations. However, these customer and operations systems have never been integrated before.

This isn't a new challenge. Dealing with numerous heterogeneous data sets has been an industry hurdle since grid data started to become digitized. In 1996, EPRI's *Guidelines for Control Center Application Program Interfaces*⁴ identified this challenge. Standards were recognized as a solution, and EPRI worked to advance the industry through the development of what was then a series of new electric industry standards referred to as the Common Information Model (CIM) that includes International Electrotechnical Committee (IEC) standards 61970, 61968 and 62325. The CIM is intended to provide software applications and system models a platform-independent view of the power system with a standards-based information model identifying relationships and associations of the data within an electric utility enterprise.

Adoption of the CIM has increased but still faces challenges. An enterprise-wide view of the electric grid is complex due to the many heterogeneous data sources within a utility. Existing systems may have proprietary interfaces with significant lifespan and investments both in the technology and knowledge. Updating interfaces just to be standards compliant is a tough business case to justify.



From Research to Action

A better strategy is to make interfaces standards-compliant when doing new acquisition or as part of a maintenance cycle. Another challenge may be that, when integrating proprietary systems into a CIM-based model, some information in the model may not exist and may need to be added to the standard. Unfortunately, virtually every CIM project requires the standard to be extended to be compatible with the unique needs of a given utility. Because the CIM is vendor neutral and designed to provide flexibility needed for integration, this may result in semantic ambiguities among different software vendor products, especially if the utility does not already have a meta-data management practice or a defined semantic model.

Approaches to Integration

Although many challenges exist related to 'Little Data,' significant progress is being made to enable innovation through Web standards like those led by the World Wide Web Consortium (W3C)⁵ and technical interoperability such as an Enterprise Service Bus (ESB) or Service Oriented Architecture (SOA). Semantic standards like the CIM are addressed by organizations such as the CIM Users

Group (CIMug)⁶. They are well-supported by vendors, such as ABB, IBM, Oracle, Siemens and more, and continue to drive towards continuous improvement. The EPRI Common Information Model (CIM) 2012 Update⁷ and 2013 Update⁸ provide insights on implementations by several utilities. The number of respondents from the 2013 CIM survey nearly doubled, indicating increased interest and adoption in the CIM worldwide.

One approach to solving these challenges is an effort by PJM Interconnection⁹ as part of its Advanced Control Center (AC²) program.¹⁰ Commissioned on Nov. 8, 2011, AC² features two fully functional control centers and data centers located at distant sites. Both sites are staffed 24/7 and simultaneously share responsibilities for operating the transmission system and PJM-administered wholesale electricity markets. Either site can run the RTO's entire system independently should the other become inoperable.

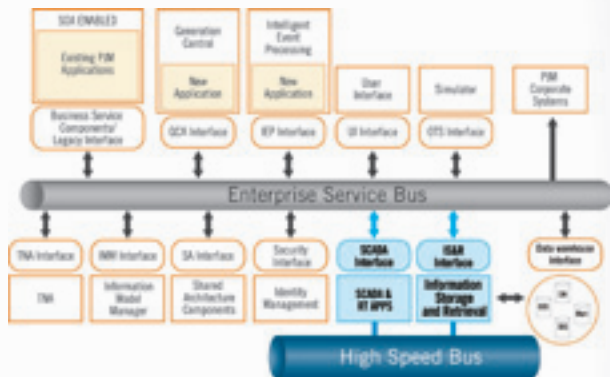


Figure 2: PJM Enterprise Service Bus

This breakthrough proves that innovative technology, such as a service-oriented architecture (SOA) and a CIM-based messaging architecture, can be adapted to real-time, high-performance, mission-critical environments leading to the evolution of next generation control systems. From the beginning of designing the new control systems to increase operational efficiency and grid reliability, PJM sought an integrated architecture with embedded security controls, scalability and flexibility. Those goals led PJM to a service-oriented architecture to interoperate with a new Shared Architecture platform, which was co-developed with Siemens, so PJM's systems could grow easily as new members integrated into the RTO and could adapt to new technologies and invite innovation.

This open, modern architecture, built on an enterprise services bus (ESB), as shown in Figure 2, enables the rapid integration of traditional utility applications and emerging Smart Grid applications. It provides flexibility and choices that previously had been unavailable due to legacy control center application investments. Utilizing a Shared Architecture enabled PJM to deploy new Energy Management and Market Management applications while leveraging legacy applications that will be replaced consistent with planned technology life cycles, thereby avoiding unnecessary reinvestment and risk.

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From Research to Action

Summary

Adoption of mature technologies and improvement of semantic technologies is increasingly important as the opportunity to improve operational efficiency and grid reliability are enabled by the combination of heterogeneous data. Because the CIM covers such a broad landscape of the electric utility enterprise, collaborative efforts such as learning from others and participating in standards development activities are essential in prioritizing the most important aspects of such development. The results of these efforts will enable the greatest flexibility in the choice of solutions that support innovation to manage the uncertainties of emerging value propositions from the availability of new and combined data.

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- ⁷ <http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=00000000300200406>
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- ⁹ <http://www.pjm.com/about-pjm/who-we-are.aspx>
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About the authors



Matt Wakefield is Director of Information, Communication, and Cyber Security at the Electric Power Research Institute. He has over 25 years of experience in the electric industry and his responsibilities include furthering the development of a modernized grid through application of standards, communication technology, integration, and cyber security.

Thomas F. O'Brien is the Vice President – Information & Technology Services at PJM Interconnection and is responsible for all aspects of PJM's information technology services activities, including integration and application services and infrastructure operations. Additionally, he has provided active leadership for the implementation of the Advanced Control Center program including oversight of creation of a new information and application architecture for PJM's Energy Management and Market Management Systems.



Mr. O'Brien is an energy professional with more than 25 years of broad experience in all aspects of the electric industry. Previously, Mr. O'Brien was employed by GPU Energy and FirstEnergy and participated in the deregulation activities and energy trading activities within the electric industry.



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Natural Ester Fluids: Flowing Into the Mainstream

By David S. Roeser, PhD

Once viewed as a nice, *niche product* for applications where environmental safety was at a premium, a recent trend reveals more and more power companies turning to natural ester fluids as a transformer coolant and insulator that delivers the operating efficiencies they need to stay competitive.

India's largest integrated power company, Tata Power, announced in June that it will use a natural ester fluid in all of its new packaged substations across its Mumbai distribution area. Tata Power serves more than half a million residential and industrial customers. Together with its subsidiaries and jointly controlled entities, Tata operates an installed gross generation capacity of approximately 8,560 MW.

Earlier this year, Transnet BW – a transmission network operator in the German state of Baden-Württemberg – commissioned a 420 kV power transformer in one of its substations in southwest Germany that is cooled and insulated with vegetable-oil-based, natural ester fluid. The substation, which has a power rating of 300 MVA with an overload condition of up to 400 MVA, is the first in this high-voltage category to be filled with natural ester fluid.

CPFL Energia, Brazil's largest privately owned energy company, announced in 2013 that it would begin transitioning its entire distribution network to natural-ester-fluid-filled transformers. CPFL serves some seven million customers in 569 towns and cities across southern Brazil. Like Tata and TransnetBW CPFL selected Cargill Industrial Specialties' Envirotemp™ FR3™ fluid (the most widely used natural ester fluid) for its transformers.

Although the more environmentally friendly qualities and increased fire safety of natural ester fluids over mineral oil were key factors in their selection for each of these companies, capturing operating efficiencies is becoming an ever more important factor driving their selection.

"Our initial interest in vegetable-oil-based fluids stemmed from our dissatisfaction with mineral oil – particularly its handling risks and leakages – not to mention the difficulty in safely disposing of expired transformers," said Caius Vinicius Sampaio Malagoli, CPFL manager of maintenance and standards. "We started to realize that vegetable oil would not only be environmentally advantageous as a replacement for mineral oil, but that it could also provide technical

advantages for the equipment itself – as well as significant gains in operational efficiency and costs."

These three companies are among an ever-growing number of power companies turning to natural ester fluids for their transformers. In 2013, a major power company in northern California that operates roughly a million transformers committed to using a natural ester fluid going forward. To date, more than 100 U.S. utilities – including five very large power companies, have made substantial investments in transformers filled with natural ester fluids. And a number of other power companies are preparing to follow suit.

More than 600,000 transformers around the world are now cooled and insulated by natural ester fluids – including more than 5,000 substation installations and more than 500 medium and large power transformers. There are a number of marketplace forces and other reasons natural ester fluids are catching on – starting with the simple fact that they have now been around long enough to establish a performance track record that people are taking seriously.

Natural Ester Fluids Come of Age

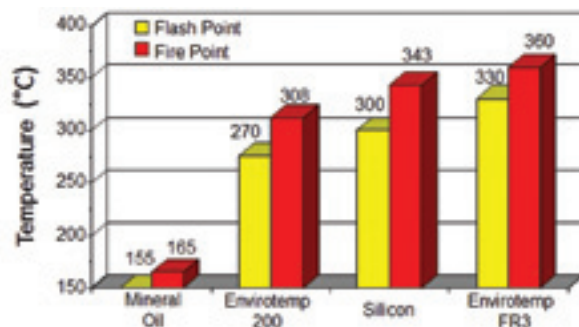
When natural ester fluid was first developed for use in transformers in 1998, it was the fluid's environmental characteristics that first captured people's attention. Because it is derived from vegetable oil, natural ester fluid is non-toxic to the environment and it is ultimately biodegradable. These characteristics made it very desirable for use in environmentally sensitive installations. Since natural ester fluids are typically more expensive than mineral oil, however, their early use was limited to those applications that demanded an extra measure of environmental protection.

Furthermore, like any new product, natural ester fluids were still largely unproven in the marketplace. Many potential users in the power industry waited to see how they would perform over time. Now that we are closing in on nearly two decades of industry usage – and public and private research on its performance – natural ester fluids have established an enviable track record. They deliver as expected in terms of impact on the environment. Perhaps more important, however, is the fact the natural ester fluids deliver very real value to power companies – above and beyond their environmental qualities.

Natural Ester Fluids: Flowing Into the Mainstream

Over time, the marketplace has come to better understand the advantages of natural ester fluid over mineral oil – both through research and through industry usage. At the top of that list comes fire safety.

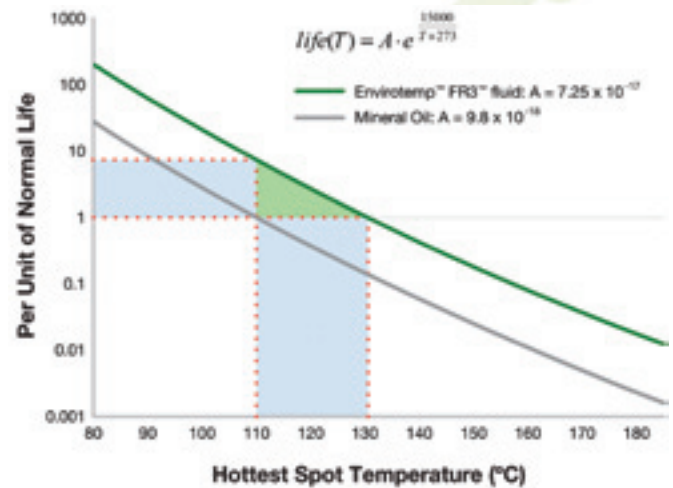
Natural ester fluids have more than twice the flash point and fire point of mineral oil. They are self-extinguishing, which mitigates the risk of pool fires. Underwriters Laboratory and FM Global classify FR3 fluid as a less flammable fluid. This enables utilities to potentially eliminate fire walls and expensive deluge systems. Also, transformers can be placed closer to each other and to buildings which saves on space-constrained installations.



For densely populated areas or high traffic buildings such as malls or airports, the improved fire safety aspects are critical for power companies to provide safe, reliable energy to their residential and commercial customers.

Natural ester fluids are also self-drying, a quality that helps them extend the life of transformers. During normal operation, transformers produce water which contributes to the degradation of the insulation paper or board. Because of their chemical makeup, natural ester fluids absorb that free water and, in turn, capture it, converting it into long-chain fatty acids through a process known as hydrolysis. These fluids can absorb roughly 10 times the amount of water that mineral oil can, which protects the cellulose insulation in the transformer from the level of degradation that typically occurs in transformers cooled by mineral oil. This unique characteristic extends the life of the insulation by five to eight times—which in turn extends the asset life.

With new high temperature capability standards published in 2012, (see IEEE C57.154 Standard for the Design, Testing, and Application of the Liquid Immersed Distribution, Power, and Regulating Transformers Using High-Temperature Insulation Systems and Operating and Elevated Temperatures), new transformers filled with natural ester fluid can operate at higher temperatures with the same life expectancy as mineral oil transformers (266°F [130°C] hot spot versus 230°F [110°C]) – which means power companies can increase loading capabilities by 15 to 20 percent or extend their asset life.



This capability also impacts how power companies can specify their ratings and design parameters. With the high temperature capability of natural esters fluid, utilities can opt to keep the same-size transformer and re-rate it to a higher power capability. Or, they can keep the specified rating, and design a smaller transformer, which can be particularly valuable in space-constrained installations.

This sort of flexibility around load capability, extended asset life, and specified ratings, holds the potential for utilities to use new methods for how they load their transformers, reduce their overall inventory, and enhance their supply chain initiatives. For example, an OEM may be able to lower costs versus a traditional mineral oil bid for its power transformer bid – and significant materials such as copper – by designing them to use natural ester fluid.

For many users, these technical advantages offer multiple opportunities to offset the additional cost of natural ester fluids relative to mineral oil – and then some.

Meeting Demands for Safer, More Reliable, and Cleaner Energy

Sustainable chemistries and new power technologies are critical in meeting the changing demands of consumers around the world. During the past 10 years, the environmental qualities associated with natural ester fluids have become even more valuable in some geographies. Brazil, for example, is a country that takes great pride in the fact that it is very 'green' when it comes to power generation. According to recent reports, more than 80 percent of Brazil's total electricity production is generated by sustainable means. CPFL Energia believes being viewed as a green company strengthens their brand value.

Natural Ester Fluids: Flowing Into the Mainstream

"It has produced immeasurable value to our brand, peer acknowledgement, and interest in our company," said Malagoli.

India, with its high population densities, has become more environmentally conscientious in recent years and fire safety is at a premium.

"Tata Power is committed towards ensuring the safety and sustainability for its stakeholders," said Ashok Sethi, executive director. "Safety is a core value at Tata Power and is an integral part of our values system."

During its time in the marketplace, natural ester fluids have achieved verification from regulatory agencies. Per the Environmental Protection Agency guidelines, natural ester fluids are deemed to be ultimately biodegradable (meaning they will completely biodegrade in 28 days). Natural ester fluids are classified as non-toxic and non-hazardous in soil and water, per the Organization for Economic Cooperation and Development. According to the BEES 4.0 lifecycle analysis, natural ester fluids have been classified as carbon neutral resulting in 56 times less carbon emissions than mineral oil. Finally, there are industry standards in place to help utilities adopt and integrate the natural ester technology into their operations. ASTM, IEEE and IEC all have published standards for natural esters. These factors alone would explain some of the reasons more and more companies are making the move to natural ester fluids in the power industry. In addition, however, customers around the world – as well as regulatory agencies – are placing new demands on their power providers.



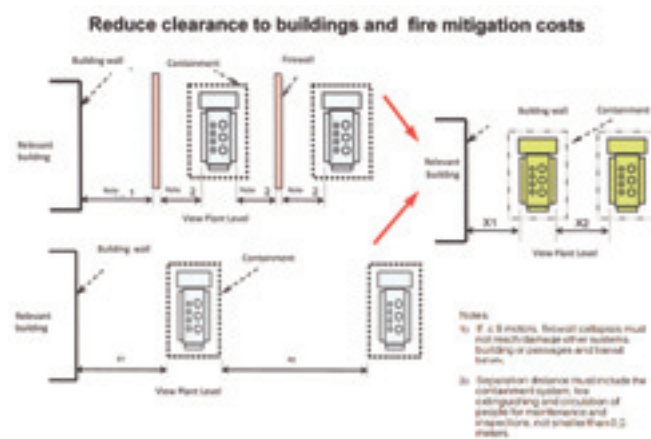
New Market Forces Multiply the Value Proposition

The power industry is a conservative, slow to change industry. But changing market forces are demanding new capabilities.

For starters, new standards are being adopted around the world making the environmental profile of natural ester fluids even more desirable. For example, the Bureau of Land Reclamation has established a higher level of environmental safety for transformers at hydroelectric dams, now requiring use of a transformer coolant and insulator that will cause no significant environmental damage at several of their installations.

In the Western United States for example, a recent transformer fire caused considerable property damage to the surrounding area. As a result, several power companies in that area are now considering using natural ester fluids to help mitigate their fire risk.

Furthermore, the increased fire safety associated with natural esters over mineral oil offers power companies additional opportunities to save money over the life of their transformers such as installations not requiring as much setback and potentially eliminating fire walls, fire mitigation, and deluge systems.



Another factor causing power companies to re-evaluate the long-term value to be captured through the use of natural ester fluids is the aging infrastructure in the power industry. The average age of transformers in service in many countries, including the United States, is 50 years. Because the use of natural ester fluid has been proven to extend the insulation life of assets – both in original equipment and when used as a fluid for retrofills – the Federal Energy Regulatory Commission has ruled that *all* costs associated with the conversion to natural ester fluids (fluid, labor, equipment) may be capitalized.

Finally, the Department of Energy is in the process of developing more stringent efficiency requirements for new transformers. They're raising the bar in terms of how much energy must be converted to electricity and capping the amount of energy allowed to be dissipated as heat. If they stick with mineral oil in their transformers, manufacturers may well have to go to new types of steel to meet those requirements. The new steel could increase the weight of transformers by as much as 30 percent – which will create a whole new layer of challenges around sturdier equipment, more demanding installations, bigger crews, and so on. Because of their higher loading capabilities, natural-ester-fluid-filled transformers could handle these more stringent requirements without increasing the size and weight of transformers.

Natural Ester Fluids: Flowing Into the Mainstream

All of these factors are combining to convince a growing number of utilities to turn to natural ester fluids as the coolant and insulator of choice for their transformers. Those companies that are taking advantage of this technology are achieving cost efficiencies, performance advantages, and improving safety – all while improving their environmental footprint in the communities they serve. It's just the sort of win-win solution that the power industry needs – and their customers want.



About the author

David S. Roesser, PhD, has over 20 years-experience in R&D, new business and product development, marketing, sales, and business management. He is currently Global General Manager Dielectric Fluids for Cargill's Industrial Specialties (CIS) business unit. In this

capacity he is primarily responsible for the P&L, growth, management, and development of the CIS Global Dielectric Fluids Business.

He previously spent one year as Chief Technology Officer for Earthshell Corporation, a start-up venture. Earlier, he spent three years at FedChem, formerly Rhodia, as Technical Marketing Director in the areas of aluminum complex grease materials for food machinery applications, lithographic ink gellants and zirco-aluminate adhesion promoters. Dave spent the first 10 years of his career with National Starch and Chemical Company in a variety of positions, including R&D Project Manager and Business Manager in the Biodegradables Strategic Business Unit. His last position at National was Global Strategic Business Unit Manager for the Natural Polymer Specialties SBU.

Dave holds a BS in Chemistry from the College of William and Mary in Virginia and a dual PhD. in Polymer Chemistry and Plastics Engineering from the University of Massachusetts.

NOTE: The views presented herein are those of Cargill Industrial Specialties ("Cargill"), a leading manufacturer of Envirotep™ FR3™ fluid, a natural ester transformer fluid. Cargill makes no representations or warranties, whether express or implied, with respect to all statements, recommendations, suggestions or use of this information.



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Operations maturity: Smart management of smart grids

Your smart grid network offers immense value – if you have the operations maturity to make the most of it

By: Kai Hui

As a longtime utility 'insider,' I know first-hand the trials and tribulations of deploying and managing a smart grid. Now, with the added perspective of being a technology provider to the industry, I can share my experiences and lessons learned.

A utility with two million smart meters in the field is inundated with approximately 750 million data elements each day – that's almost twice as many data elements as there are tweets floating around the global Twittersphere on a daily basis.

So it's inevitable for a utility with a newly deployed smart grid to feel like it's drowning in data.

The key to that utility's ultimate success is its capacity to manage the influx of data *at scale*. More specifically, we can refer to this as its 'operations maturity,' or the utility's ability to efficiently and effectively interpret the mass amounts of data it receives, in order to identify and manage the underlying issues communicated by that data, and to do it all cost effectively.

The Operations Maturity Model

To evaluate a utility's operational maturity, we can see how it places on the *Operations Maturity Model* (see sidebar), which I've adapted from Carnegie Mellon University's *Capability Maturity Model* to fit the utility industry. Ranking a utility on a scale from Level 1 to Level 5, the model measures a utility's maturity in terms of how effective and efficient its operations are. A utility that has just begun the modernization process has operations that are reactive and ad hoc; a mature utility's operations are adaptive and predictive.

Information-to-data ratio

A strong indicator of a utility's operations maturity level is its information-to-data ratio (IDR), or the ratio of actionable information that a human operator needs to deal with compared with the amount of 'noise' or data elements that can be ignored. If a utility at Level 2 on the maturity scale has an IDR of 150,000:1, and deals with 750 million data elements a day, that's 5,000 information events that need a human eye. If an operator can deal with a maximum of 100 events a day, the utility would need 50 operators on staff to

handle the data load. However, if that utility takes the steps to mature to Level 3, it might raise its IDR to 500,000:1. It now only needs 15 operators to deal with a total of 1,500 events a day – a cost savings that speaks for itself. IDR is analogous to the signal-to-noise ratio (SNR) used in science and engineering, where it is used to measure the strength of the signal against that of the noise.

At this point in our industry's modernization, many utilities are at Level 2, moving toward Level 3. A utility can move up the maturity scale by implementing plans that focus on one or more of three areas: people, processes and technology.

Make the most of your people

A newly deployed utility might still have separate departments managing IT (application) issues, OT (device) issues and telecom (network) issues. But a smart grid system involves a lot of overlap between these areas, so if you're aiming for an efficiently integrated system, siloed operations won't help you get there. In my experience, a matrixed structure knitting these three departments together works best. All queries are funneled to one point of contact who acts as an internal service provider. That person then triages the issues and sources the right expertise to deal with them. The key here is to focus on business outcomes and not the traditional roles and responsibilities of your team.

Streamline your processes

When a utility deploys its smart grid, it will naturally have basic steps it follows to handle data events that arise. In the beginning, these may be ad hoc procedures, but as the utility matures, these procedures will be replaced by more comprehensive and adaptable processes. These processes should be logically structured and well documented, and it's generally easiest to build them on an established framework such as ITIL or FCAPS. Because smart grids involve a lot of integration and overlap between departments, it's key that the documented processes span the various domains involved and identify not only what needs to be done, but who is responsible for doing it.

Integrate your technologies

Field devices deliver an endless supply of data. But while spreadsheets and databases may be useful for storing that data, it takes time to input and it's a strategy that doesn't scale well – a 50,000-row spreadsheet is just unwieldy! Moreover, data warehouses don't actively analyze the data for actionable insights without an operator manually running the reports. And most importantly, spreadsheets and databases don't offer a real-time view of network operations, which is one of the primary strengths that a smart grid offers.

To get that real-time view, a utility needs to leverage a software application that easily integrates with its asset, work order, customer, GIS, telecom management and other systems. And the more integrated your technology platform is across your systems, the greater your visibility or 'contextual view' of your operations. The application can synthesize the data it's receiving in real time, and output it instantaneously in charts, graphs, grids and interactive maps that make it easy to act on relevant insights.

What does operations maturity look like?

Without integrated software, a utility has limited visibility into its operations. If a smart meter in the field sends a tamper event or power outage notification, an operator has to take the time to find out why. Was someone tampering with the meter? Is there a problem with the communication network? But if the utility's technology platform is integrated with the work order system, it can see that the tamper alert coincides with a work order to replace that meter – and it will know to ignore the alert.

This is rule-based analysis at the most basic level. The more comprehensive the contextual view of operations, the more complex that rule-based analysis becomes. Once fully integrated across a utility's systems, the right technology will be capable of "predictive operations" – recognizing both events and data patterns happening in the field, and then automatically applying business rules to act accordingly.

The more business rules a utility 'teaches' its technology platform, the more sophisticated the virtual operator becomes. It learns to deal with the vast majority of events, data patterns and alarms, and flags only high-value issues for human operator analysis – resulting in a high IDR for the utility. Thus, predictive operations allow a utility to be *effective*, in that operators are freed up to deal with high-value issues as they arise, and *efficient*, because it can operate effectively with the minimum head count possible.

The Operations Maturity Model

Level 1: Reactive

A utility at Level 1 is drowning in data. It may have spreadsheet farms and multiple databases to house it all, but without a tool to translate that data into useful information, the utility doesn't have much visibility into how well it's functioning. Operations are generally siloed, with separate groups managing the network, the software and the devices in the field, and their operational processes are largely ad hoc.

Level 2: Informed

As a utility builds custom applications to translate its data into usable information, it has greater visibility into its operations. However, as long as it has to actively run reports to get a snapshot of what's going on, it's not making use of the real-time capabilities of a smart grid network.

Level 3: Managed

At this stage, a utility has a functioning network operations center (NOC). Integrated applications correlate events happening on separate systems and provide a real-time view of what's happening on the grid, allowing the utility to develop standard procedures to handle the situations it's observing.

Level 4: Automated

By Level 4, the utility is relying on its software tool to do the vast majority of grid management behind the scenes. With the software using rule-based analysis of events and responding automatically to certain triggers, NOC staff receive more intelligent, high-level alerts and have significantly greater visibility into operations.

Level 5: Predictive

At this point, the utility is operating at peak efficiency; day-to-day grid management is fully automated and minimal staff are necessary for responding to only high-value alarms. The software is essentially a virtual operator and there's an element of 'machine learning and discovery,' meaning the application can not only automatically respond to events, but discern and respond to patterns of events happening on the network.



The benefits of maturity

In addition to a Network Operations Center (NOC) operating at peak efficiency, operations maturity brings added value to the whole business – including optimized operations, maintenance and administration expenditures in supporting the modernized grid. It's also faster to pinpoint and resolve outages, which leads to better customer service and improved CAIDI/SAIDI ratings. A contextual view of operations also results in greater overall system security and helps to identify non-technical losses such as theft. Not to mention the peace of mind that comes from knowing that with a sophisticated virtual operator, someone's always watching your grid.

Your growth plan

Whether you've already deployed your smart grid or are still in the planning stages, take time to consider where on the operations maturity scale your utility falls now. And more importantly, where do you want to be? Depending on the size of your grid and its complexity, you may not need to get all the way to Level 5 to meet your revenue or performance targets.

Next, look at where your greatest weaknesses and opportunities lie, and make a plan to address them. Do you need to restructure your technology support department? Formalize your operating processes? Source an integrated technology platform?

Finally, whatever your next steps, remember that maturing is a process and there will be growing pains along the way – but with a strong focus and commitment to the overall goal, you'll get there!

About the author



As chief technology officer for Bit Stew Systems, **Kai Hui** works to keep Bit Stew's world-leading Grid Director™ platform at the forefront of smart grid technology standards and real-time network operations. His experience as director of technology for the smart metering and infrastructure program at BC Hydro, British Columbia's largest electric utility, informs his current role as a technology vendor.



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Managing a Mobile Workforce with Virtualization

By Michael Murphy

According to the Canadian Association of Petroleum Producers (CAPP), Canada's oil & gas industry supports 550,000 jobs nationwide, and the oil sands alone are forecasted to create 905,000 new jobs by 2035.¹ As the industry continues to grow, the technology that is required to support this growing industry will need to evolve to keep organizations competitive. Implementing solutions that enable mobility for the modern workforce can have many benefits for an organization – including business continuity, employee mobility and increased productivity, supporting a green technology environment and lower operating costs. In today's work situation, not every employee has the luxury to work from a traditional office setting. However, without the traditional walls of a cubicle or office, companies still require all employees to be productive – regardless of where their desk is located.

The 2013 Citrix Mobility in Business Report found that 71 percent of organizations consider their mobility strategy to be either very important or of the utmost importance to their business. The report also found that the ability to work freely anywhere, on any device, is important to employees and beneficial to businesses. More than half of the respondents noted that increased productivity and improved responsiveness to work-related needs as a positive outcome. Robust virtualization solutions enable mobile device management, mobile application management, and mobile data management, and in order to keep up with the rate at which the oil and gas industry is growing, organizations have to consider their employee's needs as mobility expectations change.

To stay ahead of the curve, organizations should look to virtualization solutions, which will allow them to manage and secure data on devices remotely. In the oil & gas industry, these solutions can help mitigate the risks associated with data loss, theft or damage on individual devices, whether it's a senior executive's laptop or a field engineer's smartphone. Furthermore, they enable business continuity as virtualization solutions can reduce interruptions in the field. Desktop virtualization provides remote access to deal with isolated incidents without interrupting the entire chain of business.

For employees, virtualization enables mobility which can lead to increased productivity and cost savings, particularly in a scenario where a shared services model is in place. Many in the oil and gas industry engage in a variety of activities that range from discovering new reservoirs, field development, engineering, drilling, offshore

installations, operations and maintenance, all of which are taking place with staff distributed remotely worldwide. Providing access to relevant information from any device can mean the difference between meeting a deadline or providing crucial information to an employee working onsite at a drilling rig and delivering supplies to a site on time. With the ability to complete a job on time and safely often results in increased job satisfaction and employee retention – both great benefits from a company perspective.

Employees like those in the oil and gas industry often work with applications that require high-performance graphics. These applications often can put a strain on servers and slow desktop workloads. These challenges are solved by Citrix and NVIDIA, a world leader in visual computing technologies. Easy management, business continuity and added security that virtualized desktops bring are extended to graphic - intensive applications and users. With virtualized environments, those in oil and gas based industries can see increased IT staff efficiency and lower costs. In addition, virtualized graphics-intensive desktops and applications gives oil and gas businesses the flexibility to manage its people and operations. Accessible on any device, including tablets, Mac and Windows laptops, the combined solution provides compression and graphics acceleration technologies to optimize professional 3D graphics apps over low-bandwidth, high-latency networks.

Considering the business needs behind why an organization would seek out a virtualization solution, three stand out as the biggest drivers in the oil and gas industry: mobility, security, and business continuity.

Mobility:

The rise of mobile devices in the enterprise is especially significant for the oil and gas industry, making it possible for companies to communicate and collaborate within their organizations and with contractors, business partners and outsourcing providers. However, most 3D applications are Windows-based, optimized for a full-size screen and relying on right-click inputs for full functionality. For tablets to fulfill their potential, they need to be able to provide the full functionality of these apps through touch-screen inputs with a satisfying user experience. By centralizing and virtualizing 3D apps in the datacenter, companies can leverage mobile optimization policies built into the remote protocol to intelligently touch-enable Windows-based application controls. Users gain the ability to use software easily, without the need for source code changes.

Managing a Mobile Workforce with Virtualization

Security:

As organizations expand their collaboration with the adoption of shared services business models across the industry, they need more effective ways to safeguard intellectual property and data across this virtual workforce. Many choose to lock down the corporate network and provide remote access via VPN solutions, but this approach is actually counterproductive, extending the secured network to unsecured remote devices. By hosting apps and workstations in the datacenter, and sending only pixel display data to the endpoint device through a secure remote protocol, they can eliminate the need to poke a hole through the firewall with a VPN.

Business Continuity:

Business continuity is one of the biggest factors in determining the success of an operation in the oil and gas industry. Each minute of oil production represents a considerable amount of money, so lost time comes at a high cost. Virtualization solutions help to avoid interruptions in the fields where complex geographic, climate, connectivity and infrastructure factors come into play. The solutions allow for remote operation without interruption in the worst of conditions so it is possible to manage an operation with alternative solutions as needed.

Early adopters have already been realizing the benefits of virtualization. Now, with recent technological innovations and falling

hardware costs, centralization is quickly becoming a mainstream strategy. Faced with more complete, high-performance and cost-effective solutions than ever, organizations are moving forward and virtualizing their high-end graphics apps as a way to meet the demands of today's business environment. Real-time collaboration, follow-the-sun work cycles and user mobility help companies improve productivity, while the centralization of desktops, apps and data improves security for intellectual property and information.

As the energy and oil and gas industries continue to grow at a rapid pace, business needs are changing and new strategies to stay competitive should be implemented. When it comes to both operational and employee satisfaction, virtualization is one of the best ways to stay secure, mobile and attractive to prospective employees and business partners. It allows organizations to stay 'green' and keep costs down, and overall do their work at a more productive and effective level.

¹ <http://www.capp.ca/library/statistics/Pages/default.aspx>

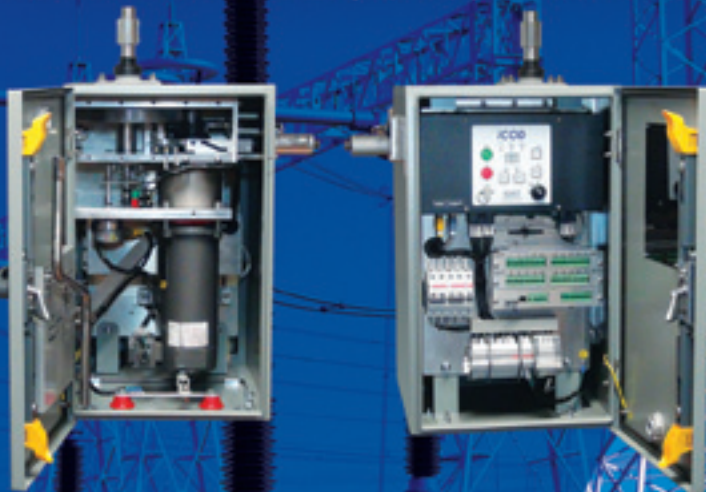


About the author

Michael Murphy is the vice-president and country manager of Citrix Canada, a global company that enables mobile work styles, empowering people to work and collaborate from anywhere.

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The Apple-ization of Smart Submeters

What meter manufacturers have learnt from pervasive consumer technology and how it could benefit your business

By Richard Morgan

One of the quickest ways to raise the eyebrows of today's smart-phone wielding generation is to show them a picture of earliest cell phones from the 1980s. It's easy to forget that these brick-like devices were once the height of innovation, now that so many of us run our personal and professional lives from a piece of kit that is smaller than our hand.

But the pace of change and innovation that has characterized personal mobile technology has been notable in its absence from other areas – and metering energy consumption is one of them. If we look to the installed base of electricity meters across the US, for example, much of the technology dates back to the era of phones shaped like a house brick.

It's not that innovation has been absent from the industry. Far from it! Submeters, like phones, have gotten smart. There have been plenty of advances in the way that data about energy usage is gathered, cleansed, distributed and analyzed to help organizations identify their consumption levels and reduce them accordingly. There is far more opportunity for interaction with that data, and real-time monitoring than the first manufacturers of energy meters could have imagined.

But until now the drive for wider deployment of smart submeters has largely been absent. After all, the US has enjoyed decades of relatively low-cost energy, and in such an environment there is little incentive to reduce consumption. Standard meters have done a perfectly adequate job of measuring consumption for billing purposes and so they have remained in situ.

But that's changing. Rising energy prices are a global phenomenon, and for many organizations they have become a profit-sapping budget line. Reducing energy consumption is a key way of controlling costs and maintaining profit margins in a difficult economic environment.

At the same time there are a number of state and federal directives on carbon emissions and energy consumption starting to emerge. Achieving compliance with these

requirements generally requires a new system or method for energy management to be monitored effectively so that any improvements can be measured and verified.

In the light of these changes, it is becoming clear that the installed meter base is not up to the task. Too many organizations do not have the visibility needed to make useful evaluations about how, when and why they use energy in every part of their business and in every location. They have an overall figure – usually too high for comfort – but not the granularity that tells them why a store in Wilmington uses twice the power as an equivalent outlet in Wichita. Or that an unexpected dip in the South West division's profits is caused by a new maintenance team in Albuquerque leaving the lights on all night.

Equally there is no way of knowing whether reduced power consumption in the Michigan office is due to an energy management program or the late onset of Fall and a delay in switching on the heating system.

Fortunately, the transformation from mechanical meter to smart sub-meter over the past 30 years has been accompanied by similar levels of innovation in meter design, installation and commissioning functions. Not only does the technology now exist to deliver this level of data and analysis to facilities managers, operations managers and heads of finance, it has never been easier to get such technology installed on-site.

So we see sub-meters that are highly modular. Like the old sub-meters they provide the information from individual circuits, so users can distinguish between power used by the chiller cabinet, and that used by the bakery oven for example. But, being modular, they can monitor up to 20 circuits from a single location. Such meters cut down on cabling requirements as there is only one device to connect, they save space and overcome the practical hurdles of retrofitting in cramped cupboard-like electrical rooms, and in a major rollout they can reduce installation time by up to half. For organizations with a geographically dispersed estate, that's a pretty major saving.

The Apple-ization of Smart Submeters

But meters are also being designed with the end-user in mind. So they offer exactly the level of functionality needed for the task, but don't require an advanced degree in engineering to install. Test pages on installation, for example, mean that electricians can tell if the meter is working or not at the time of installation – rather than running remote tests later on. They include phase indicators to make sure the right electrical phase is connected, pulse test functions to check cabling is complete, and an ability to auto-diagnose whether the accompanying current transducers are installed correctly.

But again like the smart phone, the most profound change in metering technology over the past 30 years is that the real value derived from metering hardware, is that it houses incredibly sophisticated software. This software is the real game-changer.

So there are meters that contain data verification algorithms that improve the reliability of the data that they send out. If energy management programs are to be effective they must be based on accurate data that correctly reflects usage patterns. Too often in the past this information has been compromised. With the latest smart sub-meters, data analytics packages are fed only with cleansed, relevant and accurate information.

Equally, meter communications have been transformed in recent years. There is less and less need for proprietary communication protocols, as IP and related standards are included in meter design to make it much easier to interface with energy management software and building control solutions. The wide-scale use of IP also makes it straightforward to access usage information from a web-browser or to transfer data in standard file formats to specified file locations in the existing IT infrastructure.

In other words, innovations in metering technology make it easy to integrate the data analytics and management information they produce with existing business software. For energy or facilities managers trying to convince the CFO of the need for an upgrade, that can be a powerful argument.

It also provides a strong degree of future proofing. With the new innovative meters, upgrades are achieved by updates to firmware rather than replacing meters and changes can be handled remotely. Combine that with a modular design, and it's possible for a store to be refitted or a building to undergo a change of use without re-installing the entire metering base. Instead, the relevant modules can be remotely commissioned or decommissioned to accommodate the new use.

So forget the idea that meters are a complex engineering challenge. That picture is as relevant to today's market as the block-like phones of the 1980s. Smart submeter manufacturers have adopted the consumer technology playbook: get smart, get easy and stay innovative. It's a win-win for them – and a win-win for their customers.

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About the author



Richard brings 13 years of experience in the energy management and submetering world and has been responsible for some of the largest global sub-metering rollouts, successfully installing tens of thousands of sub-meters across numerous continents. After graduating with a major in Energy Management Systems

Richard joined EnergyICT in 1999, quickly progressing to Director level before joining ND Metering Solutions as a Director in 2013.

How Utilities Can Protect the Grid against Potential Outages Due to Extreme Weather Events

By Dave Bryant

Over the past few decades, changes in weather patterns due to climate change or global warming have led to more extreme, frequent, and costly weather events that have included intense rains, ice storms, tornadoes, floods, hurricanes, heat waves, droughts, and wildfires. These events have caused hundreds of major power outages which have closed schools, shut down businesses, impeded emergency services, and cost the economy hundreds of billions of dollars. In an effort to combat the growing problem, many utilities are developing strategies to modernize and 'harden' the electric grid. New initiatives are directing substantial investment to improve the grid's efficiency, capacity, reliability, and *resiliency*. These efforts will not only help make the grid less vulnerable to weather-related outages, they will also help reduce the time it takes to restore power after this number-one cause of outages occurs.

Climate change, more commonly referred to as global warming, is a significant, lasting, and statistically-measurable change in weather patterns that can last from a few decades to thousands of years. It can generally be attributed to variations in solar radiation due to changes in solar output, orbital variations, and atmospheric conditions, among others. Volcanos, for instance, are known to have been a major cause of climate change throughout the ages. In the last several decades, human (anthropogenic) activities have also been associated with climate change. These activities include an increase in CO₂ levels due to fossil fuel combustion, the manufacture of cement, and deforestation. These also include ozone depletion due, in part, to the catalytic effect of man-made refrigerants, solvents, and propellants. While many people feel that anthropogenic influences are negligible, the scientific consensus is that the climate is changing and that human activities are playing a substantial role.



High-capacity ACCC

In Texas, for instance, statistics suggest that severe droughts are several times more likely to occur today than they were in the 1960s due to climate change. Higher temperatures lead to increased evaporation, adding moisture to the atmosphere, which can intensify storms. As the planet's temperature continues to rise and glaciers recede, sea levels are also rising measurably. This is most certainly putting coastal areas and the utility infrastructure at greater risk.

In October 2012, the storm surge triggered by Hurricane Sandy caused record flooding along the coast of New York, New Jersey, and Connecticut. More than 8 million customers across 21 states lost power. Utilities reported damage to more than 15,000 power poles and 7,000 transformers. Following the storm, the city of New York discovered that nearly 40 percent of its transmission substation capacity and more than 10 percent of its large distribution substation capacity is at risk of flooding during extreme weather events.

Nationwide, dozens of major power plants and substations located along the coast are within a few vertical feet of high tide zones. As sea levels continue to rise, the risks to these facilities from storm surges will increase. Though predictions of sea level rises range widely, data compiled by the U.S. National Oceanic and Atmospheric Administration (NOAA) shows that rates of sea level rise have nearly doubled in recent years, suggesting a rise of two to six feet in the next century. With a warmer atmosphere, hurricane and storm rainfall is also projected to increase in certain areas, which is likely to increase runoff and flood risk on riverfront and other low-lying transmission and distribution facilities.

Higher air temperatures can also cause earlier snowmelts which can allow vegetation to become drier sooner, contributing to increased risk of wildfires. According to the United States Geological Service (USGS) the number of substantial wildfires in the Western United States rose from an average of 140 per year in the 1980s to more than 250 per year between 2001 and 2012. Eight of the ten largest wildfires in California's history, in fact, have occurred since 2001. Drier conditions can not only cause wildfires to be more intense, they also tend to spread more widely and do greater damage. Though wildfires can damage transmission and distribution structures (especially wood poles), the greatest risk comes from smoke and particulate matter which can ionize the air, creating an electrical path from the transmission line to ground (structure, adjacent line, etc.) which can cause outages. Particulate buildup on insulators can have a similar effect.



Firestorm damage – ACCC Conductor unharmed



Storm damage – ACCC core remained undamaged

While climate change is increasing the frequency and severity of storms, and causing ice damage and flooding in some areas, rising global temperatures is also causing drought conditions and reduced water supplies in other areas. This has already become a problem for utilities whose generation plants require water for condensing steam and/or cooling, that are located in impacted areas. The problem should not be considered insignificant, as two-fifths of all freshwater consumed in the United States is currently used by coal, natural gas, nuclear, geothermal, biomass, and solar-thermal electric power plants that rely on water for cooling or steam generation to run turbines. A water shortage is not the only problem. Higher in-feed water temperatures caused by climate change can reduce a plant's efficiency and/or capacity, while higher outgoing temperatures can

negatively impact local ecosystems and cause the facility to fall out of compliance with federal or state regulations. When these conditions occur – often during periods of high electrical demand – generation may have to be tapered back or completely shut down.

Higher air temperatures can also impact generation plant efficiency. Thermal generation plants operate most efficiently when the air is cool. When this is not the case, more fuel must be consumed or chillers must be installed, either of which add costs to delivered power. As heat waves brought on by climate change are becoming longer lasting and more frequent in recent years, estimates suggest that existing thermal generation capacity may diminish by as much as 15 percent over the next few decades due to the impact of higher air and water temperatures. According to the NOAA, the past four decades have all been hotter than the twentieth century average, and nine of the ten hottest years on record have all occurred since 2001.

While higher ambient temperature tends to increase consumer demand, a loss of efficiency occurs with transmission and distribution equipment – as well as with generators – as temperatures rise. The efficiency of electrical conductors and transformers used for transmission and distribution, for instance, decrease as temperatures rise. Higher temperatures cause the electrical resistance of the conductive materials to climb. Increased resistance translates into increased line losses which are exacerbated by higher levels of electric current. Line losses are a function of the electrical resistance (R) of the wire multiplied by the electrical current (I) squared (I^2R). While the cost of these losses is generally passed along to the consumer, generation capacity, fuel consumption, associated emissions, and water supply are all 'spent' supporting these line losses.

To protect the electric grid from severe weather events (the number one cause of outages), and ensure reliable delivery in the future, our industry will need to continue to develop and deploy new technologies and business models to support alternative investment strategies. Design standards, inspection methods, and construction guidelines will need to be reconsidered and more efficient means of assessing damage, deploying crews, and retrieving a possibly larger inventory of standardized parts will most surely require consideration. Developing more robust critical infrastructure components such as traffic signals and installing backup generators for key institutions may also prove highly cost effective. Utilities less enthusiastic about employing new technologies may need to rethink the risk-reward equation, and entities that assess new technologies may want to consider ways to fast track their evaluations that can otherwise get caught on academic treadmills.



Sag comparison ACSR and ACCC

A first line of defense has always been to squeeze more out of less. For decades, utilities have found it very advantageous to improve the efficiency of generators to reduce operating costs. More recently, incentives have been provided to inspire consumers to use more energy-efficient appliances and build more energy-efficient homes and work places. These strategies have helped defer additional, more expensive investment in building new generation to support growing demand. The same strategy can be used on the grid itself, where a substantial amount of energy is lost during the transmission and distribution of electricity. A new bare overhead conductor that was initially developed to handle very high levels of current (during emergency conditions) with very low thermal sag due to its hybrid carbon fiber composite core (ACCC) was also found to reduce line losses by 25 to 40 percent or more compared to other conductor types of the same diameter and weight during normal operating conditions. While its high-capacity and high-strength have helped improve grid reliability and resiliency in the wake of several heat waves, storms, fires, and tornadoes, its improved efficiency is also helping reduce fuel consumption and carbon emissions, while ‘freeing up’ generation capacity. Employing energy efficiency measures on the generation side, the demand side, or on the grid itself may offer practical solutions for both adapting to – and mitigating – challenges associated with climate change.

Utilities are taking other steps to ‘harden’ the grid which include building protective sea walls or restoring naturally occurring defenses such as:

- Sand dunes and wetlands
- Elevating or relocating important electrical equipment to protect them from flooding

- Installing smart grid technologies and switches that can redirect power to undamaged sections of line and isolate problem areas
- Undergrounding transmission and distribution lines where feasible
- Reinforcing or replacing above ground poles with more robust alternatives to reduce storm and fire damage
- Improving vegetation management efforts.



Power plant upgrade

As there are always costs associated with these and other options, many alternatives and combinations of these techniques are generally considered on a system wide basis.

To help make the grid more flexible and resilient during heat waves and periods of high demand, a number of utilities and grid operators are also implementing ‘demand-response’ programs, which incentivize commercial and industrial consumers to cut electricity use during periods of unusually high demand. During a record setting heat wave in September 2013, for example, the PJM grid operator used demand-response to curb demand by six gigawatts. This was the equivalent savings of roughly 10 coal-fired power plants, which helped keep the grid stable and air conditioners running when they were most needed.

Utilities and grid operators are also pursuing other approaches to help make the grid more flexible, robust, and resilient by expanding transmission capacity, integrating energy storage, and improving forecasting and scheduling techniques. Adding transmission capacity serves not only to improve grid reliability and efficiency, it can also help reduce congestion costs – allowing the consumer access to the least expensive or cleanest source of power. Also, when a conductor on a section of the grid is replaced with a more efficient conductor, the new conductor serves to reduce ‘stress’ on adjacent sections of the grid to further improve overall grid efficiency.

How Utilities Can Protect the Grid against Potential Outages Due to Extreme Weather Events



Conventional ACSR and modern ACCC conductor

Another important component of reducing the impact of weather related outages and improving grid resiliency – or the ability to quickly restore it following an outage – relates to communication. In many respects, this is where the smart grid strategy comes into play. In many instances, utilities that are faced with storm damage are using data to identify and quickly respond to problem areas in much quicker timeframes with much success. As it relates to reducing the *impact* of weather-related outages, efforts are also being directed to helping customers better understand the nature of outages and how they can best prepare themselves, or secure assistance, when outages occur. Though climate change will continue to increase the frequency and severity of storm related outages, we now have many tools at our disposal to minimize the impact.



About the author

Dave Bryant is director of technology at CTC Global and was one of the original developers of the high-capacity low-loss ACCC conductor and ancillary hardware components. He can be reached at dbryant@ctcglobal.com.

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THE BIGGER PICTURE

BY ALLEN HAJIAN



Electric Power Generation, Transmission, and Distribution and Electrical Protective Equipment Final Rule

An Overview

Occupational Safety and Health Administration's (OSHA) recent revision of the standard for electric power generation and distribution and associated construction will improve workplace safety and health for workers involved in construction and maintenance of all facets of power distribution, including electric power generation, transmission and distribution. This new ruling is a much needed update, which will drive home the need for effective electrical safety work practices. The standard requires better fall protection for workers on poles and towers, personal protective equipment for workers against hazards of shock and arc flash and additional training to avoid electrical hazards for those that may work near power lines.

Risks associated with shock and electrocutions from inadvertent contact with energized parts have long been recognized as a threat to electrical workers. In 2005, OSHA began the rule-making process to update the outdated construction standards (1926 Subpart V), which were last updated in 1972, and the general industry standards (1910.269), which were published in 1994. Through analysis and careful review, OSHA determined that existing regulations did not provide enough protection for employees working in situations that could cause serious injury and death.

The new rule, as with most recent OSHA regulations, is performance-based, and requires employers to perform hazard analysis, train, and protect their employees from the hazards that may be present.

Prior to the updated ruling, OSHA's construction and general industry regulations were not harmonized – and were often contradictory. For example, regulations for fall protection, personal protective equipment for both electric shock and exposure to flames and electrical arc (arc flash), protective grounds and hazard analysis required review, due to contradictory guidelines.

OSHA estimates that these changes will save up to 20 lives and prevent over 100 serious and debilitating injuries per year, likely more. OSHA only investigates circumstances in which three or more employees become hospitalized in the same event. Considering there are hundreds more injuries per year that are not investigated by state or federal regulators, the updated standards will likely prevent more incidents than predicted.

Revisions to the Ruling

In all, OSHA is revising the following regulations in Code of Federal Regulations, Title 29.

- **PART 1910**
 - o *Subpart I – Personal Protective Equipment*
 - *Appendix B to Subpart I of Part 1910 – Nonmandatory Compliance Guidelines for Hazard Assessment and Personal Protective Equipment Selection*
 - o *Subpart R – Special Industries*
 - o *Subpart S – Electrical*
- **PART 1926**
 - o *Subpart A – General*
 - o *Subpart E – Personal Protective and Life Saving Equipment*
 - o *Subpart M – Fall Protection*
 - o *Subpart V – Electric Power Transmission and Distribution*
 - o *Subpart X – Stairways and Ladders*
 - o *Subpart C – Cranes and Derricks in Construction*

The most significant changes are in Part 1910, *Subpart R*, and *Part 1926 Subpart V*. The other parts were revised mostly for clarification or in reference to changes in the aforementioned subparts. Both rulings affect workers in the electric power generation, transmission and distribution industries.



These revisions affect workers in industries involving electric power generation, transmission, and distribution. For example, electric utilities, as well as contractors hired by utilities, are affected. The most interested parties in the rules are in industries involving electric power generation, transmission, and distribution. If the business is involved in constructing, operating, maintaining, or repairing electric power generation, transmission, or distribution installations, then both of these parts will be applicable. For example electric utilities, as well as contractors hired by utilities (primarily classified in the construction industry) are affected. The good news is that OSHA tried to harmonize the two regulations for similar work (i.e. both replacing and upgrading a switch have the same steps even though one is considered maintenance which is regulated under 1910, and one is considered upgrade and is under 1926).

In addition, manufacturing and other industries that own or operate their own electric power generation, transmission, or distribution installations as a secondary part of their business operations will need to carefully review the regulations for applicability to their operations. The line-clearance tree-trimming operations were also included in the scope of the construction standard including requirements for training on hazards of electricity and being able to recognize and avoid energize parts.

However, this is not all encompassing and the regulations and federal register's preamble should be consulted for additional information.

Electric Shock Protection PPE

1910.136, 1910.137 and 1926.97 standard were also updated to performance based as necessary for employee safety, conforming to the latest consensus standards, as were all the rules mention in this article. Since consensus standards are updated much more frequently than regulations, many of the specifics that are in these standards were not included in the regulation, in order to ensure flexibility in compliance. 1910.136, 1910.137 apply to **all** general industries and 1926.97 to **all** construction, even though they were revised under the 'power generation' initiative. Therefore their revisions for electrical protection are applicable to all.

OSHA was concerned that its requirement for electrical footwear may cause the employees to use the footwear as a primary form of protection against electrical shock – which would not provide adequate protection. This lead to the revision of 1910.136 to indicate that the use of electrically protective footwear is limited, as noted in the federal register to:

*"(1) when working in areas where there is a danger of foot injuries due to falling or rolling objects, or objects piercing the sole, or
(2) when the use of protective footwear will protect the affected employee from an electrical hazard, such as a static-discharge or electric-shock hazard, that remains after the employer takes other necessary protective measures."*

Class 00 and non-rubber insulating materials were recognized in 1910.137. Generally voltage-rated gloves can be used without leather protector for dexterity if they are used for next lower class (in case of 00 gloves for 250 volts or less) for which they are designed and there is no possibility of puncture with energized part or damage. However the gloves must be electrically tested before they are used again. Objections to this requirement were rejected by OSHA, primarily since the consensus standard also contains this provision.

Electrical Work Practices

As previously mentioned Subpart V (construction) was revised to match those of general industry regulations and the new regulations have similar heading and break down of the requirements throughout. Briefly, the new rule:

1. *Adopts a requirement that employers determine the degree of training by the risk to the employee*
2. *A new paragraph added to require employers to train qualified employees to recognize electrical hazards and to control or avoid them.*
3. *The existing requirement for employers to certify that they trained employees has been replaced with a requirement for employers to determine that employees demonstrated proficiency in the work practices involved. In addition, a new note added to clarify how training received in a previous job would satisfy the training requirements.*
4. *A new paragraph added to require training for line-clearance tree trimmers.*
5. *A new paragraph added to require host employers and contract employers to share information on safety-related matters.*
6. *A new requirement added to ensure that employers provide the employee in charge with information that relates to the determination of existing characteristics and conditions which he can discuss with others during the job briefing.*
7. *The existing requirement revised to require the employer to be able to demonstrate that it maintained ventilation long enough to ensure that a safe atmosphere exists before employees enter an enclosed space.*



8. *The final rule revises, and requires the employer to establish, minimum approach distances that employees must maintain from exposed energized parts.*
9. *OSHA revised the existing requirements to ensure that employees use electrical protective equipment whenever they can reach within the minimum approach distance of an energized part.*
10. *OSHA revised the requirements on clothing in existing § 1910.269(l)(6)(ii) and (iii) to require the employer to protect employees from electric arcs. Existing paragraph (l)(6)(i) redesignated as new paragraph (l)(7), and the new protective clothing and other protective equipment requirements added as paragraph (l)(8).*
11. *The existing provision revised to require independent crews to coordinate energizing and deenergizing lines and equipment. A new paragraph has been added requiring multiple crews to coordinate their activities under a single employee in charge and to act as a single crew.*
12. *The existing requirement revised to allow, under certain conditions, insulating equipment, other than a live-line tool, to place grounds on, or remove them from, circuits of 600 volts or less.*
13. *OSHA added appendix E containing information on protecting employees from electric arcs.*
14. *OSHA added a new appendix containing guidelines for the inspection of work-positioning equipment.*

Below, we will discuss some of the more impactful revisions. These are host-contractor relationship, fall protection, approach boundaries, grounding at less than 600 volts and arc flash protection.

Host/Contractor Relationship

The owner/operator is required to notify contractors, even if they are not directly hired by the owner, as to the specifics regarding construction, operation, and hazards of the system on which the contractors will be working. The contractor is also required to divulge any hazards that he may bring on site or may create while working. Owner/operators are required to give a job briefing prior to each shift; one person must be identified as the 'leader' of all activities performed by each person on site, regardless of their employer.

Fall Protection

A personal fall arrest system (fall protection) is required if the employee is working at higher than 4 feet. Starting April 1, 2015, the standards require 'qualified employees climbing or changing location on poles, towers, or similar structures to use fall protection, unless the employer can demonstrate that climbing or changing location with fall protection is infeasible or would create a greater hazard than climbing or changing location without it. According to the standard, a personal fall arrest system may be work-positioning equipment, a fall

restrain system or other fall protection meeting *Subpart D* of OSHA's general industry standards or *Subpart M* of OSHA's construction standards, as applicable.'

Minimum Approach Distances

Approach boundaries or minimum approach distance analysis is required using either formulas or tables in the standard. The system voltage, maximum transient overvoltage (from engineering study or table in Appendix B), and altitude must be known. Appendix B of 1910.269 has the work practices on working on energized parts and paragraph 'III. Determination of Minimum Approach Distances for AC Voltages Greater Than 300 Volts' has the detailed guidance in this regard. OSHA offers (https://www.osha.gov/dsg/power_generation/index.html) an easy to use calculator for determining phase-to-phase and phase-to-ground minimum approach distance.

Grounding

Application of grounds to the de-energized parts over 600 volts will continue to require live line tools. However, the standard allows application of ground to equipment that operates at 600 volts or less without live line tools under certain conditions. First, the employer must be able to show that the equipment remains de-energized during the installation of grounds. Secondly, the application of grounds must be carried out with proper shock and arc flash protection. One way employers can prove that the equipment remains de-energized is to ensure the lockout tag out steps are completed and maintain the connection between the test equipment and the part being grounded throughout the grounding process. This will verify absence of voltage while the employee is installing grounds without live line tools on equipment operating at less than 600 volts.

Arc Flash Hazard Determination and Protective Clothing

The new requirements mandate that arc flash protection, which OSHA refers to as protection from 'flames and electric arc,' be in place by April 1, 2015. The standard requires hazard analysis and engineering studies to determine the level of hazard and clothing required to protect the employee from burns.

In 1994, OSHA recognized that flames and arcs were a hazard that could cause serious injury and death to employees. However, it did not have enough information regarding protection methods, in order to require personal protective equipment. Instead, OSHA decided to limit harm to employees from meltable and flammable clothing; thus prohibited these materials from being worn when working on or near energized parts. Over the past two decades, several new methods of quantifying potential hazards have been discovered. Additionally, flame and arc resistant clothing have become more pervasive in the market.



During the evaluation period, OSHA analyzed several calculation methods, at various voltages, current, clearing time and working distance. OSHA created a table highlighting where each of these calculation methods are most accurate. Now, OSHA provides tables of incident energy based on voltage, current and clearing time of the protective device and determined the incident energy at a working distance of 15 inches, as displayed in the tables below.

Table 3 from 1910.269 Appendix E

Table 3—Selecting a Reasonable Incident-Energy Calculation Method¹

Incident-Energy Calculation Method	600 V and Less ²			601 V to 15 kV ²			More than 15 kV ²		
	1Ø	3Øa	3Øb	1Ø	3Øa	3Øb	1Ø	3Øa	3Øb
NFPA 70E-2012 Annex D (Lee equation)	Y-C	Y	N	Y-C	Y-C	N	N ³	N ³	N ³
Doughty, Neal, and Floyd	Y-C	Y	Y	N	N	N	N	N	N
IEEE Std 1584b-2011	Y	Y	Y	Y	Y	Y	N	N	N
ARCPRO	Y	N	N	Y	N	N	Y	Y ⁴	Y ⁴

Key:

- 1Ø: Single-phase arc in open air
- 3Øa: Three-phase arc in open air
- 3Øb: Three-phase arc in an enclosure (box)
- Y: Acceptable; produces a reasonable estimate of incident heat energy from this type of electric arc
- N: Not acceptable; does not produce a reasonable estimate of incident heat energy from this type of electric arc
- Y-C: Acceptable; produces a reasonable, but conservative, estimate of incident heat energy from this type of electric arc.

Table 6—Incident Heat Energy for Various Fault Currents, Clearing Times, and Voltages of 4.8 to 48.0 kV: Rubber Insulating Glove Exposures Involving Phase-to-Ground Arcs in Open Air Only^{1,2}

Voltage Range (kV) ²	Fault Current (kA)	Maximum Clearing Time (cycles)			
		4 cal/cm ²	5 cal/cm ²	8 cal/cm ²	12 cal/cm ²
4.8 to 15.0	5	46	58	92	138
	10	18	22	36	54
	15	10	12	20	30
	20	6	8	13	19
15.1 to 25.0	5	28	34	55	83
	10	11	14	23	34
	15	7	8	13	20
	20	4	5	9	13
25.1 to 36.0	5	21	26	42	62
	10	9	11	18	26
	15	5	6	10	16
	20	4	4	7	11
36.1 to 48.0	5	16	20	32	48
	10	7	9	14	21
	15	4	5	8	13
	20	3	4	6	9

Notes:

¹This table is for open-air, phase-to-ground electric arc exposures. It is not for phase-to-phase arcs or enclosed arcs (arc in a box).

For reference, the calculations are for ‘arc in the open,’ which would be appropriate if the arc is located in an overhead line, where the energy and flames can go in all directions and mostly away from the employee. However, for arc inside tunnels and vaults, on front or under the distribution equipment, which is considered ‘arc in a box,’ the tables are no longer accurate. The incident energy as it appears in Table 6 is under-estimated by greater than 2.5 times. For example, to protect from 12 cal/cm² flashes one could wear commercially available flame resistant head/face/hand protection and shirt and pants with a rating of 12 cal/cm². However, an arc in a box would be 30 cal/cm² or more which would require switching hood and what is commonly known as a switching suit, rated at 40 cal/cm²

The standard does not require protective clothing when the incident energy is less than 2 cal/cm², its reason being that untreated natural fiber will protect some level of protection down to 1.2 cal/cm² which is the threshold for second degree burn. Other standards do not agree and use 1.2 cal/cm² as a minimum, above which protective clothing is required. It is believed that the future consensus standards will require protective clothing of 8 cal/cm² whenever the exposure to energized parts of greater 50 volts is possible.

Conclusion

The final rule becomes effective on July 10, 2014. The compliance deadline for some provisions on fall protection, minimum approach distances, and arc-flash protection is April 1, 2015. This ruling will improve workplace safety and health for workers that are involved in construction and maintenance of all facets of power distribution as well as those in general industry with similar operations. Many thanks to OSHA for continuing to champion measures to better protect the men and women who work on or near electrical power lines. There is much more to do, but this ruling should put the industry on a path to safer working conditions.

ABOUT THE AUTHOR

Allen Hajian, CSP CHMM is the director of safety and environment for the Schneider Electric Services organization for North America, across all of Schneider Electric's business units. He and his team manage all aspects of safety and environment for the Services organization, which is about 5,000 employees strong. Hajian is a graduate of the University of Florida and has over 25 years of experience.

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By Siobhan MacDermott, CISO, Utilidata

SECURITY SESSIONS

Smart Grid: The Showdown at Credibility, Privacy and Security Gap

Smart meters are the devices at which individual electric power consumers will interact with utility suppliers on the proposed American smart grid. When Craig Miller, an energy consultant who works on creating the smart grid, introduced himself to a Pennsylvania utility lineman, he got an unpleasant surprise. “Smart meters,” the man informed Miller, “are a plot by Obama to spy on us.”

For a smart grid advocate like Miller, it was a painful encounter. Miller is among those who believe the smart grid is absolutely necessary to take the nation's energy industry well into the twenty-first century. Among other things (Miller and others say), the smart grid will be an essential to enable utilities to meet increasingly complex power demand, identify and repair problems faster, work with consumers to lower their electricity bills, and reduce the environmental impact of electricity production. Yet even the most ardent advocates are coming to realize that they have to take smart grid privacy and security concerns seriously. Put most simply, the old power grid was dumb – in the sense of silent. Via the smart grid, households talk – to the utilities and, potentially, to any number of third parties. What do they say? What do they reveal? And who is listening?

Level of Concern

In November 2010, AT&T commissioned the Ponemon Institute to conduct a survey of 25,000 U.S. adults concerning ‘Perceptions about Privacy on the Smart Grid.’ The report found ‘consumers... equally split about the affect the smart grid will have on the privacy of their energy consumption records. Thirty-nine percent of respondents believe the smart grid will diminish their privacy. Twenty-four percent... are unsure as to the impact

and 37 believe it will not impact or improve their privacy.’ Most significant was that among respondents who professed to know the most about the smart grid, concern about privacy was the highest. Their greatest concern was the misuse of personal information by the government and by third-party companies, which might fail to protect their personal information.

What Is the Smart Grid?

The U.S. electric power grid is the interconnected network of power plants, transmission lines, substations, transformers, and other equipment that delivers electricity to homes and businesses. Its construction dates from the early twentieth century, long before the digital age, and, therefore, most of it is a one-way power transmission system. The advent of the Internet and associated digital communication devices has made it possible to transform this one-way delivery system into an interactive system, in which (according to EEI, a power industry advocacy organization) ‘telecommunications and information technology infrastructure’ will monitor energy usage, supply, and demand to make the system ‘more reliable by automatically taking actions to help reduce service disruptions – or to minimize the effect of disruptions when they do occur.’ Additional benefits claimed for the smart grid are reduced ‘need for electric companies to build more power plants’ and reduced costs to consumers. The installation of digital smart meters, which provide two-way communication between customers and electric companies, will (it is claimed) ‘allow customers to better understand their electricity usage and to manage their electric bills more effectively.’ Yet another consumer-oriented feature, promised for the smart grid is the ability of users who have their own generating capacity—solar, wind, biomass – to sell surplus power back into the system.

SECURITY SESSIONS

Although electric utilities are the principle advocates for the smart grid, the technology has the support of the federal government via the Energy Independence and Security Act of 2007, which was enacted as Public Law 110-140 on December 19, 2007. By 2009, the U.S. smart grid industry was valued at about \$21.4 billion and by 2014 is expected to hit \$42.8 billion. Although various utilities have rolled out portions of the technology – including the installation of some 15 million smart meters – the conversion to a large-scale smart grid in the United States and elsewhere is still in its early stages. An extensive pilot project in Fayetteville, North Carolina, does provide a glimpse of what a fully developed smart grid may look like. The pilot project claims the ability to monitor and manage more than 250 individual ‘devices’ within each customer’s home. Such management includes the ability to ‘selectively’ reduce demand among its 80,000 customers by turning off devices in homes that are part of the smart grid program.

An Inventory of Risks

Those skeptical about or frankly opposed to smart grid technology assert two categories of risk – security and privacy.

Security Risks

Although the present-day U.S. power grid is not yet a smart grid – not yet extensively interactive – its operation does nevertheless depend heavily on the Internet. All aspects of electric power, from generation to distribution, are computer controlled. SCADA (Supervisory Control and Data Acquisition) systems remotely manage generating, buying, selling, and transmission of electric power. These systems are intensively networked via the public Internet, sometimes wirelessly. This interface between cyberspace and physical space – an ‘Internet of things’ – is vulnerable to attack by hackers who may be criminals, terrorists, or agents of foreign governments and militaries. Richard A. Clarke is just one of many security experts who have identified the power grid as a major national security vulnerability. “The... designers of the electric power grid... didn’t think about people... turning their systems into weapons... The easiest thing a nation-state cyber attacker could do today to have a major impact on the U.S. would be to shut down sections of the Eastern or Western Interconnects, the two big grids that cover the U.S. and Canada” (Richard A. Clarke, *Cyber War: The Next Threat to National Security and What to Do about It*).

The smart grid would use the Internet far more intensively than the already vulnerable ‘dumb’ grid. In July 2013, the Department of Homeland Security reported that “the number of cyberattacks against the energy sector rose to 111 incidents during the first half of 2013, compared with 81 incidents for all of 2012.” The smarter the grid becomes, the more attractive – and vulnerable – it may appear to would-be attackers. After all, if each smart meter communicates with the grid, potentially any smart meter may be hacked and hijacked as a route of attack.

Privacy

The digital infrastructure at the heart of the smart grid will tell consumers a great deal about their daily energy use, not just in the aggregate, but on the level of each individual appliance. The benefits of this, as pointed out, are greater user control over energy costs and, for society as a whole, more efficient electricity generation that will significantly reduce greenhouse gas emissions. The downside is that the home – traditional bastion of personal privacy – will be in continuous automatic communication with utility companies and exposed to third parties to an unprecedented degree. The granularity of the information communicated, while potentially helpful to the consumer, will be highly revealing to whatever individuals and entities receive or intercept it.

On October 25, 2013, the National Institute of Standards and Technology (NIST) issued its first draft *Guidelines for Smart Grid Cybersecurity*, volume 2 of which specifically addresses *Privacy and the Smart Grid*. Key issues raised include:

- Specific ‘appliances and generators may potentially be identified from the signatures they exhibit in electric information at the meter... This more detailed information expands the possibility of intruding on consumers’ and other individuals’ privacy expectations.’
- Smart meters ‘and associated devices and technology will result in the collection, transmittal and maintenance of personally identifiable data related to the nature and frequency of personal energy consumption.’
- Based on smart meter data, ‘behavioral inferences... can be drawn’ concerning members of a particular household.
- ‘Smart meter data also raises potential surveillance issues relating to the methods by which the data is collected and transmitted (electronic collection transmittal rather than manual meter reading and compilation).’
- As ‘Smart grid technologies collect more detailed data about households, law enforcement requests to access that data for criminal investigations may include requests for this more detailed energy usage data.’ (There is ample precedent for law enforcement use of electricity consumption data in criminal investigations, as in *Kyllo v. United States*, 358 533 U.S. 27 (2001), in which the government used monthly electrical utility records to develop a case against a suspected marijuana grower.)

Two monitoring issues raise even more complex privacy concerns:

- Most smart meters transmit their data wirelessly. Some are equipped with a second radio intended to enable a Home Area Network (HAN). If the HAN is enabled by the utility, it will allow continuous real-time polling of energy use. The intention is to feed an in-home display for use by the consumer; however, the HAN could conceivably be monitored by third parties (such as law enforcement) to provide a real-time picture of electricity usage on an appliance-by-appliance level, thereby providing a high degree of covert surveillance.

- An area of special concern is the smart grid monitoring of electric and hybrid-electric vehicle charging. Geolocation data will certainly be collected and recorded in this process. With this, it will be possible to determine when a vehicle was charged (and therefore present) at a particular residence or other charging station location. Researchers at the MIT Geospatial Data Center have posed the following privacy-related questions: (1) “Will a charging vehicle’s location be shared with the utility operator?” and (2) “In ‘authenticating’ charged vehicles for billing purposes, will the authentication scheme... address the privacy and security issues?” We would add, would geolocation data be available to third parties, such as advertising networks, marketers, law enforcement, private investigators, or media organizations? And will it be vulnerable to illicit interception by criminals or espionage agents?

Depending on the individual consumer’s contract with the utility, smart metering may allow the utility to restrict or automatically disconnect certain household appliances at specified times or during periods of high electric demand. How intrusive will this be? What safeguards will exist – for the use of in-home medical devices, for example, such as dialysis equipment? To what degree will the consumer be able to override automatic scheduled or non-scheduled shut offs? And will landlords who participate in a utility load-management program have authority to disconnect tenant appliances at will?

Finally, the IT researchers pose other privacy and security questions well worth asking. Among these are:

- What happens when a smart meter detects a meter bypass? ‘While this technology will reduce theft, will it produce false positives and expose innocent individuals to possible fines or criminal proceedings?’
- ‘Will data collection and communication be secure? Will the utility develop proper policies and procedures for maintaining data privacy?’
- With regard to in-home devices (such as HANs), intended to communicate usage data to the customer, “Will these devices also share data with third parties, and if so, on what basis?” Will such third-party sharing require the customer’s consent? Additionally, will energy-related information accessible to the customer (via a user name and password) be kept secure? Or can it be readily captured by third parties?
- Will smart grid fault detection systems ‘have access to personal information regarding electricity use in real time, without direct interface with the consumer?’
- Will smart grid load management systems give generators ‘direct access to electricity demand information, and if so, could individual household electricity be discernible?’

- When smart grid data is used to monitor ‘distributed’ or ‘on-site’ generation (such as individual solar, wind, or biomass systems), will customer information and transactions – as when the customer provides power back to the grid – be kept private and secure?

Credibility Gap

Clearly, the work of safeguarding the security of the smart grid and the security and privacy of data on the smart grid must be a collaborative effort of the utility industry and the government. Such an effort is possible and even feasible, but is it likely?

We have doubts and concerns.

As Richard A. Clarke (cited earlier) and others point out, the security of the existing “dumb” power grid remains inadequate and has been inadequate for a long time. As for the privacy and security of consumer information on the Internet, the private sector – e-commerce providers, advertising nets, advertisers, and marketers – have been steadfastly resistant to government regulation and have provided transparency and control to consumers grudgingly, if at all.

As for the U.S. government, its approach to regulation has been gingerly at best, and such recent events as the Snowden revelations concerning the omnivorous surveillance practices of the NSA and other U.S. (and British) intelligence agencies have opened up a ‘credibility gap’ possibly even wider – and apparently even more thoroughly institutionalized – than what existed during the administrations of Lyndon B. Johnson (the Vietnam War) and Richard M. Nixon (Vietnam and a host of White House criminal misdeeds).

The real crisis presented by the emergence of the smart grid may actually be less an issue of endangered security and privacy – though these dangers are certainly real and significant – than a crisis of public faith in the motives of companies and, even more, of government. As a result of this crisis of credibility, the development and deployment of the smart grid, with all the benefits it does offer, may be retarded and/or curtailed. If it is, Americans will be deprived of an important modernization of our obsolescent infrastructure.

There is no question that protecting the security and the privacy of a smart grid will require not only collaboration between private industry and the government, but the passage of laws and regulations with teeth. In the current landscape of justifiable cynicism and outright distrust, the credibility gap will almost certainly discourage and impede both the necessary legislation and the further development of smart grid technology.

SECURITY SESSIONS

ABOUT THE AUTHOR

Siobhan MacDermott, CIPP/IT, CIPM is one of the foremost experts on the future of the Internet, cybersecurity, privacy, and business-government relations globally. MacDermott is currently Chief Information Officer at Utilidata, a digital technology company providing solutions for electric distribution grids.

As both advisor and executive to some of the best global technology brands, she helped direct strategy, communications, investor relations, government relations, issue management and policy for companies such as Intel-McAfee, AVG Technologies, Oracle, HP, RSA Security, Betrusted and Sprint PCS. She has experience working global policy issues, and has worked extensively with Boards of Directors to lead successful initiatives to engage governments, stakeholders, policymakers, NGOs, and global institutions on regulatory issues. She has created

and executed successful communications strategies to shape policy outcomes in China, the U.S. and the E.U.

She is widely published, appears frequently in the media and speaks at conferences around the world – working with and participating in the World Economic Forum and the Clinton Global Initiative. She has authored white papers and articles on privacy, children's safety, consumer dynamics, cyber security and critical infrastructure protection.

Ms. MacDermott is an EU and U.S. citizen, has worked on four continents and speaks five languages. She has an MBA from Thunderbird, and a Global Master of Arts in Law and Diplomacy from the Fletcher School at Tufts University and advises and serves on several Board of Directors.

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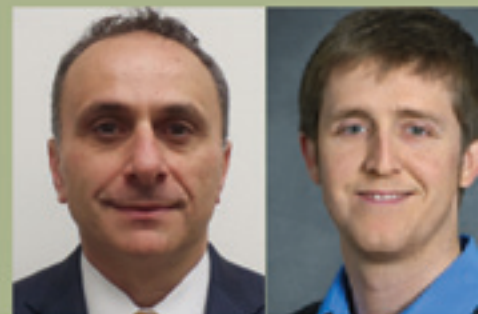


Latest Auto DR Platform Empowers Customers

New Energy Market Incentives
& Advanced Management
Opportunities

By Robert Nawy and Jason MacDonald

Guest Editorial ▶



Introduction

The new, highly-secure automated Demand Response (DR) platform, OpenADR 2.0b, opens up the next generation of markets for DR and energy market program participants. Recent OpenADR 2.0b pilots focused on Ancillary Services, including Synchronous Reserve and Regulation, at PJM Interconnection, LLC eclipses historical viewpoints that DR may not be relied upon to deliver the easily measured and verified performance required in the small intervals necessary for program participants to receive best treatment valuation and market incentives. The pilots have shown that DR resources show great promise as a provider of ancillary services.

Changing supply paradigm and new regulations requires new resources!

EPA driven coal plant shuttering, nuclear energy facility closures, shale production, and related energy market price reductions all coupled with unpredictable climate create the need for critical planning by grid operators to meet ever growing and changing energy supply needs. The OpenADR 2.0b pilots successfully demonstrate that proactive demand and load management may be relied upon as an efficient and cost effective method of meeting today's changing supply, regulation and price reductions.

What is OpenADR 2.0b?

OpenADR is a standardized method for electricity providers and system operators to communicate DR signals with each other and with their customers using a common language over any existing secure IP-based communications network, such as the Internet. It is designed for sophisticated devices supporting most DR services and markets, with flexible capabilities for generating past, current, and future data reports.

Characteristics of the 'New DR'

'New' DR programs are more granular in several ways:

- Some existing programs are locational forms of Emergency DR Programs. These programs, enabled by GIS systems, permit a utility to 'turn-off' participants located on an overloaded feeder line, rather than turning off program participants throughout their operating area.
- New DR programs, enabled by the new OpenADR 2.0b autoDR standard, enables programs to be called piecemeal or incrementally – some examples include:
 - i) A shed request might be for twenty percent (20%) against a committed shed level
 - ii) Setting a thermostat controlling a HVAC up three (3) degrees on a hot day
 - iii) Dispatching participants in certain ancillary services programs, described in more detail, below.

In each use case listed above, the 'new' DR programs provide participants new monetization incentives too, often at minimal inconvenience to the facility, while enabling continued evolution of grid reliability and stability. The protocol pilots have successfully demonstrated the ability to make demand side load available in an efficient and cost effective manner for a variety of markets such as:

- Capacity
- Energy

And further enable such ancillary services as:

- Regulation
- Synchronous Reserves

Over the past year, the company participated in and led trials of the use of OpenADR 2.0b in certain ancillary services programs. The results and 'lessons learned' from that trial are discussed in the rest of this article.

2013 to 2014 OpenADR 2.0b Pilot at PJM Interconnection, LLC

IPKeys announced in April 2014 the successful conclusion of multi-phase pilots at PJM Interconnection over the course of the last year for Ancillary Services (Synchronous Reserve and Regulation) utilizing its OpenADR 2.0b certified Energy Interop Server & System server and end point hardware. The pilot participants – Walmart, PJM, Lawrence Berkley National Laboratory (Berkeley Lab), and Schneider Electric – succeeded in showing the technological feasibility of using the OpenADR 2.0b profile in the field for ancillary services and regulation signaling.

Walmart provided a signaling test bed at one of its 24x7 Super Centers in Pennsylvania as part of the pilot's synchronous reserve (SR) phase. This involved translating the PJM SR web service signal into an appropriate OpenADR 2.0b service message to successfully control a series of lighting and HVAC loads via Walmart's Building Management System (BMS) solution.

According to the author;

This highly secure technology enables energy consumers such as Walmart to receive actionable open standard and machine interoperable market signals directly from ISO's and begin the process of automating participation in ancillary services and other rapid response markets, reduces risks associated with the wholesale market and empowers participants to focus on realizing value.

In the regulation phase of the pilot program, funded by the U.S. Department of Energy's Office of Electricity Delivery and Energy Reliability, Schneider Electric provided a signaling test bed in its variable frequency drive (VFD) laboratory in Raleigh, NC. Work in this project phase concerned translation of the PJM regulation signal into the appropriate OpenADR 2.0b web service messages. Schneider Electric also monitored its ability to track both the various PJM test regulation signals as well as its ability to convey the regulation signal via both XMPP and HTTP Internet protocols.

"We have demonstrated that it is possible to perform four second regulation using secure web services – this capability dramatically reduces the cost and complexity barriers for loads to participate in regulation markets when compared to dedicated DNP3 or ICCC links," said Jim Boch, Senior Electrical Engineer and EISS™ product manager.

"The team's end-to-end demonstration has shown that the open signaling architecture is fast enough to satisfy the timing requirements of PJM's ancillary services," said Jason MacDonald, Senior Scientific Engineering Associate at Berkeley Lab. "This demonstration shows how easily resources can connect to various markets when they are enabled with OpenADR clients."

"PJM is pleased to have participated in this innovative pilot project for automated demand response," said Sarah Burlew, Manager of Applied Solutions. "For PJM, one of the key elements of this project is its incorporation of secure communications, which is critical to protecting and maintaining a reliable grid."

The technical setup and business outcomes of the pilots is described in the sections following, below.

Technical Description – OpenADR 2.0b Pilot at PJM Interconnection, LLC¹

Synchronous Reserve Test Setup

The synchronous reserves tests were performed in October 2013 and included the company's end-to-end tests in April 2014. The participating retail store was a Walmart in Pennsylvania. Roof top air conditioning units and interior lighting were shed in response to a test reserves call from PJM. The signals were comprised of instructions to shed different levels of load corresponding to the shedable load of the two subsystems under control. The signaling architecture is shown in Figure 1.

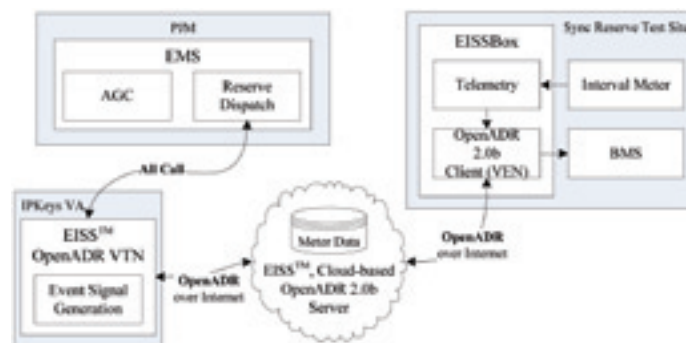


Figure 1: Synchronous Reserve Test Setup

Frequency Regulation Test Setup

The frequency regulation tests were performed with a VFD-retrofitted heat pump supply fan that cools a small laboratory at a Schneider Electric facility in North Carolina. The VFD can drive a previously constant volume fan within a range of ± 5 hertz in 0.5 Hz steps. To run the tests, normalized regulation signals were sent via OpenADR 2.0b and translated into the frequency range in which the device operates. In this scenario, the model for translating the frequency range resides in the EISSBox, although for scalability the control logic should be migrated to the PLC or ultimately a BMS for a true deployment in a commercial building. Additionally, the controller is open loop with respect to its objective, power.

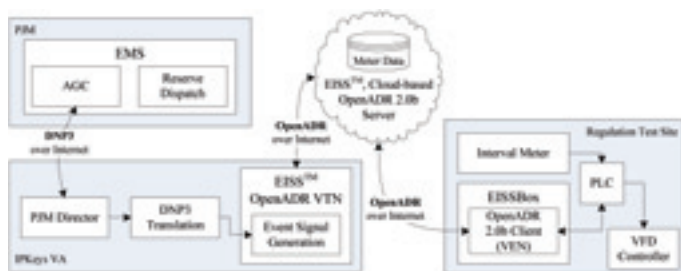


Figure 2: Frequency Regulation Test Setup

Business Impacts & Market Value Capabilities that OpenADR 2.0b Provides

***Synchronous Reserves appears to be a better option than most traditional DR programs as long as the building management system is capable of receiving a response request and shedding load within the ten minutes required.

***Regulation Participation in PJM markets is valuable for resources that have the control and metering capability to perform two second regulation whereby the signal is sent every two seconds. There is a ten second lag before response is required.

PJM splits its Synchronous Reserve Market into two tiers:

Tier 1 reserves are those that result from economically dispatching generation at levels less than their rated capacity. Tier 1 resources are not paid for their capacity, as they have no lost opportunity cost; however, they receive a premium on the price of energy they supply during reserve events.

Tier 2 resources are those resources that are dispatched for energy at a sub-optimal level in order to maintain adequate reserve in the system. These resources do have a lost opportunity for supplying energy and are thus paid a capacity price that is equivalent to the largest opportunity cost payment of all such resources, termed the market clearing price (MCP).

Demand Response is considered a Tier 2 resource, although it does not have an opportunity cost in the same way a generator might. Thus a DR resource relies on other, more traditional Tier 2 resources to set the market clearing price for synchronous reserves.

To get a sense of the range of prices for synchronous reserve, analysis of historical data may be useful.

Table 1 displays market clearing price statistics for synchronous reserves in PJM's Mid Atlantic Reserve Zone in 2013 taken from publicly available data.²

The data suggests that if a demand response resource were available for all hours of a month, then the resource may expect to capture \$2.24 per kW of DR capacity per month. However,

the spinning reserve MCP is the most uncertain of the Ancillary Services (AS) prices in PJM, as evidenced by the very large standard deviation and the fact that 54 percent of hours recorded a market clearing price of zero. A more thorough analysis would consider only the value during the hours in which a DR resource is available to shed load, such as during business hours for lighting and HVAC in a retail store. This value is also only inclusive of the capacity value of providing SR, this does not include the value of the energy provided when called, which is paid at the locational marginal price plus \$0.05/kWh.

Table 1. Market Clearing Price Statistics for PJM AS in 2013

Units = (\$/MWh)	Average	Std Dev	Min	Max	MCP = \$0
MCP for Synchronous Reserve*	3.06	8.83	0.00	210.07	54.0%
MCP for Capacity (Regulation)	24.02	28.74	0.00	756.05	0.1%
MCP for Performance (Regulation)	4.12	2.52	0.00	29.14	2.5%

* For PJM Mid Atlantic Reserve Zone Only

In addition to the value available for SR:

Table 1 also contains data pertaining to the value of regulation during 2013. The average market clearing price suggests that the capacity value to a resource that can provide regulation for all hours of the day is approximately \$17.5/kW-mo. This is considerably higher than the value of SR and the clearing price has less uncertainty with very few hours in the year clearing at \$0/MWh. Additionally, resources earn revenue from their performance each hour, which is tied to the market clearing price for performance. The nearly order of magnitude difference in the value of regulation suggests that resources that have the control and metering capability should give significant consideration to participation in regulation in PJM's markets.

Energy Impacts: Frequency and Duration of Events

A common concern of potential demand response participants in ancillary services markets is what impact participation will have on their operations. One way to examine this would be to consider the frequency or probability to be called in any hour as well as the duration of response required.

In SR, participants who have bid into the market are paid to stand by. Historical SR data from the last five years suggest that on average, PJM makes SR calls in their Reliability First Corporation Reserve Zone an average of 31 times per year, with a range of 19 to 39 reserve deployments per year.³ This corresponds to a roughly 0.4 percent probability that awarded capacity will be called in any given hour. Additionally, the average duration of events in these five years was 11 minutes and 18 seconds, with a standard deviation of the sample around 7 minutes. The minimum duration was 4 minutes and the maximum was 1 hour and 8 minutes. These statistics suggests that 80 percent of reserve calls in PJM are less than 20 minutes in length.

This makes the SR market in PJM look much less impactful than traditional emergency demand response programs that typically have 2 to 4 hour response durations and can be called for upwards of 100 hours per year.⁴ In terms of impact to building operations, Synchronous Reserve appears to be a better option than most traditional DR programs as long as the building management system is capable of receiving a response request and shedding load within the ten minutes required – capabilities that OpenADR 2.0b provides.

Conclusion

Demand response resources show great promise as a provider of ancillary services. The present work and pilots describes a battery of tests that show adequate capability of HVAC and lighting loads to provide ancillary services in the PJM Interconnection territory. The synchronous reserve test displayed noticeable load sheds for both the lighting system and the HVAC system within a few minutes of receiving the signal. For both load drops, the response was much faster than the ten minutes required by the synchronous reserve product definition.

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ABOUT THE AUTHORS

Robert Nawy is the Managing Director & Chief Financial Officer of IPKeys. He has served in these roles since the inception of the company 2005 and oversees the development and delivery of Municipal and Smart Grid products and services. He currently serves on the Boards of Directors of the Open Automated Demand Response (OpenADR) Alliance and the Advanced Energy Management Alliance (AEMA).

Mr. Nawy also served as CFO & VP Business Development of Exenet, the first Application Infrastructure Provider ('AIP') and as CFO of Maden Technologies, a DoD focused high technology services provider.

Additionally, with an MBA, CPA and Civil Engineering credentials from Rutgers University, Mr. Nawy oversees all internal Corporate Services functions of IPKeys and has successful capital raising, merger and acquisitions, strategic partnership and solution implementation and delivery experience in evolving IP technologies in the commercial sector. His previous assignments include CFO at Stronghold Technologies, a publicly held technology company that created the first wireless CRM solution for the automobile retail industry.

Jason MacDonald, a Senior Scientific Engineering Associate at Lawrence Berkeley National Laboratory, has focused his career in distributed energy resources. As a member of the Grid Integration Group in the Environmental Energy Technologies Division at LBNL, Jason researches fast, automated demand response for bidding into bulk power system ancillary service markets. This work includes analyses of market and policy barriers to DR's market entry into ISO/RTO markets, the development of mathematical models for demand response availability and pilots to test control paradigms for resource aggregation of thermostatically controlled loads and PEVs for AS participation.

Prior to joining LBNL, he pursued his graduate work in Mechanical Engineering and Sustainable Systems in the University of Michigan's Engineering Sustainable Systems dual degree program. As a student researcher, Jason examined the electricity consumption profile, fleet marginal electricity demand and environmental impacts of PEVs. He has held positions as a system engineer for a photovoltaic integrator in Southern California, and as a systems integration engineer on the Chevy Volt powertrain at General Motors.

Advancing Work Rules in the National Electrical Safety Code®

Guest Editorial 2

By Jim Tomaseski, IEEE, NESC® Main Committee

Since the earliest installation of electrical power lines, the need to develop comprehensive construction and maintenance work rules was recognized as essential to ensuring lineman safety.

For many decades, few rules existed meeting these requirements in the United States other than the **National Electrical Safety Code® (NESC®)**, which was introduced in August 1914. Higher voltages, customer service continuation, circuit reliability, unacceptable injury, and fatality rates among other factors demanded attention to a protocol for appropriate work rules. The federal Occupational Safety and Health Administration (OSHA) was established in 1970.

August 2014 marks the 100 year anniversary of NESC's creation, and today the NESC still remains one of the most widely adopted safety codes. Specifying best practices for the safety of electric supply and communication systems such as telephone, cable TV, and railroad signal systems at both public and private utilities, the code has been continually refined and innovated to help protect the public, electrical professionals, equipment, and property. Part of that process is working to harmonize the NESC with the workplace-health and safety regulations issued by OSHA.

How are these work rules evolved and brought to bear in the field to drive the real-world improvements in work procedures that deliver better protection for both utility workers and the public?

Aligning OSHA and NESC Specifications for Worker Safety

The NESC has been in continuous use since its inception 100 years ago. The code sets ground rules for basic provisions that are considered necessary for the safety of employees and the public during installation, operation or maintenance of electric supply, and communication lines and their associated equipment. It applies from inception or receipt from another entity up to the service point where electric energy or communications systems are transferred to a premises wiring system. Most U.S. states have adopted or use the NESC in some manner (some just as a reference or model), and the code is used in about 100 countries around the world.

Since 1972, **IEEE** has served as the secretariat of the NESC. In September 2014, the **IEEE Standards Association (IEEE-SA)** – the standards and collaborative solutions arm of IEEE, with a portfolio of over 900 active standards and more than 500 standards under development – is scheduled to release a preprint of proposed changes for the 2017 edition of the NESC. This will touch off an eight-month period of open commentary, closing on 1 May 2015, to allow interested parties to review, affirm or suggest additional changes to the code proposals. Additional reviews are scheduled to take place over the next year, leading to a scheduled publication date of 1 August 2016 for the 2017 code.

Among the possible revisions for the next edition of the code will be six new change proposals developed by NESC Subcommittee 8 on Work Rules that are intended to harmonize with new OSHA regulations. OSHA 1910.269 *covers the operation and maintenance of electric power generation, control, transformation, transmission, and distribution lines and equipment*.¹ The associated NESC change proposals address areas such as:

- Minimum approach distances (MADs) for supply workers in various situations (performing live line work with or without tools, bare hand, rubber glove work etc.)
- Requirements to address reach and extended reach
- MADs for communications workers
- Requirements for fall protection while employees are climbing, transitioning and/or transferring and while in working positions
- Requirements for arc-rated clothing and equipment and minimum necessary protection for a worker's head, body, hands and feet

The upcoming commentary period on these and other change proposals for the 2017 NESC marks the next phase in a time-tested development process for the long-standing code. The code is a product of an open collaboration among the professionals and industries that it serves through a structured five-year process that is facilitated by the IEEE-SA.

Keeping the Code Current and Relevant

The current, 2012 edition of the code introduced key changes and/or clarifications around where the NESC applies in relation to:

- National Electrical Code® (NEC)
- Methods for achieving effective grounding connections
- Rules for protecting electrical supply stations from interference by activities outside the stations and for guarding inside the stations
- Requirements for inspections and for facilities to be grounded or insulated
- Underground inspection rules and requirements for direct-buried cables and conduits not part of a conduit system
- Arc ratings for apparel (specifically for exposures of less than 1,000 volts)
- MADs and employee protective grounds



Source: New Brunswick Power

With the 2012 NESC's release, work on the 2017 edition commenced. The procedure for revising the code is straightforward and proven:

- A proposal may be prepared and submitted electronically by any substantially interested person, organization, NESC subcommittee or member of the NESC Committee or its subcommittees.
- NESC subcommittees consider each proposal and endorse them, prepare proposed revisions or additions, refer them to technical

working groups for detailed consideration, request coordination with other subcommittees, and/or recommend rejection.

- A preprint of the proposed revisions is published and available at standards.ieee.org/store.
- Proposed revisions and comments are processed for consideration by NESC subcommittees.
- Based upon the subcommittee reports, a draft of the revision of the NESC is distributed to the NESC Committee for approval by a six-week letter ballot and the ANSI Board of Standards Review for concurrent 60-day public review.

For users of the code, the revision process provides an opportunity for the expertise in the real-world field of implementation to help shape the code's future and ensure that their particular experiences and needs are reflected in upcoming releases. Through constant refinement, the NESC remains a relevant, essential resource that is one of the prime elements in the culture of safety that has grown up around electrical work around the world over the last 100 years.

Contributing to Safety in the Real World

The NESC is not a design specification or instruction manual itself, but its work rules and other safety intelligence is brought to bear in the field in a variety of ways.

Adoption by state legislatures and public service commissions (PSCs) is one primary avenue through which the NESC helps keep linemen, other electrical workers and the public safe. Almost every U.S. state adopts the NESC in whole or part. Some adopt only the code's construction and maintenance rules, for example; other states do not directly adopt a safety code for utilities but look to the latest edition of the NESC when issues related to its scope present themselves. California, on the other hand, has its own state code but reviews its requirements when the NESC is revised.

The Caribbean islands, U.S. territories and U.S. military bases globally also rely on the NESC, and consulting engineers have leveraged the NESC in bringing electricity to nations through U.S. Agency for International Development (USAID) programs in cooperation with the U.S. Department of Agriculture Rural Utilities Service. Today, about 100 countries around the world use the NESC in some way – sometimes with modifications to account for local climate anomalies.

Furthermore, the NESC often is an integral element in the holistic safety programs (encompassing safety manuals, 'tailboard discussions,' all-hands safety meetings, spot checks to ensure regulations are being followed, apprentice programs, etc.) that utilities typically follow. The commitment to safety that is demonstrated by individual electrical workers is the primary factor in ensuring that the NESC contributes to safety as intended.

Conclusion

The United States' first electric supply and communications systems were limited to specific towns or regions. Before standardization of clearances of energized parts from public and worker areas, strength of supporting structures, wiring and electrical work methods, etc., electrical workers traveling from one area to the other encountered problems when working with disparate systems. The hazardous environment (for workers and the public alike) led to a congressional mandate for the National Bureau of Standards (NBS), the first secretariat of the NESC, to leverage contemporary engineering theory and generally accepted good industry practices in promulgating national standard practices.

The resulting introduction of the NESC in 1914 helped drive consistency and safety across the design, construction, operation, and use of electric supply and communication installations throughout the United States. Over the years, the NESC's benefits have been felt by electrical workers and the public in more and more of the world.

During this span, the NESC has continually evolved to remain realistic, practical, and useful with the arrival of new technologies and developments in the industry. The launch of OSHA in 1971 represented one such development, and keeping the code in harmony with OSHA's work rules is one of the prime, ongoing areas of focus for the NESC's developers.

One hundred years after the NESC's inception, the determination to deliver a robust, relevant code contributing to the safety of electrical workers and the public is as strong as ever.

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- ¹ <http://www.osha.gov/pls/oshaweb/owadisp.show-document?p-table=STANDARDS&p-id=9868>

ABOUT THE AUTHOR

Jim Tomaseski is Vice-Chair of the NESC® Main Committee, a Member of IEEE and Corporate Director of Safety at PAR Electric.



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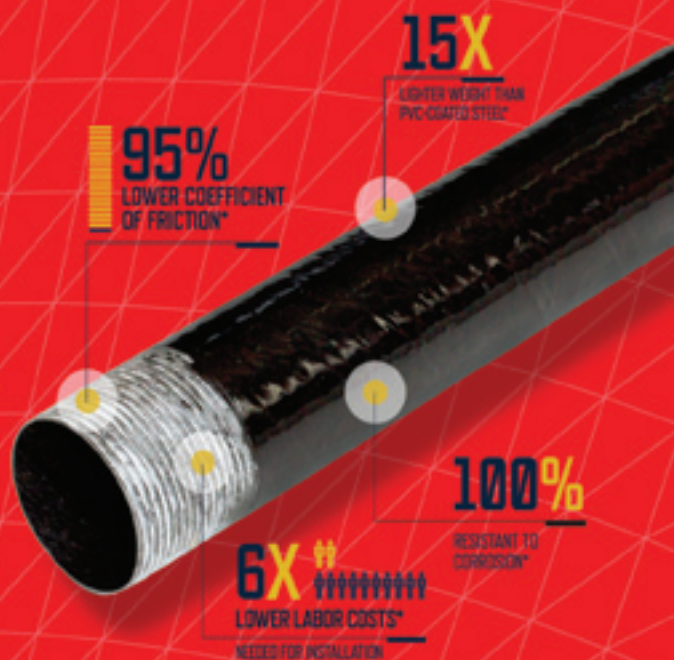


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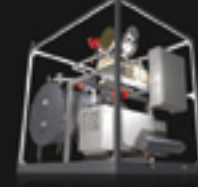


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TEST EQUIPMENT - FAULT

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Tel: (518) 329-3275
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www.sircomachinery.com

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www.valmont-newmark.com

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UTILITY COMPOSITE SOLUTIONS
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22/6nyn9?utm_source=eetd&utm_
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www.envirottempfluids.com

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www.lubricants.petro-canada.ca

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www.deltastar.com

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www.moloneytx.com

PACIFIC CREST TRANSFORMERS
Tel: (541) 826-2113
www.pacificcresttrans.com

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www.trenchgroup.com

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