

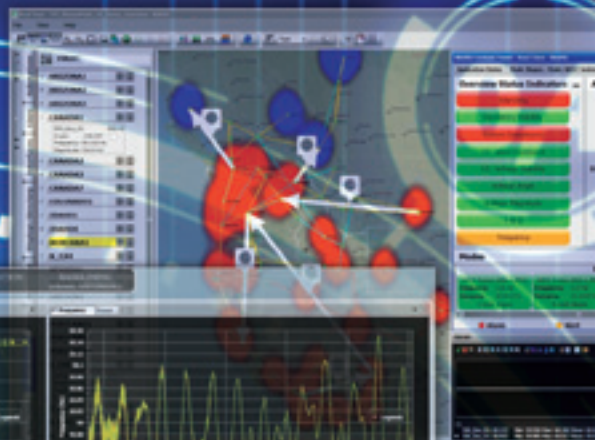
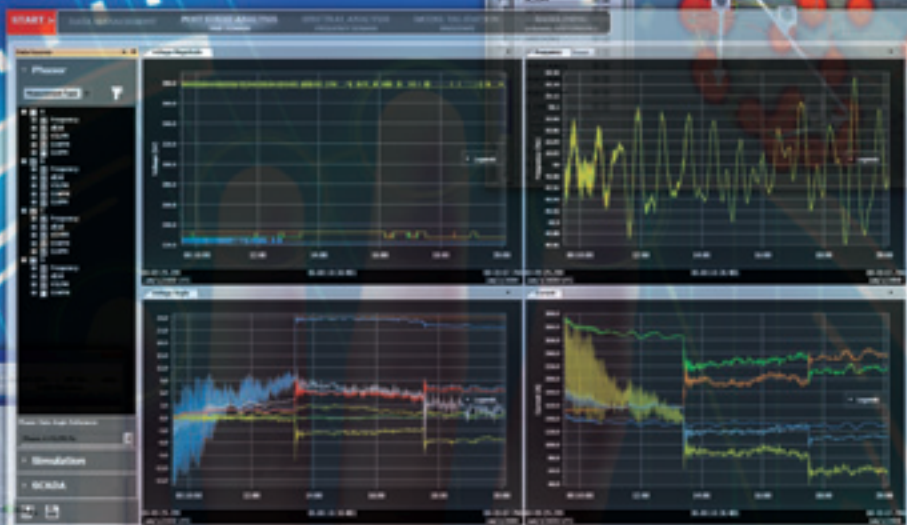


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## MAGAZINE

NOVEMBER-DECEMBER 2014 Issue 6 • Volume 18

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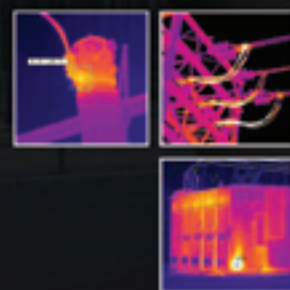


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# POWERPOINTS

## Impressed and Hopeful

I recently attended the CIGRÉ Canada conference in Toronto and was very impressed by the lineup of presenters and cross-section of topics. As expected, smart grid was the underlying theme but there were many presentations on renewable technologies and the integration of same into the grid. Main subjects included:

- System planning and operating relative to the evolving grid, including modeling and simulation tools
- Not In My Backyard (NIMBY) – approaches to dealing with expectations surrounding new construction
- Approaches used in obtaining approvals
- Aging infrastructure and its sustainment
- Integration of renewable generators on the transmission and distribution (T&D) systems
- Power quality, including harmonics and voltage fluctuations
- Smart grid and grid modernization, including automation and storage technology
- Electric vehicles and the associated power system impacts and opportunities – vehicle to grid (V2G) and grid to vehicle (G2V)
- Finding capacity on the transmission system
- Advances in providing good customer service
- Accountability for transmission in a deregulated industry; increased competition in transmission development
- Inertia and the stability of the transmission system
- HVDC development
- DC application at the customer level
- Extreme weather impacts
- Data and information management relative to T&D
- Real-time monitoring and control including related telecommunications
- Best Student Paper awards

At one point I sat down with a fellow who works with one of the largest utilities in the country and asked him about a subject very near and dear to me – wind energy, in particular offshore wind energy.

When I lamented about the NIMBY and BANANA crowd hanging about along the north shore of Lake Ontario just east of Toronto in an effort to stop any construction of turbines, he didn't seem at all fazed by their occupation. I suggested that we live in one of the primo 'wind tunnels' that spawns awesome winds across Lake Huron, Georgian Bay, Lake Erie, and Lake Ontario and that offshore wind production is a no-brainer. He flatly agreed there's an abundance of wind but he said it's just as powerful onshore surrounding Lake Huron and Georgian Bay and also in Southern and Southwestern Ontario so why go to the expense of building offshore. He also reminded me that studies about bird and bat migration paths show unequivocally that the north shores of Lakes Erie and Ontario are of prime importance to the welfare of these creatures.



# These Utilities Bought



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"Look at Wolfe Island wind facility and the grief the turbines there are causing to bird and bat populations," he said. "Arguably, the creatures would likely, in time, change their habits but why should they? There was obviously not enough study done to circumvent the issues. The price is high and we owe it to all Canadians to be the caretakers of this land."

I totally agreed with him.

"Although it's hellishly expensive," he continued, "Ontario alone generated more than 2550 MW of wind power in 2013. Imagine the cost if we go crazy constructing offshore turbines? Don't forget, there will be no quantitative easing and other bailout handouts for the climate system as there was for the banks and auto sector a few years ago."

"I dare say, though, that it has to be a win-win if we can promote wind, solar and other forms of renewable energies," I said.

"I hear you," he remarked. "Tragically it's a double-edged sword in so many places on the planet. Many 'above-it-all' types persuaded themselves that biofuels were the perfect low-carbon alternative to oil and gas – only to discover that using prime land to grow food for fuel can put an intolerable squeeze on food for people. Widespread hunger is the predictable result. And we see the same problems when policymakers ram through industrial-size wind farms and sprawling desert solar arrays without local participation or consent. As we both know, there will be no shortage of people living in those areas with their own inconvenient opinions about how the land should be used and who should benefit from such projects."

We were both running thin on time. I thanked him for his insights and bade him good morning.

As I started auditing presentations, it became clearer and clearer how much renewable energy means to this country and by extension, the world.

The first panel talked about *Life beyond Smart Grid*:

Substantial changes to the electricity distribution system are expected with the drive for automation, and implementation of smart grid technologies. Aside from the emerging technological challenge of information technology and telecommunication, addressing approaches to store, retrieve, and rapidly transfer/transport data, the larger challenge is the 'analytics' part and its practical application.

Beyond mass-deployment of smart grid technologies, how can one cleverly analyze the vast amounts of data, for effective use by utilities for real time power system operations, customer service, mid-to-long-term-system

planning, asset management, predictive analyses, business decision making, and business operations.

Next morning, the panel discussion centred on questions faced by Innovation and the *Evolving Grid*:

What are the current broad challenges faced by T&D utilities and customers? What are the recent innovative solutions provided by your company to address a few of these challenges?

What are the future broad challenges faced by T&D utilities and customers? What are the areas of innovative research and development being pursued by your company to address a few of these challenges?

The afternoon session was aimed at *Extreme Weather and the Resilient Grid*

Extreme weather covers severe weather phenomena that are unseasonal (abnormal) and at the extremes of historical events. Recent studies have shown an increase in the occurrence of extreme weather events in the last decade, some of which have resulted in wide-spread customer power interruptions, stressed power system operations, and caused devastating damage to the power grid.

Extreme weather events have elevated concerns on long-term reliability of the power system, and the adequacy of the existing way of designing, planning, and operating the power system to accommodate extreme weather conditions. There are emerging needs for advanced weather prediction, and risk management techniques to address extreme weather events.

Panel members from the electricity industry discussed and provided their views on recent extreme weather events and spoke about utilities' response to these events. The discussion covered topics on how to develop a more resilient grid through various measures including: advanced planning and coordination of restoration crews and mobile equipment; enhanced communication systems to effectively identify outages; implementation of effective outage management system; and developing forecasts of changing extremes.

I was also able to sit-in on a couple of workshops. The first one opened the floor to *System Development and Economics*:

It focused on the applications of asset analytics in managing aging electricity transmission & distribution system infrastructure. As a large number of assets age and deteriorate, their operational risk increases and could impact electricity customers. The building and application of asset analytics tools to support better decisions in planning and prioritizing asset investment has been practically implemented by a few utilities.





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Asset Analytics considers factors including asset condition, reliability performance, utilization, economics, criticality to the system, and geospatial information. Asset analytics covers both historical and predictive capabilities to better manage work and planning the management of assets. The workshop was designed to leverage the implementation experience in Canada.

Later in the morning the workshop on *Distribution Systems and Dispersed Generation* really piqued my interest:

This workshop focused on practical aspects of applying smart grid technologies towards further automating electricity distribution systems. Three utilities highlighted the benefits and challenges of integrating smart grid technologies into the existing systems.

Ontario's Hydro One covered the implementation of their Advanced Distribution System (ADS) or 'smart grid' technical pilot project, to enhance the operating and effectiveness of a portion of the electricity distribution system. Their topics included Hydro One's ADS 'Living Lab,' advanced distribution management system (DMS) algorithms, and WiMax for protection and control applications.

Hydro Québec outlined its work on distribution automation, and the more advanced innovative technologies into their distribution system.

Burlington Hydro in Southern Ontario showed how 'Disruptive Energy Technologies' could significantly change electricity utilities business and operation

My brain was spinning by the time I walked out of the various sessions pleased, as I say that so many presenters focused on renewable energies and proud that *Electric Energy T&D* magazine was a core event sponsor.

As encouraging a look into the future as the talks were, we are running out of time and other resources if we are to get on top of the climate change and other globally pressing issues. After some reading, I discovered that as far back as 2011, the U.N. Department of Economics and Social Affairs looked at how much it would cost for humanity to 'overcome poverty, increase food production to eradicate hunger without degrading water resources, and avert the climate change catastrophe.' The figure was \$1.9 trillion a year for at least 40 years hence. 'At least half of the required investments would have to be realized in developing countries.'

As we all know, public spending is going in the opposite direction almost everywhere except for a few fast-growing so-called emerging economies. In North America and Europe, the economic crisis that began some six years ago is still being used as a pretext to slash aid abroad and cut climate programmes at home. All over Southern Europe, and the United Kingdom environmental policies and regulations

have been clawed back drastically cutting life-giving subsidies for renewable energy sending solar projects and wind farms spiralling toward default and closure.

Moments when the impossible seems suddenly possible are exceedingly rare and the most must be made of them – if we have the confidence to do so. Time is running out. Since we have only a few short years to dramatically lower our emissions, the only rational and sensible way forward is to fully embrace the principle already well ensconced in Western Law: make the bad guys, i.e. the polluters, pay.

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## ANTI-THEFT TRANSFORMER WITH METERING ENCLOSURE



Electric utilities throughout the world lose millions of dollars to non-technical losses. Non-technical losses are often a result of electricity theft, which is a growing problem, especially in developing countries. A common form of electricity theft occurs through unauthorized connections to an 'open secondary' line. In addition, electricity theft occurs through tampering, bypassing or damaging the electrical meter, typically located on the customer premises.

Moloney Electric Inc. has developed and patented an anti-theft single phase distribution transformer solution to protect against theft of electricity for both overhead and pad-mounted applications.

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Canadian Patent No. 2,814,478

Dominican Republic No. P2013-0098

Patent Cooperation Treaty No. PCT/IB2013/002826

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## Toronto Hydro CEO Anthony Haines officially named Energy Council of Canada's Canadian Energy Person of the Year on the eve of the one-year anniversary of the 2013 ice storm

On November 6th, the Energy Council of Canada (ECC) presented Anthony Haines with its 2014 Canadian Energy Person of the Year (CEPY) Award.

The event opened with remarks from Ontario's Minister of Energy, the Honourable Bob Chiarelli, as well as a video message from the Premier of Ontario, the Honourable Kathleen Wynne. Also participating in the ceremony were municipal, provincial and federal officials, and other energy sector leaders.

Mr. Haines was awarded the CEPY Award for his dedicated service as the head of one of Canada's largest electricity utilities, as well as his steadfast leadership during the 2013 ice storm. The ECC also celebrated the outstanding efforts and contributions of the men and women at all local electricity utilities who work to provide reliable power every day, on the eve of the one year anniversary of the December 2013 ice storm "Safe, reliable electricity underpins our daily lives, our businesses and our economy" said Colin Andersen, Chair of the ECC and CEO of the Ontario Power Authority. "We depend on it day in and day out and events like the Toronto ice storm remind us just how vital the work of these men and women is."

Mr. Haines was nominated for the Award by the City of Toronto's City Manager, Joseph Pennachetti, in recognition of Mr. Haines' exceptional leadership of the city's electricity utility, which delivers electricity to approximately 2.5 million people in the City of Toronto.

The Canadian Energy Person of the Year Award, established in 2001, recognizes and pays tribute to a Canadian energy leader who has made a significant impact in the field of energy at the national and international level.

A critical characteristic for nominees is that they must demonstrate a strong sense of social responsibility and giving back to the community. They focus on as well as environmental as well as social issues. . . Anthony's passion for community giving is illustrated in his commitment to the Greater Toronto United Way as Public Sector Chair, his work with several Toronto charities and as a member of the Finance Committee for the Pan Am Games, Toronto 2015. Their forward thinking and innovative spirit inspires other energy

leaders to promote the Canadian energy sector and Canada's role on the world energy stage  
"I am honoured to receive this award and be among its distinguished recipients," said Haines. "This award is really a testament to the talented and creative senior leaders at Toronto Hydro and, most importantly, the men and women at Toronto Hydro who work hard every day to keep the power on and put our customers first."

The Sunnybrook Burn Unit was selected by Mr. Haines to receive a charitable donation provided by the Energy Council of Canada in recognition of the annual CEPY award,

As the 2014 Canadian Energy Person of the Year, Mr. Haines will serve as an ambassador of Canada's energy sector, demonstrating a clear vision and commitment to fostering the sustainable use and development of energy for the benefit of all.

## North Carolina's Electric Cooperatives Award Bright Ideas Grants Worth \$600,000 To Teachers

North Carolina's Touchstone Energy cooperatives are celebrating 20 years of Bright Ideas grants and innovation in the classroom this month by awarding Tar Heel teachers more than \$600,000 in Bright Ideas education grants. The grants will fund more than 500 creative projects statewide designed not only to help students master core skills, but also spark higher interest in learning for years to come.

"Bright Ideas grants provide additional resources to teachers who create innovative projects that light up learning for their students," said Lindsey Listrom, Bright Ideas coordinator for the North Carolina Association of Electric Cooperatives. "North Carolina's Touchstone Energy cooperatives are committed to the local communities we serve, and we believe investing in the education of our future leaders is one of the most important contributions we can make."

The Bright Ideas program, sponsored by North Carolina's Touchstone Energy cooperatives, provides grants directly to teachers to fund innovative learning projects not covered by traditional school financing. This year, the cooperatives are celebrating the 20(th) anniversary of the Bright Ideas grant program. Since 1994, N.C. teachers have won more than \$9.1 million for 8,800 projects, and more than 1.6 million students have participated in Bright Ideas-funded projects in all subjects including math, reading, science, technology, engineering, music and the arts.

Throughout November, the co-ops honor Bright Ideas grant winners at local ceremonies, banquets featuring acclaimed guest speakers, and even a grant presentation that includes Carolina Panthers players and mascot Sir Purr at a Charlotte-area elementary school. Bright Ideas "prize patrol" teams will also visit schools across the state to surprise winning teachers' and award their grant checks.

Applications are accepted from April through September, and North Carolina K-12 teachers may learn more and apply online at [www.ncbrightideas.com](http://www.ncbrightideas.com).

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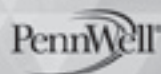
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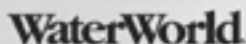
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# THE GRID TRANSFORMATION FORUM

Envisioning the 21<sup>st</sup> Century Grid

## Alstom and PG&E Advance Synchrophasor Grid Monitoring into Proactive Grid Stability Management

We are in discussion with Karim El Naggar, Vice President Network Management Solutions with Alstom Grid on the subject of the latest technology related to phasor measurement units (PMUs).

**EET&D:** What were the main drivers in your decision to work with Pacific Gas & Electric (PG&E)?

**Karim:** PG&E has been an Alstom EMS customer for many years using our core product **e-terra**platform to manage their grid. It was a natural progression to include the new suite of PMU-based applications to augment their EMS.

**EET&D:** Can you tell us something about Phase I of the synchrophasor project?

**Karim:** Phase 1 consisted of several deliverables to PG&E's Proof of Concept facility. We deployed the openPDC – phasor data concentrator – to collect and align PMU data. Our full suite of synchrophasor applications were integrated into our existing EMS solution, enabling us to improve the accuracy of our State Estimator by accessing PMU data. We also integrated an advanced Dispatcher Training Simulator to help train PG&E operators on the new tools.

**EET&D:** Is the solution limited in any way? Does a utility have to be a certain size before the technology can be applied?

**Karim:** The solution is not limited or constrained by utility size. It can be applied to a smaller utility with just a few PMUs as we have done in Iceland, or could be as large as 1200 PMUs for a very large national grid like we are doing in India and the Western US.

**EET&D:** Please explain how Phase II will work?

**Karim:** Phase II is about moving from proof-of-concept (POC) to a hardened production system. Measurement-based PMU applications in **e-terra**phasorpoint will be integrated with the model-based EMS applications and DSA tools to provide decision support tools in PG&E's control room.

**EET&D:** How well would you expect Alstom's Grid Stability Package to perform in a utility in Tornado or Hurricane alley where blackouts and system failures are most common?

**Karim:** PMU data are typically received in the EMS via channels that are different from the RTU data. So there is some physical backup here. In fact, at Entergy during Hurricane Katrina, the RTU data were lost but the PMU data continued to give them grid visibility for a while.

The high-fidelity synchrophasor data provides early detection of events, so this helps accelerate reconnection and restoration of service.

**EET&D:** Is installation of Phases I and II dependant on the age of the utility's existing system/How adaptable is the EMS to systems already in place?

**Karim:** Phases 1 and 2 can be installed at virtually any utility regardless of the EMS system they use. The PMU measurement-based applications in **e-terra**phasorpoint have well-defined standard industry interfaces for integration with any existing EMS, and the system offers a unified visualization of EMS and PMU information via **e-terra**vision.



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# THE GRID TRANSFORMATION FORUM

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**EET&D:** What impact, if any, will the program have on a utility's ability to integrate renewable energies into the grid?

**Karim:** Our Grid Stability Package monitors grid conditions at a sub-second rate – much faster than SCADA. Installing PMUs at the terminals of the renewable resources - where they tie into the grid – will enable much quicker determination of the highly variable and unpredictable output changes which are typical of wind and solar generation. The PMU measurement-based voltage and oscillatory stability monitoring capabilities can identify imminent stability issues, which when coupled with sub-second control

actions can therefore greatly improve utilities' ability to integrate renewable energies into the grid.

**EET&D:** Can Synchrophasor Grid Monitoring be applied to a rural co-op situation involving multiple utilities?

**Karim:** Yes. The concept of wide area monitoring across multiple utilities is the fundamental basis of our Grid Stability Package. It can be deployed for a single utility or across several utilities, as is the case with Peak RC, the Reliability Coordinator for the Western Interconnection Bulk Electric System, where they are using Alstom software to monitor system conditions at all times across the region.

**EET&D:** In a cost sensitive environment, is this cost effective?

**Karim:** The PMU itself is not very expensive. The overall cost is really dependent on the network communication system. If already in place, the incremental cost is low. Furthermore, most modern relays and disturbance fault recorders (DFRs) have inbuilt PMU capabilities, which further reduces the deployment costs.

**EET&D:** Karim, we really appreciate your taking this time to speak with us. It's a very busy time for you and, indeed, in the life of smart grid going forward.



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## About the Author

**Karim El Naggari** is Vice President of the Alstom Grid Network Management Solutions product line. He held the same position at Areva T&D, from 2009 until the company was acquired by Alstom in 2011. Today, he has worldwide responsibility for all Network Management business including: Transmission, Distribution, Energy Market and Demand Response, Smart Grid software solutions, Telecom solutions for Utilities and Energy Market Participants, as well as SCADA software solutions for Oil & Gas.

Early in his career, Karim held various positions in Product Management, Supply Chain and Information Systems, as well as Project Management, in France, East Asia and Egypt. His extensive Telecom background comes from having worked over 12 years in the Mobile Communication Industry. This includes being named Vice President of the Circuit Core Switching Product Line within Alcatel in 2005, before heading the Wimax Product Line of Alcatel-Lucent from 2006 to 2009. Karim holds both a Master's degree in Business Administration from the Harvard Business School (USA) and a Master's in Engineering from Ecole Polytechnique in Paris (France).



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# GREEN OVATIONS

Innovations in Green Technologies

## Mapping the Building Genome

How data analytics enables a better understanding of how buildings consume energy, and why open data can be a game-changer in the energy efficiency sector

By Bennett Fisher



Forty percent – that's the portion of energy that commercial and residential buildings consume.<sup>1</sup> Yet, in spite of the fact that buildings are driving nearly half of all global energy consumption, 30 to 50 percent of that consumed energy is wasted.<sup>2</sup>

And energy usage is increasing. The US Energy Information Administration estimates that the commercial building sector will account for the second-largest increase in the US' total primary energy use – 3.3 quadrillion BTU from 2012 to 2040.<sup>3</sup>

In many areas throughout the United States, this increase in commercial building usage is putting more stress on the electric grid. The American Association of Civil Engineers estimates that an investment of more than \$670 billion is needed by 2020 just to keep the power grid functioning.<sup>4</sup>

A viable solution to head off some of these costs is to reduce both overall consumption and peak demand through energy efficiency – America's cheapest, most scalable energy resource that we have at our disposal.<sup>5</sup>

While efficiency is an obvious approach, it's not necessarily a simple one to attack. Buildings are complex and difficult to understand. The traditional process to better understand which buildings are ripe for energy efficiency projects and to evaluate which specific actions are required to achieve those savings is time consuming and expensive. The traditional process relies heavily on manual approaches to identify energy-saving opportunities. Because buildings are not being evaluated in a timely and cost-effective way, many building owners and managers do not understand their opportunity to save. This creates an information barrier that prevents the industry from achieving deeper savings.

Fortunately, the growing availability of utility meter and building data, the proliferation of cloud computing, and new advancements in analytics are enabling a fundamental shift in the way utilities,

energy service providers, government organizations, and building managers can address this problem. Combined, these factors allow for rapid, mass-scale generation of data-driven insights and models that provide a sophisticated understanding of how a building uses and wastes energy.

### The Building Genome Project

The adoption of analytic tools for utility efficiency programs is growing, but many stakeholders do not fully understand how powerful they can be to tackle this problem. The Building Genome Project was established for this reason – to mine, collect, and organize publically available building data for the purpose of gaining a deeper understanding of the energy efficiency opportunities present. Through the Building Genome Project, publically available building data is combined with advanced analytics to create unique physics-based energy models of commercial buildings in minutes. Data is the starting point to develop an energy model, which is typically building asset and/or consumption data. With these models, the Building Genome Project can demonstrate how both small and large changes can influence energy consumption and drive savings.

Like the human genome, the Building Genome is a detailed mapping of hundreds of distinct markers that influence how a building consumes energy. These markers are composed of a variety of mechanical equipment, construction materials and configurations, energy fuel sources, and operational characteristics. These can include lighting markers like fixture type, utilization, and building coverage; HVAC markers like equipment type, fuel type, and system performance; or building envelope markers like roof, wall, and window type, the number of glass panes, and insulation performance. The building markers can become very intricate – each building's occupancy, geometry, hot water system, and many other types of equipment can contain additional markers that impact energy usage.



Once a building's markers are properly understood and ordered, they can be combined to create an energy model of each building, helping to provide critical insight into how a building consumes energy, every hour of every day. The energy model can also help determine the most effective equipment and operational changes to save energy. Physics-based energy models also account for interactions between building systems, including how elements like window and wall performance or lighting systems affect heating and cooling requirements for a space.

Another benefit of energy models, in addition to better understanding a building's energy usage and drastically cutting time to insight, is the ability to run scenarios to determine how equipment or operational changes to a building may impact its energy usage. By gaining these insights, utilities, policy makers, energy service companies, and building owners can make more informed portfolio-wide and building-specific decisions about energy efficiency.

## Energy Savings Potential for New York City

New York City was the first city analyzed for the Building Genome Project, which included the development of unique energy models for more than 30,000 buildings and uncovered over \$380M in annual savings potential in just a few days. For New York City, the Building Genome Project was able to tap into public data sources, including tax assessors' information (e.g., basic building information) and consumption data – annual site energy use intensity for most buildings over 50,000 square feet and zip code level consumption data for electricity, gas, and steam. In addition, data on buildings with oil boilers was also available for the city. The energy models were developed by supplementing this information with privately sourced, hyper-local weather data and statistical inference algorithms based on data from tens of thousands of previous audits.

To better understand how sample equipment and operational changes may impact New York City's commercial building portfolio, three scenarios were run against these energy models. Each scenario not only showed the potential for significant financial savings and portfolio energy savings, but also gleaned further insights to be used when implementing an energy efficiency program.

### First Scenario

In the first scenario, the Building Genome Project looked at the potential impact if every commercial building turned the thermostat up one degree in the summer and down one

degree in the winter. The analysis found that New York City could save \$145M annually as well as a portfolio energy savings (MBTU) of 1.9 percent. With this finding, it's important to note that even though buildings can often have similar issues that result in inefficient energy use, the most effective measure or treatment for a particular issue can vary from building to building.

For example, there are many behavioral and educational efforts that can be employed to encourage multi-family building tenants to change their thermostat settings, and these efforts can usually be implemented quickly and at no cost. However, in the commercial market, automated, controls-based measures are usually necessary to help achieve these goals. Measures like re-commissioning building management systems to improve HVAC operations can include aggressively changing thermostat settings during certain periods of the year or times of the day. In buildings or smaller spaces with no centralized controls, new advanced thermostats can be more easily programmed and monitored to ensure persistence.

### Second Scenario

The Building Genome Project's second scenario looked at the impact of upgrading old windows to new windows. The analysis found that if buildings with old windows installed new, efficient ones, the city could save \$227M annually with an MBTU savings of 4.5 percent. In addition, sorting New York City's zip codes by potential energy savings found that the top 35 zip codes had an estimated savings three times greater than the 35 zip codes with the lowest savings potential. Many of the high potential zip codes were located in Manhattan, where tall, skinny, glass-laden buildings are plentiful and are the ideal target for high performance window upgrades, from an energy savings perspective. This demonstrates that, in certain instances, it may be beneficial for utilities and policy makers should evaluate their own geographical areas to determine whether more tailored, appropriate solutions in different parts of a given region.

Other considerations should be factored in before deciding to promote or incentivize window retrofit technologies. For example, a full building window retrofit for many buildings in a place like New York City may be disruptive and may or may not yield attractive paybacks for each building. Instead, alternative complementary technologies like window film could also be evaluated for each building.

## Third Scenario

In the third scenario, the Project focused on the impact on financial and energy savings if every building with an oil boiler that burned grades #4 or #6 oil replaced it with a high efficiency natural gas boiler. This scenario showed that the city could save \$10M and 0.4 percent MBTU annually. In 2011, New York announced that it would phase out these boilers since they burn the dirtiest heating oil types available in New York. At the time of the City's announcement for this plan, it noted *only one percent of the City's buildings still burn #4 and #6 heating oil but they account for more soot pollution than all the cars and trucks in New York City combined.*<sup>6</sup>

Compared with the other scenarios, scenario three offers the lowest absolute dollar savings across the portfolio, since it applies to only a small subset of buildings, but the energy savings to those buildings are significant at an average savings of 10 percent per building. This scenario highlights that it's important to consider the economic impact, in addition to considering the environmental impact of a regulation.

## Enhancing the Building Genome

The Building Genome Project leverages only publically available data (unless private data is supplied to the project) to drive the analytic-based insights. The information contained in public data tends to vary by geographic location, but typically offers high-level data points about a building. Due to the limited data used to inform these energy models, the Building Genome Project focuses on portfolio-level and zip code level insights.

The more data that is provided about a particular building, the more accurate a building energy model becomes. For instance, if energy consumption data were added to the Building Genome Project models, which are based on public data, these models could be used to evaluate the savings potential of an individual building.

Greater availability of public data could support further innovations and enable the efficiency market to reach its full potential – a market that is estimated to hold \$370B of annual energy savings worldwide. For the New York City analysis, its annual energy benchmarking data was extremely helpful.

There are a number of beneficial applications that can come out of mapping the building genome and enhancing it with data analytics and rapid energy modeling. With an energy model of a building, utilities, and energy service providers can identify the highest potential customers, increase

their interest by sharing specific insights about their buildings, comprehensively and quickly evaluate projects, and constantly scan for new efficiency opportunities. In addition, the building genome can help government agencies, utilities and building owners and managers more easily deploy energy efficiency solutions to geographically target constrained areas instead of increasing capacity, and better forecast load requirements in the future. Finally, leveraging the building genome can help to better understand market potential and more effectively and strategically plan for efficiency programs. While robust approaches exist to support these efforts, running scenarios like those for the New York City Building Genome Project enables us to ask and answer more questions and consider more scenarios, better, faster, and cheaper.

## About the Author



**Bennett Fisher** is CEO and co-founder of Retroficiency, the building intelligence company for utilities and energy service providers. In 2009, Bennett co-founded Retroficiency to help address the manual bottleneck of identifying and evaluating commercial buildings for efficiency upgrades, which was

preventing the market from realizing its true savings potential. Retroficiency enables utilities and energy service providers to target the right buildings, engage customers with building specific insights, convert real projects, and track opportunities at scale to achieve critical energy efficiency targets. Bennett has a BA in economics and entrepreneurship from The Johns Hopkins University and an MBA from the Massachusetts Institute of Technology Sloan School of Management.

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# From Research to Action

## Integrated Security Operations Centers: Advanced Security Monitoring and Threat Management

By Ralph King

Electric power companies increasingly are the targets of sophisticated attacks. These assaults include not just advanced cyber security threats, but physical attacks as well. At the same time, the quantity and types of communication and automation systems deployed by utilities continues to grow, increasing the utilities' attack 'surface.' For a well-resourced attacker, the question often is not 'if' but 'when' it will compromise an organization, and advanced attacks have been known to escape detection for weeks or months.

As this threat landscape has intensified, there is a greater need for a coordinated view of all aspects of an organization's security posture, including how events may impact that posture and how best to respond to those events. Utilities have greatly increased their security monitoring and defenses in the last several years, deploying defense-in-depth strategies, real-time alerting, and security awareness training. However, companies that only react to events spend most of their energy putting out fires, struggling to keep up with the current threats.

An intelligence-driven approach to cyber defense, using threat indicators, gets ahead of attackers while quickly responding to incidents as they occur. Unfortunately, the security monitoring necessary to execute this approach typically happens in different parts of organizations. These security operations centers (SOCs) are common in physical security, business, and industrial control environments. Many utilities have one or more of these individual SOC's responsible for defined physical regions or business functions.

Utilities increasingly see security benefits in integrating these information silos, and EPRI is working with companies and vendors on technologies and applications for creating integrated security operations centers, or ISOCs. An ISOC brings together the many isolated security monitoring and response functions into a unified framework. The benefits include:

- Real-time intelligence
- Improved analyses of vulnerabilities and threats across organizational domains
- Efficient forensics and root cause analyses
- Unified (corporate information technology (IT) and operations technology (OT)) security incident management
- Centralized configuration and patch management
- Optimization of security resources
- Building workforce trust relationships across business functions

Figure 1 shows a potential architecture for an ISOC, which can aggregate and correlate security logs and events from IT systems, OT systems, security appliances, and physical security systems. If a utility has a network operations center (NOC) for its field networks, events from the NOC or other network management systems can be integrated as well. While these sources help a utility identify and react to security incidents across its enterprise, they are not sufficient to support advanced threat management. This requires an ISOC also receives input from external threat and vulnerability sources, providing analysts with the information necessary to prevent threats from becoming incidents.



Figure 1: Example ISOC Architecture

An advanced ISOC could integrate several other information sources as well, such as a work management system and power operations data from the SCADA system. Having more information available to the correlation engine and security analysts can provide more indicators of attack and potentially reduce false positives. Below are several examples of scenarios which an ISOC could help to detect more efficiently:

- Anomalous power system behavior is logged by the ISOC from a device or system at a substation. The ISOC also logged a physical security event at the same substation shortly before the anomalous SCADA behavior was detected. The appropriate SCADA operator could be informed of the possible correlation of events, allowing them to respond appropriately.

# From Research to Action

- An IT employee logs in remotely to perform maintenance on the Historian database. The ISOC detects that no work order exists in the work management system for this work to be performed. The remote connection to the database could then be terminated.
- An employee has logged into a workstation in the control center. However, the physical access control system badge credentials to access the control center do not match the login credentials from the identity management system. An onsite facilities security team could be dispatched to investigate.
- The IT operations center is alerted to a USB drive plugged in to a field device at the substation. The physical security monitoring center is alerted of a cut fence and an unauthorized person on the grounds of a substation. A security team could be dispatched to the substation to investigate.

Migrating from technology or business unit SOC's to an enterprise ISOC can be a multi-year, phased process that requires significant planning and investment. Several internal stakeholders must be engaged to reach consensus on the business drivers, potential challenges, and high-level phases of the effort. In 2013, EPRI published Guidelines for Planning an Integrated Security Operations Center (<http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002000374>). This technical update, which can be downloaded at no cost by searching for the report number on EPRI's website, focuses on the initial steps of setting up an ISOC – developing the business case, identifying potential organizational challenges, determining tradeoffs for different ISOC architectures, and planning the implementation process.

EPRI's research for 2014 focuses on the process of integrating the physical and cyber security monitoring of control center systems into an ISOC – understanding potential security failure scenarios, developing requirements, understanding the impact of different ISOC architectures on the security monitoring process, and establishing guidelines for the implementation process.

EPRI's Cyber Security Research Lab (CSRL) in Knoxville, Tennessee directly supports the ISOC research. The CSRL is generally used to conduct proof-of-concept and use-case testing to support EPRI's annual research, as well as focused testing for utility projects. Currently, ISOC research is being conducted in the CSRL through testing of various attack scenarios with an array of vendor products and devices. Vendor solutions that make up the ISOC test bed include:

- Security Incident and Event Management (SIEM) software
- Protocol-aware firewalls
- Security gateways
- Security appliances
- Substation SCADA devices
- Security cameras
- Video management software
- Logical and physical access control systems
- Ballistic detection simulation software



Figure 2: ISOC Data Sources

As the security threats to utilities become more sophisticated, companies must leverage their security monitoring resources more efficiently and intelligently to stay ahead of the attackers. A centralized approach for threat management provides greater situational awareness of security events and threats across the entire enterprise, improving threat analyses, optimizing security resources, and supporting better root-cause analyses.

## About the author



**Ralph King** is a Principal Technical Leader for Cyber Security in the Power Delivery and Utilization (PDU) Sector at the Electric Power Research Institute (EPRI). Prior to joining EPRI, he spent over thirty-years in the electric power industry where he served in various leadership roles in security and information technology. His academic background is in Computer Science, Mathematics, and Business.



# Demand Response for Utilities in Restructured Markets: How to Get More from Existing Assets

By Kristen L.K. Brewitt

Effectively meeting electric utility distribution-level needs includes a focus on system reliability. To meet this need, distribution utilities must constantly consider how best to manage and operate distribution networks to deliver power and services continuously, efficiently, and safely at the lowest cost possible. This is a complicated task – one that involves making many complex asset-based decisions as well as being prepared to address factors beyond control, such as extreme weather conditions and other natural events. Demand response (DR) is one option that can offer utilities a cost-effective alternative to supply-side infrastructure investments. Currently, many independent system operator and regional transmission operator (ISO/RTO) regions have existing reliability-based DR programs. However, these ISO/RTO resources address broad system-wide needs and do not necessarily solve the specific distribution level or peak demand challenges that the individual utilities within the ISO/RTO footprints face.

As DR capacity continues to evolve in wholesale electricity markets, though, there are use-cases in which electric utilities can gain cost-effective distribution level benefit through ‘incremental (or layered) dispatch’ and/or ‘incremental capacity’ DR program models. Over the past several years we have seen utilities take three general approaches to implementing ‘incremental DR’ programs within restructured markets, including:

1. Acting as their own curtailment service provider (CSP)
2. Entering into a bilateral contract with one or more CSPs
3. Creating a standard offer program.

This article outlines the options available to utilities as they consider leveraging existing commercial and industrial (C&I) DR assets to address their specific distribution-level or peak demand needs.

## An Overview of Demand Response

DR is the reduction in electric consumption by end-use customers during periods of peak demand, high wholesale market prices, or system emergencies. DR can defer or eliminate the need to build new supply-side infrastructure, like peaking power plants, and transmission and distribution assets. Utilities and grid operators can also rely on DR as an economic resource that reduces the overall cost of power.<sup>1</sup>

DR resources represent a substantial and increasing percentage of peak demand in the United States. A 2009 study by the Federal Energy Regulatory Commission (FERC) estimates the total potential for DR will be as high as 20 percent of peak demand in 2020,<sup>2</sup> with more than 66 Gigawatts (GW) built out as of 2012.<sup>3</sup> A large portion of this existing DR capacity is in restructured markets where ISOs / RTOs include DR resources in their capacity procurement processes. For example, as of September 2014, emergency programs administered by New York ISO (NYISO), ISO New England (ISO-NE), and the PJM Interconnection (PJM) represented more than 9 GW of DR capacity.<sup>4</sup>

As DR continues to achieve scale in these and other competitive markets, electric utilities have the opportunity to leverage this infrastructure for distribution-level challenges that are beyond the goals of an ISO/RTO-wide program. In many cases, it is economically prudent for electric utilities to leverage existing DR assets for additional purposes. In general, the cost of acquiring new DR resources is higher than harnessing existing DR resources for more frequent use.

## Demand Response Serves Various System Needs

DR can be used to address a variety of system needs – and system operators design DR programs differently depending on these needs. It is helpful to categorize a DR resource by the role it plays in system operations. For example, DR can improve reliability during system emergencies, mitigate high wholesale market prices, and address distribution-level problems. These program drivers are best defined as ‘dispatch triggers,’ that is, the circumstances under which a DR resource will be activated. The more frequently the defined system conditions are achieved, the more frequently the resource will be dispatched, and therefore the more significant the required commitment from C&I program participants. Three core categories of DR resources include reliability-based DR, distribution-level load relief, and peak load management.

**Reliability-Based Demand Response:** The most basic DR resources are intended to address system emergencies and are typically known as ‘emergency’ or ‘reliability’ DR programs. Many ISO/ RTO DR programs are considered emergency programs, including the Electric Reliability Council of Texas’ (ERCOT) Emergency Response Service (ERS), NYISO’s Emergency Demand Response Program (EDRP) and ICAP Special Case Resources (SCR), and PJM’s Emergency Load Response Program (ELRP). In exchange for capacity and energy payments, the curtailment service providers (CSPs) that represent (C&I) customers are obligated to provide a certain amount of capacity when dispatched, at the risk of financial or other penalties for non-performance. For emergency or reliability programs, dispatch triggers are usually defined by system conditions such as actual or forecasted reserve shortages.<sup>5</sup>

**Distribution-Level Load Relief:** Electric utilities can use DR resources to alleviate distribution-level issues or problems that ISO/RTO programs are not designed to address. Such programs usually apply only to targeted areas, and as a result can be built on top of emergency DR programs such that all participants in the distribution-level DR program are also enrolled in the emergency program (but not vice-versa). The distribution-level and emergency programs are dispatched separately based on their own distinct dispatch triggers – triggers which can sometimes occur simultaneously. Because distribution-level resources can also be dispatched in response to wider system emergencies, participants enrolled in both programs can potentially be called more frequently than those enrolled only in the emergency program.

**Peak Load Management:** Peak load reduction programs are designed to shave peak demand, creating economic benefits for the utility. Utilities have greater flexibility when it comes to dispatch triggers for peak load shaving programs, and events are often called for economic reasons. For example, an event may be triggered when system demand exceeds a specified level. While the exact trigger will determine the frequency of dispatch for participants, it is safe to assume that a utility may dispatch peak load reduction resources to meet both emergency and distribution-level challenges, and as a result, participants in a peak load reduction program should expect more frequent dispatch than in either emergency or distribution-level programs. The relationship between reliability, distribution-level, and peak load reduction programs can be seen in Figure 1.

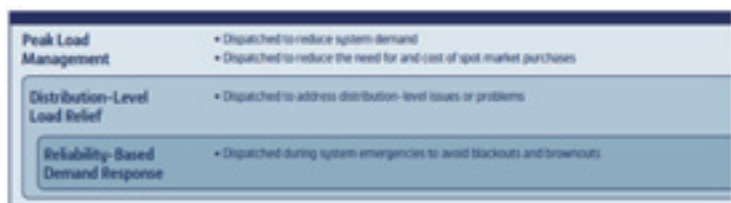


Figure 1: Demand Response Dispatch Triggers

## Demand Response Program Constructs Restructured Markets

Increasingly, utilities are building upon existing ISO/RTO DR resources by creating supplemental programs to realize specific distribution level or peak demand objectives. These utility DR programs in restructured markets typically take one of two forms: *incremental capacity* programs and *incremental dispatch* (or layered) programs. Put simply, the incremental capacity construct is intended to attract new participants into the ISO/RTO program in a particular geographic area by increasing total payment levels; the incremental dispatch construct gives existing participants the opportunity to earn more money in exchange for making themselves available to participate in events more frequently.

**Incremental Capacity Programs:** Incremental capacity programs focus on providing added incentives to increase the amount of DR capacity enrolled in ISO/RTO programs within a utility’s service territory. Examples of incremental capacity programs include those in Connecticut, Maryland, and New Jersey.

- **In the late 1990s and early 2000s, Connecticut** faced substantial load growth in the southwestern part of the state, with transmission and generation infrastructure unable to keep up. In the face of FERC-approved Reliability-Must-Run (RMR) contracts that drove retail electricity prices up, Connecticut’s Legislature, the Department of Public Utility Control, and ISO-NE recognized a need for new resources, and the opportunity for bilateral DR contracts to play a role. In 2003, ISO-NE issued a “Gap” RFP to provide special payments for up to 300 megawatts (MW) of new supply- and demand-side capacity in southwest Connecticut (SWCT), with the intention of providing a stop-gap until new transmission and generation infrastructure came online. As a result, additional funding was made available to attract more resources to ISO-NE’s 30-minute real-time DR program in SWCT. The annual supplemental payments associated with the SWCT Gap RFP translate to \$14.04/kW-month in addition to the capacity payments that were already available through the installed capacity market.<sup>6</sup>

**Incremental / Layered Dispatch Programs:** Incremental dispatch programs provide the utility with dispatch capability above and beyond those specified by an existing ISO/RTO program. Typically, customers are enrolled in both the ISO/ RTO program and the utility program. Incremental dispatch programs compensate customers who choose to participate with incentives incremental to the ISO/RTO payments in exchange for an incremental commitment. Because these programs essentially build a new DR resource on top of an existing one, they are often referred to as “layered” programs. An example of layered DR is Con Edison (New York).



- **Con Edison's Distribution Load Relief Program (DLRP)** is a distribution-level DR program that can be categorized as 'layered.' Con Edison is a part of NYISO, and NYISO administers Special Case Resources (SCR), a reliability-based DR program. However, NYISO can only dispatch SCR by zone (there are 11 across the state) and only for actual or forecasted system-wide operating reserves shortages. Thus, in order to meet localized distribution challenges, Con Edison developed the DLRP program in a way that allowed them to leverage participants already enrolled in SCR to commit to more frequent events in exchange for additional incentives. Participants in DLRP earn the payments available from SCR, in addition to supplemental payments that range from \$6/kW-mo to \$15/kW-mo depending on the network to which the customer is connected.<sup>7</sup>

## Delivery Models for Demand Response in Restructured Markets

A utility in a restructured market can procure incremental capacity and layered DR resources in three general ways. A utility has the option to:

1. Act as a curtailment service provider (CSP) and build and manage its own program
2. Sign a bilateral contract with a third-party CSP to provide guaranteed DR
3. Create and administer a standard offer program open to all approved CSPs in its service territory

Figure 2 provides a matrix of example incremental capacity and incremental dispatch programs by these three delivery models.

	Utility as a CSP	Standard Offer	Bilateral Contract
Incremental Capacity	N/A	New Jersey BPU program	Maryland GAP RFP (Allegheny Power, Baltimore Gas & Electric, Delaware Power & Light, PEPCO) Connecticut GAP RFP
Incremental Dispatch	Commonwealth Edison's Distribution-level DR	Consolidated Edison's Distributed Load Relief Program (DLRP)	Burlington Electric Department

Figure 2: DR Program Matrix: Construct and Delivery Models

**Utility as CSP:** In many ISO/RTO regions, utilities and CSPs alike enroll participants. Often, utility involvement is motivated by customer service considerations, and utility account managers may provide their most important customers with an opportunity to earn payments in exchange for making a DR commitment. It is important to note that in these cases, the utility is serving as a CSP as part of another entity's DR program – and not procuring the resource for its own use.

In the case where a utility wants to foster more DR participants in its service territory (incremental capacity) or harness existing resources for more frequent events (incremental dispatch), the utility might choose to manage its own DR program.

While a utility may act as a CSP in an ISO/RTO DR program, it may be, but is not necessarily, positioned to manage its own DR program. If a utility needs firm DR capacity for planning purposes, it will need to make a substantial investment in DR infrastructure, training, and processes – responsibilities generally considered to be outside the utility's core competency. For example, utility account management personnel are not specialists in identifying and maximizing unique energy reduction plans across a wide variety of C&I facilities, and as such, curtailment levels at facilities enrolled through a utility might be lower than those delivered by a third-party CSP. In contrast, CSPs are uniquely positioned to guarantee the delivery of DR capacity to utilities (through financial assurance and nonperformance penalties, thus reducing utility risk) while also insulating participating customers from all financial penalties.

- **Utility as CSP: Exelon's Commonwealth Edison (ComEd)**, an electric utility in northern Illinois in the PJM footprint. ComEd administers its own DR program to defer distribution expenses. It enrolls customers that are located at or near a substation that is nearing capacity, but where demand is growing slowly.<sup>8</sup> Nothing precludes these resources from enrolling in PJM's ELRP and other PJM DR programs. Under this construct, ComEd shoulders a majority of the performance risk and planning risk.

**Bilateral contract:** When a utility decides that the most prudent course is to outsource DR activities to CSPs, it can use either a bilateral contract or a standard offer. Both models are used for layered and incremental capacity programs. In most cases, a key difference between a bilateral contract and a standard offer construct is the notion of certainty. Through a bilateral contract, the CSP makes capacity commitments, typically backed by financial guarantees. Examples of both incremental capacity and layered programs delivered via bilateral contract include experiences in Maryland and Vermont.

- **Incremental capacity:** In 2008, **Maryland** identified challenges similar to those Connecticut faced in the early 2000s, with PJM forecasts showing capacity shortfalls in the state by 2011 and 2012, particularly in central and eastern Maryland. As a result, the Maryland Public Service Commission (PSC) initiated a proceeding in August 2008 to investigate how best to address this capacity need. The proceeding resulted in the PSC requiring Maryland investor-owned utilities (IOUs) to file Gap RFPs for the delivery of incremental DR capacity into the PJM emergency program. This Gap RFP resulted in the four Maryland IOUs signing individual bilateral contracts with four CSPs and one large institutional customer for a total of 400 MW of contracted capacity. In exchange for supplemental payments, the contracts required that CSPs guarantee their capacity commitments for the 2012-2013 delivery year and beyond, to ensure sufficient reliability resources within Maryland.

- **Incremental or Layered Dispatch: Burlington Electric Department (BED)** in Vermont is an electric utility within ISO-NE. BED signed a bilateral contract with a CSP<sup>9</sup> for capacity delivery beginning in June 2008. Through this contract, BED reduced the demand charges and energy charges it paid to ISO-NE and mitigated distribution-level congestion by leveraging existing ISO-NE DR participants in its service territory. Customers enrolled in the BED program received additional compensation in exchange for being able to reduce consumption more frequently than required by ISO-NE's program.

**Standard Offer:** In contrast to the bilateral contracts described above, resources procured through a standard offer can deliver little certainty when it comes to minimum guaranteed capacity levels or timing, with a cap on maximum allowable capacity or payment levels acting as the utility's only controllable lever. Under the typical standard offer construct, stakeholders determine compensation up front and provide the incentive to any parties interested in and qualified to participate, up to the maximum level of specified capacity. Examples of the standard offer approach for both incremental capacity and incremental dispatch include New Jersey Board of Public Utilities and ConEd.

- **Incremental Capacity: The New Jersey Board of Public Utilities (BPU)** created a standard offer program for incremental capacity. The BPU initiated a proceeding in 2007 to increase the level of DR in PJM's ELRP. Based on input from a range of stakeholders—utilities, CSPs, and ratepayers—the BPU's effort resulted in a standard offer program, where electric utilities were required to make available an additional incentive of \$22.50 per MW-day (or about \$8.20/kW-year) for all incremental capacity added to the PJM ELRP in the state in advance of the 2009-2010 PJM year.<sup>10</sup> The BPU capped the program at a maximum of 600 MW, with the total capacity allocated on a pro rata basis across the state's electric utilities.
- **Incremental Dispatch: ConEd's Commercial System Relief Program (CSRP)** program allows participants to enroll in a peak shaving program in addition to NYISO's SCR and Con Ed's distribution-level DLRP program. The CSRP program is open to

all qualified providers and CSPs, up to a specified cap. Unlike the NJ program, CSRP requires participants to commit to more frequent events to address distribution-level congestion.

## Incremental DR Programs Benefit All Stakeholders

The investment has already been made – a large and growing DR resource base exists today throughout ISO/RTO regions. In these areas, electric utilities are increasingly taking advantage of this existing infrastructure to meet local needs. Importantly, by leveraging existing ISO/RTO infrastructure, these programs can be built for considerably less cost than would be required if designing a DR program from scratch. Given the range of options facing electric utilities, from incremental capacity to incremental dispatch and bilateral contracts to standard offer programs, understanding program goals will be critical to the development of these cost-effective programs. Regardless of program goals or construct, all stakeholders will benefit as existing demand-side investments are leveraged to provide further benefit to the electric grid.



### About the author

Kristen Brewitt is a Senior Manager of Utility Solutions with EnerNOC, a leading provider of energy intelligence software and managed services for utilities and enterprise customers. Kristen has more than 15 years of experience in the utility and infrastructure industries as a marketing strategist, consultant, and public policy advisor. Her core focus has been on distributed energy resources, including demand response and energy storage, transmission and distribution system technology, and transportation and infrastructure policy. Kristen has held numerous consulting and marketing positions with DNV GL (formerly KEMA) and served as a senior legislative aide to two members of the U.S. Congress.

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# On the Frontlines with High Voltage Power

## A retired lineman on his quest to improve safety for his profession

By Jim Tomaseski

Like many linemen I've known, I was initially attracted to the job because it offered good pay and benefits, I enjoy working outdoors and, as long as I performed, I'd have job security. Linemen will be needed as long as people use electricity.

I knew that working as a lineman would present challenges, but I felt I was up to the job. There'd be climbing, rope work, and hauling heavy equipment up a power pole or transmission tower. And I knew I'd have to master both high voltage equipment and, especially, the safety practices and procedures that would ensure I arrived home safely to my family after the job was done.

Like many others, I did not immediately envision the storms I might work in, the irate customers I'd encounter or the endlessly different configurations I'd find at the top of the pole. Nor did I realize that, despite the industry's devotion to safety, significant shortfalls in safety-related practices remained.

Of course, working as a lineman is not for everyone. When apprentices encounter the full picture, some choose a different line of work. Personally, fortunately, I weathered the storms, calmed the customers, and met the challenges of building or repairing complex, high-voltage equipment while dangling dozens, sometimes hundreds of feet in the air. But I also had the opportunity to pay forward by improving safety for thousands of linemen who face daunting challenges so that you and I can flick a switch and power our lives.

I'd like to share a few highlights of my journey to keep the spotlight on linemen safety, which remains a moving target. It's bounded by the lineman's practical needs and concerns on one side and by costs and productivity demands on the other.

### My journey

Today, recently retired as safety director at the International Brotherhood of Electrical Workers (IBEW) – though, as you can see, I've taken on new responsibilities – I can look back over a nearly 40-year career as a lineman and active

participant in the IBEW effort to improve safety for the men and women on the front lines of building and maintaining our electric grid.

What a difference 40 years make! I feel like I've seen it all – or at least enough to be grateful that I met the challenges and retired from lineman work in good health to enjoy my family and a little golf and bow hunting. Too many of my brethren, to my sorrow, cannot say the same thing. I dedicate this article to them.

Statistics tell us that lineman safety has markedly improved over the past few decades, but we still experience preventable deaths and disfigurements. Safety-related work remains to be done. I remain active in this effort and I urge everyone in the industry to remain mindful of the lineman's challenge: to build or restore the power grid and return home safely every night.

### Becoming a lineman

For the uninitiated, here's a brief sketch of the lineman's profession:

One starts at the bottom, literally, as a 'groundman,' trainee or apprentice. Weeks of climbing school goes along with assisting a lineman on jobs learning the tools and techniques used for high-voltage equipment in the field. All along, most of us work as part of a team or crew, the bigger the job, the bigger the team. Everyone has each other's back. Typically, one works for a utility or a contractor; in either case, a lineman often is a member of the IBEW union.

### My passion for safety

I went to work in 1973 as a groundman for Virginia Electric & Power Company (now Dominion Virginia Power), and joined IBEW Local 905. (I also served three terms as Local 905's business manager.) As a lineman, I faced daily decisions. Though the basic hazards are the same, every location uses different brands of equipment or presents unique configurations. I knew the work was hazardous; I'd been in tricky situations. I prefer the term 'hazardous' to 'dangerous.' I should also state that being a lineman can be a safe job.

During my two decades on the job, I witnessed co-workers die or sustain horrible injuries and I developed a passion for lineman safety. I'd also had the opportunity to attend the University of South Carolina and the George Meany Center for Labor Studies. My eyes were open to solutions.

By 1993 I was assigned by the union to the utility department at the IBEW's international office in Washington, D.C., so I left the utility's employ. I soon took a role on ASTM Committee F18 on Electrical Protective Equipment for Workers. (ASTM is the American Society for Testing and Materials.)

I also represented the IBEW on reviews and updates of the National Electrical Safety Code (NESC), the fundamental basis for lineman protection and safety. Being involved in contract negotiations as well gave me further education and experience with the business of power, and the needs and constraints of linemen on one side and utilities and contractors on the other.

I got involved in work on ANSI (American National Standards Institute) and IEEE (Institute of Electrical and Electronic Engineers), ESMOL (Engineering in the Safety, Maintenance and Operation of Lines) committees doing standards-related work and I served as a liaison between the IBEW and OSHA (Occupational Health and Safety Administration) on standards development and compliance issues. Sometimes positive change takes years to develop and implement. It's a long game.

In 2001, the then-director of safety at IBEW retired and I was appointed IBEW's director of safety – a further opportunity to be involved in every aspect of safety for the nation's linemen.

### How lineman safety works

My experiences impressed upon me several axioms relating to power and safety for linemen.

Safety isn't an absolute state, for instance. It's a process and a culture that encourages safe practices and anticipates hazards. It must work for the lineman and it must meet constraints on cost and allow cost-effective productivity because utilities are mandated to provide affordable power and, ultimately, consumers foot the bill.

Safety equipment and practices must be codified and regulated by the various agencies involved. Linemen must adopt these practices as they go about their daily tasks, so equipment, rules, and best practices must be acceptable to the worker too – linemen must get the job done. And the pressure is always on to get the job done. On the other side of the fence, employers must have clear, usable, enforceable rules governing the workplace. Both sides need clarity and practicality or adoption and enforcement cannot work.

### Progress on safety

We've talked about safety in principle. Two examples will illustrate the strides we've made over the years.

Probably the single most important change in the past 40 years is the development and adoption of flame-resistant or 'FR' clothing. ('Fire retardant' material is a different animal.) As recently as seven years ago, linemen weren't required to wear FR clothing; today, few work without it. This adoption, as usual, wasn't the result of a simple mandate. Fifteen years ago, FR clothing consisted of difficult-to-wear fabric. It didn't breathe; it was hot and uncomfortable – before a lineman even started climbing. Acceptance by linemen was the challenge. In my view, fabric manufacturers really stepped up by developing wearable FR clothing, stuff a lineman could wear up the pole.

The adoption of FR clothing means that if a lineman is exposed to an arc – a fierce blast of energy – he or she won't suffer potentially fatal or disfiguring burns. These new outfits are several-fold as expensive as in the past. But what price can you put on a lineman's life? With adoption will come economies of scale that bring down costs.

### Benefit or burden?

Another example of safety in action is the development and adoption of fall protection equipment. Linemen are a hardy breed and they used to free climb a pole using a belt around the pole for balance and foot spikes for traction. New types of fall protection equipment back in the day were cumbersome and difficult to use up the pole; it slowed the lineman down. Adoption of better gear was slow. With new gear, such as wood pole fall restrictive devices, adoption has improved. The lineman simply asks himself whether new gear is a benefit or a burden. As one might guess, the old timers are slower to embrace new gear, but younger linemen become accustomed to it from the first day of training.

The bottom line in both examples of improved gear is that no lineman expects to get hurt. It's only after years on the job that the potential hazards sink in.

### Linemen rodeos and safety

Linemen take great pride in their skills. The desire to demonstrate their prowess among peers and to compete among themselves has led to several decades of so-called lineman rodeos, held around the world. These events help emphasize doing the job correctly, and safely, while competitors are timed for speed and scored for technique. All applicable safety rules must be observed. Many lineman rodeos also co-locate with safety conferences.



### Training and instinct

I've been asked about the relationship between courage and knowledge in a lineman's work. I'd say that knowledge contributes to courage. When you know what you're doing, you have the confidence to carry out the task. Training is critical to safety-related knowledge, but you can't teach courage. It's in your blood.

That's why the focus must remain on training. Linemen must know the rules and best practices embodied in the NESC, OSHA and other pertinent codes and regulations. And every lineman must hone his or her instincts on when to go slow or even stop if conditions or configurations don't make sense.

### Job satisfaction

In this look back on my own experience, I've emphasized the challenges linemen face. Pressure to restore people's power comes with the job. Sometimes residents are irate; they've been without lights, refrigeration, cooking, hot water, TV, even communications. No Internet!

You don't learn how to manage such situations by reading a book. You learn as each new experience unfolds. You may have to reassure an individual, even a small crowd that you're there to get the power back on. You may have to listen to a tirade. Then you suit up and start climbing – that's when the real job begins. Later, if you're fortunate, you may get a round of applause or even a hot meal from a grateful homeowner.

Regardless, a lineman takes personal satisfaction in accomplishing the mission, safely and effectively. For a lineman, that's all that really matters.

### About the author

**Jim Tomaseski** was a lineman for 20 years and has been actively involved in lineman safety for over 40. He is a member of IEEE, vice chair of the NESC Main Committee and Corporate Director of Safety at PAR Electrical Contractors.



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# Pioneering Spirit is Alive and Well in Alaska

## Land Clearing Contractor Routinely Clears Way for Infrastructure Developments

By Tom Gross and  
Courtney Shafer

Although the golden age of railroads is long past, clearing rail extensions is just one of the infrastructure pioneering projects that TJs LandClearing – a Fairbanks, Alaska company routinely accomplishes. In addition, they often cut roads to remote Alaskan villages, clear right-of-ways for electric utilities as well as fiber optics, and even cut vegetation from areas that will be runways and hangars when relocating airports.

Remote doesn't begin to describe it. Calling the conditions cold qualifies for the understatement of the year. And to top it off, Tom Gross and his crews wear headlights because at best, the conditions are dusk-like. Few people in the world are equipped to handle this kind of work – and few would probably want to. But it is all in a day's work for Tom Gross and his LandClearing crews.

### A New Definition of Remote

Every contractor talks about the importance of equipment durability and uptime. But when you routinely work hundreds of miles from the nearest town, downtime can be disastrous – ruining not only your project timeframe, but your reputation as well. Throw in a few months of weather where the high temperatures are sub-zero while working in extremely dark and remote locations, and you get a glimpse of what life is like for TJ crews. Despite these conditions, Gross has found that Fecon mechanical mulchers are a hot commodity by keeping his crews productive throughout the long, dark, and frigid winter – and keeping his well-earned reputation intact.

One aspect of Alaska that often draws visitors and new residents is the vast expanse of natural areas that are so prevalent. It is a beautiful sight – and a welcome one for a man whose company earns a living through vegetation reduction.

"We do infrastructure preconstruction – all sorts of vegetation reduction and clearing," explains Gross, whose arsenal of equipment includes 2 Franklin C4550 rubber tired tractors fitted with BH120 mulchers, a Franklin 5000 with a BH120 mulcher, a tracked Takauchi TL150 with a BH74 mulcher head mounted to it, and a SuperTrax 200 fitted with a BH120. The Franklin tractors deliver between 200 and 215 HP to the masticator heads – allowing Gross and his crews to mulch anything in their path, and easily meet the chip size spec from the Alaskan DOT. "The fixed teeth and the counter-cutters really blow apart heavy woody debris," continues Gross, but he is quick to point out that, "we don't do any earth moving."



This type of vegetation reduction is required for clearing in advance of infrastructure projects like the railroad track laid from Fort Mackenzie after TJ's crews cleared the path. Bringing roads or electric utilities to remote villages is another area where Gross' team excels. Clearing right-of-ways for new power lines and maintaining existing ROWs are two types of projects that they specialize in. Fiber optics is another area where they excel. But getting power to the people who call the 49<sup>th</sup> state home does not mean that you are necessarily close to any amenities. Gross recalls a few specific projects that epitomize just how desolate and challenging it can be.





## Pioneering Spirit is Alive and Well in Alaska

"We did a project on the Canadian border, where we were 300 miles from the nearest sizable town and more than 400 miles from Anchorage," recalled Gross. "The nearest place for any support at all was 110 miles away. So, you might be able to get a (hydraulic) line made, but if a pump quits, you are outta luck."

At those distances you can burn a couple days just getting parts. And that's if they are on the shelf. Special pumps, gears, and fittings that are not stock items present problems.

"Alaska in and of itself is notoriously expensive to do business because you are so far away from the real world," continues Gross. "A lot of logistical planning must take place."

Part of that planning means knowing what sort of spares you might need, and bringing those with you. But inventorying spares also cuts down on job profits, so it is a balancing act. Another part of the logistics equation is bringing enough fuel – not just for the equipment but for the heaters as well.

"A lot of the ground is soft up here, so you have to work when the ground is frozen. That means you are working in the cold. It is 40-degrees below zero up here today, and that is ambient temp without wind."

Working in these conditions requires Gross and his crews to take precautions that most of us have never dreamed about.

"We put parachutes over the machines and let the heaters run," says Gross. "When they are blowing full time you are burning between 9 and 10 gallons an hour of fuel – and you have to keep that sucker going with the machine under there because you are not going to start the machines cold. At 25-degrees below zero the hydraulic oil is as thick as molasses. And those sensitive hydraulic systems will not tolerate that thick syrupy fluid."



### All Obstacles Present Challenges

In addition to severe weather, Gross and his crews also have endangered species, extremely difficult access, and even mating seasons to contend with. A case in point was the Golden Valley

Electric Association Northern Intertie project which included 105 miles of power line right of way clearing that was 150 feet wide. This highly visible project included a total of 1,900 acres – some of which was only accessible on foot or by helicopter. Work was stopped by hunting seasons for moose which runs most of September, and for bear, which is encompassed within that timeframe. Additionally, the Migratory Bird Act, originally devised to safeguard raptors like peregrine falcons, eagles, osprey, and other large avian predators, now affords protection for any birds nesting in the spruce, birch, willow or alder trees commonly found in Alaska's interior.

### Cold? BRRRR-ing It On!

While pausing for animal migrations and hunting season are not the norm, more often than not TJs crews are working in the cold. In the deep of winter, Gross and his crews run their heaters all night and perform service in the mornings. Just how much heat does it take to overcome these frigid temperatures?

"After the machine has been under that parachute with that heater blowing a million BTUs – and that's not an exaggeration – one million BTUs of heat under those parachutes trying to thaw them back out – then you can get the zircs to take grease. When you can get oil to move – then you fire up the machines."

Given the demands required to keep fluids flowing in these frigid climes may prompt readers to ask whether mechanization is really the answer under such conditions. Gross is quick to point out the production advantages inherent with the mulchers.

"The biggest advantage of mechanical mulching in general and Fecon in specific is that mechanical vegetation reduction is quicker and safer than having men on the ground."

Gross figures that in typical Alaskan vegetation – not riparian vegetation – but typical spruce, birch, willow and alder (from 3 to 10-inches in diameter), his crews can clear an acre a day. That's one man, and one machine – a BH120 operating with 205 horsepower—clearing an acre in a 9-hour day.

Contrast that with hand crews and you'd have 8 sets of boots on the ground working a day and a half – or a total of 96 man-hours for clearing and chipping. Mechanization is much safer than 8 guys wielding chain saws on uneven footing in cold climates.

### Versatility to Meet Any Job Spec

Gross appreciates that he can handle virtually anything he encounters on projects with his mulcher heads. After the equipment has passed through, it leaves a carpet of mulch in its wake. Gross and his crews leave the organics in place to aid in erosion control.

## Pioneering Spirit is Alive and Well in Alaska



But versatility to shred everything in its pathway is just one aspect of the Fecon story. If the project calls for it, he can even work some of the mulch into the top layer of soil by adjusting the mulchers' 'shoes,' as might be the case in fiber optic clearing projects. The same result, if accomplished by hand, would require additional steps – and time.

For other projects, however, minimal disturbance of the ground is essential because the work is all permit-driven and must be done when the ground is frozen. Here Gross and his teams mulch to ground level but no deeper – again thanks to the adjustable shoes on the mulcher heads.

Gross has observed plenty of other mulchers and has found that while they attempt the same task, they are not all the same. Before buying his first mechanical mulcher 11 years ago, he "researched the heck out of them." Now that he's got a fleet of mulchers, he continues to survey what is available to make sound decisions for future projects.

"We look at way they are constructed," continues Gross, "the gauge of metal, how things are set up, how pumps are run, how easy they are to service, and flat durability. They say that you only get so many hours out of these pumps, or these cutting tools, and we've far surpassed the hours on that from where they are saying the wear should be – we're getting more time out of our stuff."

Others in the industry do not fare quite so well, however. Gross recalled a competitor who recently purchased a different brand of mulcher, and had "the whole cutting head fall off."

It takes a special breed of person to live and work in these environments. Forget the Holiday Inn—most often crews end up camping by the equipment and checking heaters throughout the night. Gross has plenty of stories of similar conditions – setting up tents by the equipment – and the photos to prove he's not just spinning yarns.



But these self-reliant workers are lost without equipment as durable and hard working as they are.

"Equipment that is accountable," says Gross, "that's what it is all about. It is tough up here, so you need tough gear... and Fecon makes tough gear."

### About the authors



**Tom Gross** is President of TJ's Land Clearing, a Fairbanks, AK based land clearing contractor that specializes in clearing projects for infrastructure including roads, railroads, airports, and ROW clearing for utilities. Although originally from North Dakota, Gross settled in Alaska after being stationed there in the military. He started TJ's in 1988 as a completely hand-clearing operation and has grown it into a largely mechanized one. He is also an accomplished opera singer, performing as a Lyric Tenor. Tom earned a BS in Biological Science with an emphasis in Marine Science from the University of Alaska, Fairbanks in 1994.



**Courtney Shafer** is the Manager of Marketing Services at Fecon, Inc, a Lebanon, OH based manufacturer of forestry tracked carriers and attachments for use in the land clearing, vegetation management & Right-Of-Way industries.

Courtney earned a BA in Public Relations with a Minor in Radio/Television from Northern Kentucky University. She has been with the company for five years.





# THE BIGGER PICTURE

BY KENNETH WACKS



## Appliance Energy-Usage

### Introduction

The Home-to-Grid Domain Expert Working Group (H2G DEWG), part of the Smart Grid Interoperability Panel (SGIP), has participated in the development of a new American National Standard important for smart grid customers. ANSI/CEA-2047, *Consumer Electronics – Energy Usage Information (CE-EUI)*, was published by the Consumer Electronics Association (CEA) in May 2014. The H2G DEWG reviewed the specifications during the drafting of the standard.

The objective of ANSI/CEA-2047 is to specify uniform methods for consumer devices to report energy consumption to an energy management device or service provider via a home network. Consumption data by individual appliances may be useful for augmenting the Green Button program offered by some utilities to educate consumers about their electricity usage. Also, demand response programs can be enhanced with information about appliance consumption so power can be allocated when supplies are constrained or relatively expensive.

### Beyond the meter

Traditionally, the electric network terminated at the customer meter. A smart grid can extend information technology (IT) beyond the meter into premises to help manage the demand for electricity from building machinery and home appliances. Also, IT can integrate distributed energy resources (DER) such as solar power, wind turbines, and storage facilities while maintaining a balance of supply and demand on the electric grid.

According to the GridWise® Architecture Council<sup>1</sup> (GWAC), IT will revolutionize planning and operation of power grids just as it has changed business, education, and entertainment. IT will enable the integration of new distributed technologies such as Demand Response, distributed generation, and storage with traditional generation, transmission, and distribution assets. The purpose of IT is to improve interoperability among the subsystems that constitute an electric grid. The key challenge<sup>2</sup> for the electric industry according to GWAC is how to overlay IT and communication networks on the existing grid while maintaining operations and then enhancing these operations<sup>3</sup>.

The domain of the traditional electric utility has reached from the generator to the customer meter, as illustrated in Figure 1. The Energy Independence and Security Act of 2007 mandates that utilities manage the grid for increased reliability. IT and data communication networks make this possible.



Figure 1: The Traditional Electric Utility

The IT and communication networks can improve the operation of the traditional parts of the grid. The transmission and distribution grids can be instrumented with sensors for wide area situational awareness that enables remote monitoring via an IT network.

The policy shift away from increasing supply to managing demand requires that the domain of the utility be extended beyond the meter, through a gateway, and connect to a communications network inside the house. From there, utility signals can reach those devices that can participate in energy management. The homeowner may choose to install local power generators such as wind and solar. Thus an integrated smart grid includes the elements shown in Figure 2. A home network can provide the interconnections among the devices in the home involved with energy management.

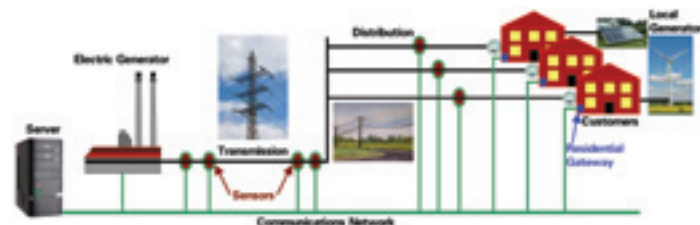


Figure 2: The Electric Smart Grid



For the grid beyond the meter, IT and communications enable effective energy management using methods such as:

- Demand response
- Integration of local generation and storage with microgrids and the public grid
- Allocating power for electric vehicle charging

Data critical for these functions are drawn from devices in the home that use electric power. Most appliances have a required safety label that lists the maximum power needed so consumers do not overload electrical circuits. However, effective energy management requires data about actual consumption that may vary by operating mode. ANSI/CEA-2047 specifies methods for acquiring more detailed operating data for energy management functions.

## ANSI/CEA-2047 functions

ANSI/CEA-2047, the new American National Standard for Energy Usage Information, specifies data acquisition methods while addressing the following challenges:

- The cost of measuring and recording device energy consumption during a specified interval
- The cost of an electronic interface between a consumer device and a home network for reporting device energy consumption
- The complexity of reporting consumption by operating mode and time duration of that model

Consumer markets are very competitive by features and price. Consumers tend to value product features that enhance entertainment and alleviate chores such as washing dishes and clothes. New functions that may reduce energy consumption are difficult to value and to sell. Therefore, the CEA committee responsible for ANSI/CEA-2047 provided options to reduce complexity that could impact product costs. The approach was to acknowledge that some reporting of approximate consumption data was more practical than mandating high precision real-time data.

The ANSI/CEA-2047 standard allows conforming devices to report energy consumption using a range of options with increasing precision. These options accommodate variations in energy consumption of many consumer electronic devices and home appliances according to the mode of operation. For example, a dishwasher uses more energy to dry the dishes than to rinse them. Here are some of the optional reporting methods specified in ANSI/CEA-2047:

1. A pre-stored average energy usage for each operating mode
2. A pre-stored average power usage for each operating mode multiplied by the duration of that operating mode
3. An actual measurement of energy consumed during the time interval of an operating mode

The recipient of energy-consumption messages from the device is responsible for recording and processing the data.

## ANSI/CEA-2047 data for energy management

The data provided by consumer devices that conform to the specifications of ANSI/CEA-2047 for reporting energy usage (even if approximate) can enhance energy management using demand response. Demand Response includes programs and technologies to modify customer demand for energy directly by remote control of customer appliances (called Direct Load Control) or indirectly through pricing incentives or event notifications (such as an anticipated heat wave). A framework for Demand Response is included in an international standard, ISO/IEC 15067-3, published by ISO and IEC in June 2012.<sup>2</sup>

To implement Direct Load Control the utility sends Demand Response control signals to interrupt the operation of selected devices such as air conditioners and water heaters remotely from outside the house. In a typical version of Direct Load Control the utility sends a signal via the power line or a specialized radio to a switch that shuts off air conditioners up to 15 minutes each half-hour for up to six hours each day. Water heaters are generally turned off entirely for two to six hours.

Direct Load Control requires prior arrangements with customers for permission and equipment installation. Direct Load Control has limitations because it treats each type of customer equipment the same. Much more effective Demand Response is possible by exploiting microprocessor-based intelligence at the customer premises using Distributed Load Control. Distributed Load Control afford customers increased flexibility and control compared to Direct Load Control.

With Distributed Load Control utility suppliers do not operate any customer appliances or devices remotely. Instead, they issue a static or dynamic price signal or message that indicates the state of the electricity supply (called an event message). The objective is to influence customer choices about using appliances that consume significant amount of electricity. The price or event messages may include the following:

1. *Price signals*: A multi-level signal that indicates at least two different states corresponding to the electricity price
2. *Time-of-use pricing*: A static rate structure (called a tariff) with specified rates that change at specified times in a repeating pattern such as weekdays and weekends
3. *'Real-time' pricing*: Prices that change dynamically. The specific price, time duration of this price, and amount of prior notification before this price level is in effect vary by utility practice
4. Event notices sent by the utility to customers about pending supply limitations that are usually temporary
5. Event notices sent by the utility to customers about temporary rate changes.





The utility has the opportunity to change prices when a peak demand is expected. Eventually, utility policy makers would like to adjust prices according to the wholesale market price of electricity to reflect actual utility costs. Appropriately designed smart appliances respond with minimal user involvement or inconvenience.

The following scenario is an example of how a user might interact with an integrated Distributed Load Control system:

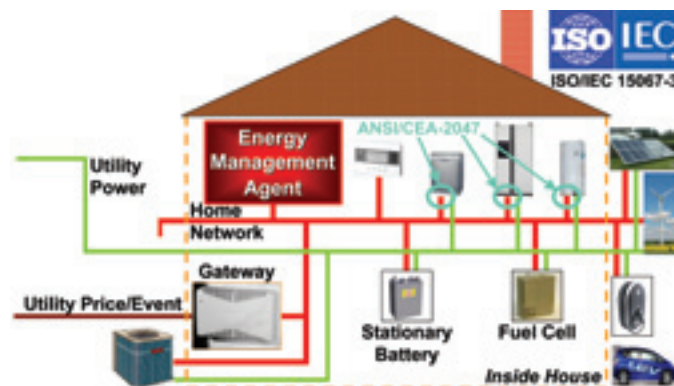
It is 4 PM and the user is about to run the dishwasher. The options in Figure 3 might appear on an appliance display panel:



**Figure 3: Simple Consumer Choices for Distributed Load Control**

The user makes a simple decision based on criteria that are understandable: “Do I need the dishes cleaned in the next three hours (perhaps for a dinner party at 7 PM), or can I wait and save some money?” This makes buying energy as simple as shopping at a retail store.

The introduction of an Energy Management Agent (specified in ISO/IEC 15067-3) adds functionality to Distributed Load Control by enabling the allocation of limited energy (or a limited budget for energy) among appliances. It may switch energy sources from the public grid to local generators or a battery. As shown in Figure 4, the utility sends pricing data electronically to all houses in real-time via a wide area network. The H2G DEWG has issued a white paper on using broadcast communications facilities for distributing pricing and event data.<sup>3</sup> This pricing signal enters the house through a residential gateway. This gateway interconnects a public network using telephone, cable TV, power lines, or radio with a home network. The gateway may be a separate device, as shown in Figure 4, or could be integrated with other gateways, controllers, or even inside an electric meter.



**Figure 4: Distributed Load Control with an Energy Management Agent**

As illustrated, the consumption data are sent over the home network via a communications interface (specified in another standards issued in 2013: ANSI/CEA-2045, *Modular Communications Interface for Energy Management*). The Energy Management Agent uses the ANSI/CEA-2047 data to help the occupant determine which appliances to operate while conserving energy and managing energy costs.

## Applying ANSI/CEA-2047 data for Demand Response

The Energy Management Agent (EMA) in Figure 4 determines how and when to operate appliances based on the cost of energy, the energy requirements of the appliances, the availability of distributed energy resources (DER – wind, solar, etc.) including stored energy, and user inputs, as illustrated in Figure 5.

Communications between the utility and the EMA consist of the two data flows shown on the left side of Figure 5. The user might specify a monthly energy budget (for example, \$100 per month) and preferences (shower at 8 AM, air conditioning at 6 PM, clothes washing after 8 PM, etc.). The customer should always be able to override decisions of the EMA. After processing these data, the EMA issues signals that are distributed over a Home Area Network to the relevant appliances.

The energy requirements of appliances can be provided by messages specified in ANSI/CEA-2047. The algorithm in the EMA might adapt to the precision of the data provided by the networked home electronics and appliances.

The EMA receives the energy pricing and event data, the ANSI/CEA-2047 data, and users preferences. It acts an intelligent agent for the customer as it processes these data. The EMA is programmed with algorithms, including elements of artificial intelligence, to optimize appliance operation. Smart appliances that can operate in energy conserving modes may improve the effectiveness of a Distributed Load Control system. An EMA is application software that could be located in a personal computer, a cable TV set-top box, or a security system.



Figure 5: Energy Management Agent Parameters

Demand Response, coupled with local intelligence and a home network, should increase residential customer cooperation. The decisions are simple, while consumer privacy and convenience are not compromised. ANSI/CEA-2047 is one of many important standards that enable an effective ecosystem for energy management.

## ABOUT THE AUTHOR

Dr. Kenneth Wacks has been a pioneer in establishing the home systems industry and a management advisor to more than 150 clients worldwide. His business spans home and building systems, utility customer services, and digital entertainment networks (including HDTV and IPTV). His worldview, insights, and expertise are valued by executives for enabling competent decisions on complex technology issues. He also provides due diligence for investors and expert witness services for litigants.

The Consumer Electronics Association chose Dr. Wacks to chair the international committee (ISO/IEC) establishing world standards for home and building automation. In addition, he has written American National Standards in home automation and networked home appliances.

Dr. Wacks serves as chair of the Smart Grid Interoperability Panel (SGIP) Home-to-Grid Domain Expert Working Group (H2G DEWG). The United States Department of Energy appointed him to the GridWise Architecture Council. For electric and gas utilities, he has designed and demonstrated new customer services by linking utility communications with home automation to deliver demand response and value-added services. He received his Ph.D. from MIT as a Hertz Fellow and studied at the MIT Sloan School of Management.

### About the Home-to-Grid Domain Expert Working Group

In 2008, the Smart Grid Interoperability Panel (SGIP) Home-to-Grid Domain Expert Working Group (H2G DEWG) was established by the National Institute of Standards and Technology (NIST), U.S. Department of Commerce, and the GridWise® Architecture Council

(GWAC), an industry panel of 13 experts appointed by the U.S. Department of Energy. The H2G DEWG is now part of the Smart Grid Interoperability Panel (SGIP), a member-funded, non-profit association created with support from NIST to identify technical and interoperability standards harmonization that accelerates modernization of the grid.

The H2G DEWG scope includes applications and communications linking energy service providers (utilities and other third-party providers) with customer equipment in residential buildings via the electric grid and associated networks. Customer equipment may include home appliances, consumer electronics, plug-in electric vehicles (PEVs), plug-in hybrid electric vehicles (PHEVs), and local power sources (such as photovoltaics). Participants in the H2G DEWG include representatives from utilities, services providers, equipment vendors, and appliance manufacturers. Further information is available at: <http://www.sgip.org/home-to-grid-h2g-dewg>.

### About the Smart Grid Interoperability Panel

The Smart Grid Interoperability Panel (SGIP) is a public-private non-profit collaborative working to identify requirements for interoperability and technical standards. SGIP members work together to accelerate interoperability, testing and certification so that efficient, secure electrical power can reliably maintain and increase standards of living around the world. Members also have privileged access to the collected knowledge and expertise of all the domains in the Smart Grid ecosystem.

## References

- 1 In 2004 the United States Department of Energy created the GridWise Architecture Council to guide the utility industry toward smart grids. The Council consists of 13 experts drawn from the electric and high-tech industries. The author of this paper, Dr. Kenneth Wacks, was appointed to the GridWise Architecture Council to focus on utility services for residential customers including the interconnections of utility networks, home networks, and attached devices.
- 2 ISO/IEC 15067-3, Information Technology – Interconnection of information technology equipment – Home Electronic System – Application models – Part 3: Model of an energy management system for HES.
- 3 Broadcast-based H2G Communications Solutions, an SGIP white paper, January 2014. Please see 'Broad-cast-based Energy Management' in Energy Central, February 25, 2014 for an overview.



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By Rudi Carolfeld

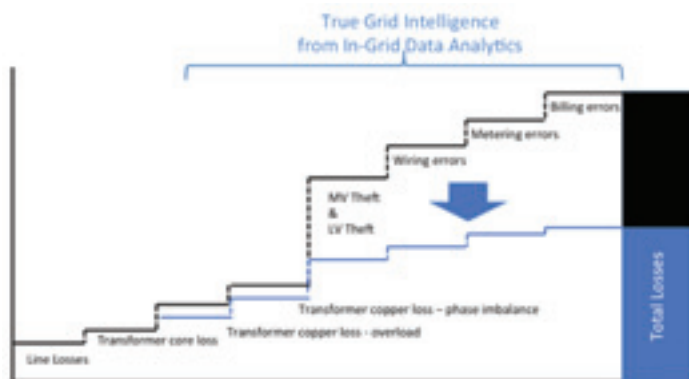
## SECURITY SESSIONS

# In-grid Data Analytics Helps Utilities Slash Grid Losses and Power Theft

### Introduction

Electricity distribution network operators face unique security challenges in that they cannot possibly track every 'leak' in their distribution grids using smart meters alone. With yearly losses estimated to exceed US\$200 billion worldwide and growing, network operators are under pressure to reduce risk and improve safety, increase efficiency and improve financial performance. Awesense Inc has introduced the True Grid Intelligence (TGI) platform to address this problem.

The approach acknowledges the fact that there is rarely enough monitoring in place to pinpoint overloaded or imbalanced transformers, illegal bypasses and metering errors. It also recognizes that it is not practical to build a security perimeter around thousands of miles of distribution lines, nor to monitor hundreds of thousands of distribution transformers. With the opportunities for power theft so widespread and easily accomplished, but difficult to detect, it's little surprise that losses due to theft, imbalance, overloads and errors can go unchecked for years.



TGI can identify grid losses stemming from both technical and non-technical sources

The platform offers a new approach that gives utilities the in-grid data analytics they need to understand real grid operating conditions and identify a complete range of losses between billing points and substations.

### Big data analysis can leave costly information gaps

Data analytics have been used for many years to battle fraud and abuse in the insurance and finance industries, and more recently in the IT industry to address the mounting need for cyber security. In the last few years, a few major analytics vendors have applied these big data analytics techniques to massive volumes of data generated by the widespread deployment of smart meters; this is called meter data analytics, (MDA).

When an MDA system generates an alert, that alert needs to be investigated – and MDA systems can generate hundreds or even thousands of alerts every month. How can a utility efficiently investigate so many alerts coming from a vast service area? Compared to the challenge of investigating losses (due to fraud and abuse and errors) in a closed system like a data center used by a credit card company, for example, investigating losses on an open system with thousands of kilometers of distribution lines and millions of widely dispersed billing meters is extremely daunting. Although a good starting point, big data analytics cannot tackle this problem alone.

TGI addresses the challenge by providing a framework to prioritize the highest risk areas of the grid, to carry out investigations in an effective and systematic manner, and to document the facts of an investigation for legal or audit purposes.

Comparison to other industries is useful: an insurance provider might identify fraud through unusual claim patterns, and send a field investigator to confirm whether or not the claims are legitimate. A finance company might identify fraud through unusual credit card purchase patterns and call the cardholder by phone to see if the purchases were legitimate. These investigations are relatively easy to carry out quickly and cost effectively.

In an electrical distribution network, the MDA system may generate an alert if a subscriber's consumption pattern has suddenly dropped off, for example, or if the voltage on one house is lower than his neighbors. These techniques can be effective in finding the most blatant thieves. The field investigator now has to prove that these alerts are the result of fraudulent behavior (theft by diversion) rather than legitimate changes in usage. Smart meters and MDA, according to an EPRI study,<sup>1</sup> can identify about 30 percent of theft – but they do not address the complex requirements of investigations of fraud and abuse of the electrical grid.

Furthermore, MDA cannot find losses if the meter was installed incorrectly (intentionally or inadvertently), if there is a wiring or a billing error, if there is no meter installed, or if the diversion is near the transformer or on the MV line. MDA is also unable to identify inefficient transformers (severe phase imbalance) or heavily loaded transformers caused by unknown loads.

## Utilities need more than traditional modeling

Utilities want to leverage their investment in smart meters and analytics. All of the alerts and alarms and usage trends can help identify areas in the grid that deserve further attention. Engineers and customer service personnel can use this data to create load models and try to predict consumption trends.

But modeling is only as good as the data it uses. No model based only on meter data can identify the severity and location of non-technical losses such as illegal connections, meter wiring errors, meter setting errors, and billing multiplier errors. Without the ability to gather in-grid data (which is downstream from the substation and upstream from the billing meter) a distribution grid operator is blind to the real operating conditions on their distribution lines.

Some vendors have recently introduced sensors and meters that can be connected directly to medium voltage (MV) lines and on the low voltage (LV) side of distribution transformers. These devices provide additional data streams that can dramatically improve the awareness of line operating conditions – if enough of them are installed.

Rarely can a distribution network operator afford to place enough permanent line or transformer meters throughout the network to pinpoint fraud, abuse and other losses in the grid. Furthermore, even if the area of interest can be narrowed down to a small neighborhood there will always be a need to carry out a field investigation to identify the cause. TGI addresses this need.

## True Grid Intelligence based on in-grid data

This technology offers an efficient and effective solution for establishing what is really happening on an electrical distribution grid. With it, the highest-risk areas within the grid are sampled to collect in-grid data over a relatively short period of time – typically one week – taking a 'snapshot' of the actual operating conditions in those parts of the grid.

With this in-grid data, the network operator can identify the majority of losses, and introduce preventive measures as appropriate. This type of in-grid data is cost-effective to obtain and can easily be compared against probable operating parameters in order to rapidly confirm if a particular grid segment is compromised, or in need of extra investigation.

The platform defines and supports a scalable mechanism to prioritize the highest risk grid segments, carry out investigations and collect in-grid data, analyze the in-grid data, and identify ways to reduce or prevent losses, improve efficiency, and reduce service disruptions.



Four simple stages underpin the advantage of the TGI approach

## Planning & prioritization

Since measuring every grid point is impractical, it is important to identify high-risk segments and focus limited resources on identifying losses in these areas first.

The TGI Risk Advisor uses alerts generated by MDA systems and a variety of other information sources that may include: tip line, demographics, customer types, historical trends, high loads, transformer ratings, etc. In this system, these data points are assessed and weighted to rank the targeted areas according to the highest risk of loss, inefficiency or service disruption due to overloads.

In addition to helping optimize which areas to investigate, managers can configure dashboards to help plan their investment into their Revenue Assurance team. Dashboard metrics include the expected number of monthly investigations, expected identified losses by region and total annual identified losses. Identified losses are further categorized as theft, phase imbalance, metering error, etc.



## Investigation and in-grid data collection

Where operational data is available (for example, substation feeder meters, line sensors, and transformer meters), the platform will make use of these readings and determine if there are significant energy or phase imbalance problems in that area.

Where no permanent device is installed, actual up-to-date distribution operational data can be obtained quickly and easily by sampling the live distribution lines. The software helps users select the best location for the installation for temporary current sensors, usually for one week at a time. Sensor data is collected, combined with other essential details of the investigation (photos, meter data, rating information, etc.), and stored in the Investigation Data Repository for future reference.

The Data Repository is an important aspect of the system: all data relating to a particular investigation, including the GIS asset data that defines the actual grid topology and all operating conditions of the grid segment under investigation, is stored in the Data Repository as a system of record. This makes it possible to refer to the data and provide an evidence chain to prove theft, for example, in situations where the case may be subject to a legal challenge in the future.

## Analysis

TGI provides comprehensive analysis tools to identify the main causes of avoidable loss in an electrical distribution grid. The most common issues are: theft, metering/billing/wiring errors, and inefficient transformer loading due to phase imbalance or overload.

*Energy imbalance* can be determined using the software by comparing upstream readings from feeder meters and in-grid line sensors against downstream billing information. If there is a significant mismatch between the energy supplied to a group of downstream consumers, then the system can pinpoint the location of that imbalance.

*Phase imbalance* can be identified by in-grid line sensors deployed on the outgoing lines from a polyphase transformer, or from a group of single phase transformers. When one phase carries a substantially higher load – or a substantially lower load – than the other two phases, the efficiency of the transformer(s) is not optimized and might be improved by rebalancing the loads.

This technology makes it possible to visualize whether or not there is a significant and sustained imbalance of load levels between the phases. Comparing the transformer load levels against downstream load levels make it possible to pinpoint the cause of these imbalances.

*Transformer load surveys* can also be accomplished using in-grid line sensors deployed on the outgoing lines of a transformer. In this case, the software determines if the aggregate load is near the rated load of the transformer or exceeds the rated load for sustained periods of time. Heavily loaded transformers are less efficient and subject to earlier failure than transformers that carry lighter loads.

Also provided by the platform is a *risk map for transformers*, identifying those transformers that are heavily loaded and deemed to have a higher impact on the grid operations if they fail. This helps the network operator decide where to spend scarce capital on most urgent upgrades, and where capital spending might be deferred.

## Recommendations

The system can link case management functionality to the in-grid field investigation process. Results from in-grid data analysis can also be a feedback source of analytics for the Risk Advisor, and can be a critical input to machine learning capabilities that can further optimize investigation planning, reduce false positives, and enhance actual outcomes.

Users can utilize these results to classify the cause and extent of each loss and inefficiency in the distribution grid segment under investigation, while making practical decisions that improve overall financial and operational performance.

## Conclusion

True Grid Intelligence offers a new way for distribution network operators to locate energy losses and improve operational efficiency, while reducing enterprise risk. It offers utilities a unique level of visibility on high-risk network areas that can lead to better use of resources.

Utilities that have implemented the platform have enjoyed a return on investment in excess of ten times their initial outlay. TGI has helped utilities worldwide reduce losses by as much as 50 percent over a given three-year period – with an annualized value of hundreds of millions of dollars. Lower losses have also reduced the requirement for more generating capacity, in turn having a positive impact on the environment footprint.

## ABOUT THE AUTHOR

**Rudi Carolsfeld** is Executive Vice President of Global Sales & Alliances at Awesense Inc. He has more than 20 years of technical sales and marketing experience solving Smart Grid problems. At Power Measurement Ltd. Rudi held numerous roles in engineering, marketing, and domestic & international sales until the company was acquired by Schneider Electric. At RuggedCom Inc. he was Vice President Asia Pacific when the company was acquired by Siemens and held the position of Global Sales and Business Development.

<sup>1</sup> Electric Power Research Institute, *Revenue Metering Loss Assessment*, (November 2001):

## Applying Lessons Learned from Leading a Nuclear-powered Ship to the World of Advanced Utility Operations

By Mike Varney



As a former U.S. Navy captain with over 20 years' experience in operating nuclear-powered submarines, Mike Varney draws insightful parallels between commanding a submarine and operating a utility. He offers relevant lessons learned from his time with the Navy, as well as a glimpse into the cutting-edge naval technologies that the utility industry is now adopting.

A submarine might not be the first comparison that comes to mind when thinking of utilities. Yet they have more in common than one would imagine. In some ways, a submarine is a miniature utility in totality – complete with a nuclear-powered generator, a distribution system, storage capacity, operations personnel and even a smart-grid-like operations network. And that's just electricity—submarines also have sewage, water and air networks that are all required to stay afloat. Being submerged thousands of feet underwater can be fairly daunting if the lights go out. In this environment, power is not just a luxury; it's a matter of life and death.



In my career as a submarine commander with the U.S. Navy, I dealt with many of the same challenges that utilities transitioning to smart grids are now facing. Challenges like how to establish situational awareness to operate more efficiently; how to build a knowledge repository into your operational processes to safeguard against staff turnover; and how to increase resiliency so you can bounce back when you, quite literally, take a hit. While these issues are new to utilities in the nascent phase of their smart grid networks, the

Navy encountered these challenges years ago—making the technology of today's submarine a glimpse into the technology of tomorrow's utility.

### Situational awareness provides visibility into daily operations

Operating in dark ocean depths, submarines are able to 'see' using sonar that gathers and interprets massive amounts of acoustic data from everything under the sea, including marine life and other ships in a 1,000-mile radius. It's a finely tuned technology that provides unparalleled situational awareness, but one that creates an overwhelming number of data events. All of this data can be information overload and, quite frankly, useless unless you're able to cut through the 'noise' instantaneously. In the case of a naval ship, this ability allows you to pinpoint the enemy warship over the horizon in a big, noisy ocean. Or, for a utility, you can stay on top of network exceptions, security threats and operational problems.



As a result, modern submarines operate an intelligent software solution that integrates massive amounts of data from sonar including water, environment and weather conditions, ship and navigational data, off-ship intelligence data, weapons systems data and, of course, visual and video data from the periscope when at shallow depths. The system can quickly determine which data to ignore and what warrants alerting operations personnel to act upon immediately.



A utility's smart grid faces the same challenge – all the data it gathers is invaluable for creating situational awareness and visibility into its daily operations, allowing the utility to more swiftly pinpoint outages, security breaches and other threats. But it's important to access that invaluable awareness without increasing manpower. To achieve this, utilities require a grid management application that integrates with OT and IT systems to provide a contextual, real-time view of operations. By synthesizing data relayed by field devices and integrating it with data from other networks and systems, the application can analyze all the information together, apply business rules to manage the vast majority of data events, and only alert operators to important anomalies and security threats.

### Creating a knowledge repository through machine learning

As the commanding officer in charge, it was a given that I could operate the submarine's systems better than anyone else on the ship. Although it took me 30 years to reach that level of proficiency, new recruits today could start out operating at about 90 percent of my capacity on their first day – all based on the information and tools now available to them. This is because, over the last several years, the Navy has developed technologies that compensate for operators' lack of experience by building the expertise right into the operating system. The average age of a worker on a submarine is 24, and he or she only spends about two years in any position before either moving up the chain of command or transferring to another ship or to a shore facility. So we recognized the risk inherent in departing knowledge and experience a long time ago. When the Navy transitioned to digital and computer OT systems, we had to build systems and technologies that would continue to improve our performance and our peoples' performance without relying solely on workers staying in a job for over 30 years. The systems themselves compensated for, and mitigated, the 'brain drain' that many utilities are now facing.

This is a key lesson for the utility industry. As the majority of its most experienced operators are on the brink of retirement; utilities are facing an imminent loss to their operational knowledge base. They, too, need to build that knowledge base into their operating systems to avoid losing it through staff turnover. The way to do this is with a highly configurable grid-management application that is capable of machine learning. The more business rules you 'teach' your technology platform – complex procedural rules that apply specifically to your unique operational needs – the

more sophisticated and effective the virtual operator becomes. This allows you to operate your utility just as effectively, whether your operations personnel have two years of experience or 20. In addition, a virtual operator increases efficiency by allowing you to manage operations with the minimum head count possible.

### Improving resiliency to weather the storms

For submarines in a warfare situation, resiliency is paramount to survival—the consequences of losing power can be a matter of life or death. If you're hit by a depth charge, you need to get any affected systems back online in a hurry in order to return fire. The best way to do that is to be able to learn from past experiences in order to anticipate the most efficient way to restore power based on the type and location of damage you've sustained.

While utilities may not need to worry about being hit by torpedoes, severe weather conditions like wind, ice, fires, tornadoes and hurricanes are a very real threat. And although there's nothing you can do to prevent bad weather, you can use past experience to be better prepared for it. Specifically, utilities can use the data collected from their smart grids to analyze historical patterns of which systems tend to go down when, and then correlate that information with past and current weather patterns. When linked to real-time grid and weather conditions, systems are able to predict events, incidents and problems, resulting in more proactive and predictive operations. The technology, when coupled with new processes, matures the operations teams and enables utilities to better anticipate, prepare for, handle and recover from outages due to severe weather situations. This, in turn, creates more stable and resilient networks.

A smart grid software solution with this capacity for pattern analysis and correlation represents the ultimate level of machine learning, and allows a utility to practice "predictive operations" and mature its operations. Through a solution like this, utilities will be able to monitor and analyze patterns on the grid and bring to light issues that otherwise may not be found. This is key, because being both predictive and proactive is crucial to good customer service—and with customers more dependent than ever on their electricity supply, they have equally increased expectations for the stability and consistent reliability of the network.

### Cutting-edge technologies enable smooth sailing

As national energy strategies drive the public to lower their consumption, utilities' revenue streams are feeling the crunch, and they need to operate more efficiently than ever to stay profitable. Smart grids

offer this capability as long as you can harness and extract value from the massive volumes of data they provide. While the Navy may have been a pioneer in this realm, utilities are certainly catching up—in part thanks to cutting-edge technologies and industry-specific software

solutions that integrate seamlessly with all systems. Solutions that can be programmed with business rules to automate operations, and have the analytical capability to make operations predictive rather than reactive, are mission critical to a utility's success.

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### ABOUT THE AUTHOR

**Mike Varney** spent over 20 years in the U.S. Navy, where his experience included commanding the most advanced nuclear-powered submarines in complex operations around the globe, leading a special operations team in reconstruction efforts in Afghanistan, and directing a Naval Operations Center. He has also served as a strategic advisor for the U.S. Department of Defense, a senior evaluation officer at nuclear power plants, and an advisor to companies providing smart grid technologies to utilities.

Mike holds Bachelor of Science degrees in Nuclear and Marine Engineering as well as Engineering Management. He also holds a Master's of Science degree in National Security Strategy. Today, he is the senior director of strategic advisory services at Bit Stew Systems, where his knowledge of operational standards, emerging methodologies and key market drivers ensures that Grid Director™, Bit Stew's world-leading smart grid operations platform, provides business value to utilities in the real-time network operations domain.

## San Bernard Electric Installs Advanced Data Exchange

### Part I

By Doug Lambert and  
Dominic Geraghty



San Bernard Electric Cooperative, a rural cooperative distribution utility in southeast Texas, recognized the time, expense, and difficulty inherent in connecting a host of disparate, internal, customized systems that had been independently developed and were not interoperable.

The utility decided to implement the National Rural Electric Cooperative Association-sponsored and trademarked MultiSpeak® specification, which is the de facto standard for data exchanges among enterprise application software commonly applied in utilities. The foundation of the specification is an agreement on the details of the data objects that need to be exchanged to more fully integrate disparate software applications. It is intended to assist vendors and utilities in developing interfaces that enable software products from a variety of vendors to interoperate without the need for extensive custom interface development.

The systems targeted for integration via the MultiSpeak specification included a metering system (in transition), an outage management system, a customer information system and a geographic information system, among others. The specification documents how interfaces between these systems may be used to implement utility business processes in over 300 standard use cases, thus reducing the time required for implementing MultiSpeak-compatible integrations.

The utility's decision on implementing the MultiSpeak specification coincided with its decision to transition from a power line carrier-based automated meter reading system to an advanced metering infrastructure system in a manner that would leverage the supplementary functionality provided by the new metering technology.

The utility found that cost/benefit calculations to build a business case with positive return on investment were difficult to conduct prior to implementation. Instead, the initial proposal to utility management rested on the credibility and experience of utility specialists and on their qualitative assessment of the benefits.

Post-implementation tracking of benefits, however, has established that operational efficiencies and related, customer service improvements justify the time and cost of implementing the MultiSpeak specification. Specifically, the MultiSpeak specification was successful in automating a host of hitherto manual functions, which significantly improved interoperability and led to cost savings in terms of reduced field operations/truck rolls as well as other benefits.

The MultiSpeak installation and commissioning process provided a host of lessons learned which will be useful to other utilities embarking on similar projects.

When the utility realized that the MultiSpeak specification would not address all of its integration needs, the utility identified which applications it could immediately incorporate into its MultiSpeak-enabled suite of applications. For unaddressed integration needs, the utility sought to learn whether those gaps would be addressed by future development by the sponsoring National Rural Electric Cooperative Association and/or vendors.

Further, in the integration of an advanced metering infrastructure system, an outage management system and the customer information system, some incompatibilities required custom coded-application programming interfaces to achieve interoperability, which were developed internally.

Pay careful attention to software issues relating to iterative versions. A vendor that is 'MultiSpeak compliant' doesn't mean that the vendor's system can integrate seamlessly with MultiSpeak-compliant systems the utility already has in place. Different vendors may be running different versions, so it is important to understand the capabilities and limitations of the version of the MultiSpeak specification that your vendor is supporting, especially as versions are not backwards compatible.

A MultiSpeak implementation demands well-understood, even required responsibilities internal and external to the utility. Internally, the team must grasp the utility's business processes and functions that integration and automation are expected to support. For external parties, including vendors, interoperability should be broadly defined; software iterations should not be specified. Instead, procurement requirements should focus on the business processes being supported and integrated. Requests for proposals, contract awards, service level and maintenance agreements and testing documentation should explicitly place responsibility on vendors for a) participating in MultiSpeak development activities, b) maintaining interoperability, c) interoperability testing and documentation.



- Beyond documentation, the procuring utility must assess the methods within the interoperability affirmation/assertion documentation to ensure that the testing address their required business functions. In fact, interoperability testing between utility systems should be contractually required as part of system-acceptance testing. Vendors must guarantee that functionalities in current system offerings needed to support utility business processes continue to be supported in future versions.

### Implementing company overview

San Bernard Electric Cooperative (SBEC) is a rural cooperative distribution utility in southeast Texas. It covers an area approximately 96 miles long by 35 miles wide. It was formed in 1939 when several leaders from Austin and Colorado counties became interested in securing service for their farms. The cooperative derives its name from the San Bernard River, which is the common boundary between Austin and Colorado counties.

SBEC has 26,000 metered customers, 78 miles of transmission, 16 substations with **supervisory control and data acquisition (SCADA)** control and monitoring and four offices across seven counties. It utilizes microwave backhaul between its offices and substations. Figure 1, SBEC's service area, west of Houston, Texas.



Figure 1: San Bernard Electric Cooperative's service area

### Business challenge

In the early days at SBEC, a large amount of customization was required to transport data from one operating system to the other. The utility had a spider web of custom solutions (see Figure 2). Over time, technologies evolved requiring even more customization. SBEC found itself deploying more and more customized solutions, adding further to the siloed nature of solution-specific data flows within the utility.

One example of this evolution was in automated meter reading (AMR). SBEC had used a power line carrier (PLC) AMR solution since 1988. More recently, before implementing MultiSpeak Specification Version 3.0 (See Appendices B, C and D for details), the utility deployed a new Sensus AMI wireless system in place of the older PLC AMR system. The problem was that the new AMI system was not interoperable with the utility's existing customer information system (CIS) and geographic information system (GIS)/outage management system (OMS) systems. This incompatibility created unexpected operating issues. For example, in the creation and receipt of numerous alerts and alarms, not all of them had the same time-sensitivity, creating an unscreened information overload for SBEC system operators.

SBEC realized that it was no longer tenable or productive to operate its spider web of customized solutions and it decided to transition to standardized data flows to create a more interoperable operating system. At this point, SBEC examined the MultiSpeak specification as a solution; management understood the benefits of interoperability. SBEC began its journey of untangling its spider web by replacing each process with the MultiSpeak specification, with the goal of creating an interoperable suite of applications.

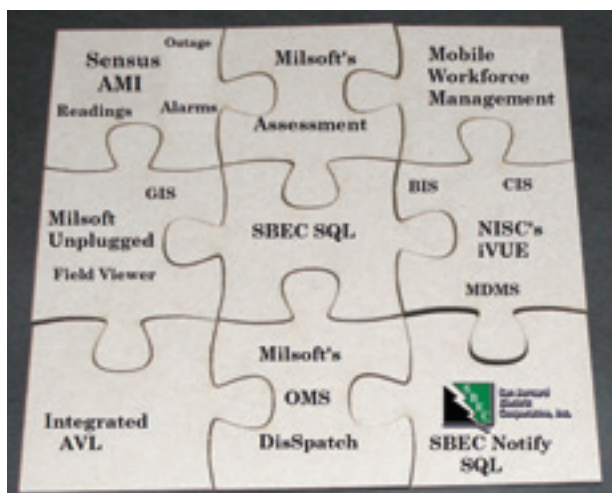


Figure 2: Numerous customized applications shifted to one interoperable system by implementing the MultiSpeak specification

### Solution description

When the utility realized that the MultiSpeak specification would not address all of its integration needs, SBEC set out to identify which applications it could immediately incorporate into its MultiSpeak suite of applications.

Where it was determined that the MultiSpeak specification did not meet all of its needs, SBEC set up discussions with its vendors and with the MultiSpeak specification's sponsor – the National Rural Electric Cooperative Association (NRECA) – to ascertain if future development would fill those gaps. For example, in deploying the smart meters of its new AMI system, SBEC was using machine-to-machine (M2M) batch processing in some cases – the 'ship file' that came with each shipment of meters was batch-dumped into the inventory system, a National Information Solutions Cooperative-developed application. The data management for the new-for-old meter exchange followed processes that paralleled the deployment processes in the field.

SBEC uses a daily interval reading that batch uploads to the billing system. This is a custom query with scheduled tasks inside of Standardized Query Language (SQL). For the meter data management system (MDMS), California Metering Exchange Protocol (CMEP) and Meter Level Alarms (MLA) standards are used. Alarms are sent to the OMS and field viewers through custom SQL. Blink counts are gathered and stored as a daily reading to an SQL table. Operators run deltas against the blink counts and compare them to outages in the area to determine what actions are needed to improve the quality of service. For this process to work smoothly and cohesively, the utility's Information Technology (IT) department had to be intimate with all of the relevant enterprise systems, business processes and data exchanges.

The installation of the MultiSpeak specification automated the meter exchange from the field device data base to the CIS.

SBEC included MultiSpeak methods to:

- update meter changes to the AMI and OMS applications,
- allow for self-reporting of outages from the AMI to the OMS before a phone call from a customer could occur,
- automate the connect/disconnect process from the CIS/billing system to the AMI system,
- notify the OMS in real-time when a meter had been disconnected for non-payment and
- notify the OMS when an account on the pre-payment option had been disconnected due to insufficient funds.

The automation of these functions prevented unnecessary trips by utility linemen.

Using the MultiSpeak specification, the interactive voice response (IVR) is notified about outages from the OMS when a phone call is received. Engineering analysis (EA) receives energy usage from the AMI system through the MultiSpeak specification.

Some custom SQL integrations were required in this implementation scenario. These custom integrations can be challenging, depending on the willingness of vendors to allow access to their proprietary schema protocols and tables that enable the custom integrations.

Examples of custom SQL coding that were developed by SBEC include:

- auto-posting of alarms into Milsoft's OMS package,
- a permanent historical record of all alarms, outages and phone calls at individual locations,
- provision of a meter alarm to the operator's field viewer, and
- creation of a system email to communicate alarms to the utility's meter department.

In an upcoming issue, Part II will discuss MultiSpeak analytics and alarms using OMS and field viewer; SBEC's AMI smart metering and alarm interpretation; interoperability-related lessons learned from SBEC's implementation; and general recommendations to industry.

## ABOUT THE AUTHORS

**Doug Lambert** is the Senior Principle of Distribution Engineering and System Automation with the National Rural Cooperative Association, an organization of more than 900 not-for-profit rural electric cooperatives and public power districts providing retail electric service to more than 42 million consumers. Previously, Doug worked with the San Bernard Electric Cooperative in Texas for 15 years as an IT manager and SCADA and engineering data supervisor, among other roles.

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