



# ***Electric Energy T&D***

## **MAGAZINE**

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**8 Industry News**  
**52 Advertisers Index**



**Electric Energy T&D**  
is proud to be a member  
of these associations

**4 POWER POINTS**  
**Justin Time for this Optimist**  
If a biographer were to ask me to name one of the more dominant traits I possess, I'd have to say that I'm a true optimist. I have an inherent trust in the goodness of people.

**14 THE GRID TRANSFORMATION FORUM: How Operational Analytics can bring clarity and aid decision making for the smart grid**  
We are in conversation with Dr. Neil Rothwell, Director of Business Development, AssetWise Analytics with Bentley Systems.

**18 GREEN OVATIONS**  
**There's some Super-Hero in all of us**  
If you're reading this magazine, there's a fairly good chance you're old enough (but not too old) to remember the phrase "Holy Cow, Batman!" The reason I bring this up is because the world of energy in whatever city, Gotham or otherwise, you happen to live in is more exciting, daunting, and incredible than any of us could have ever imagined.

**24 FROM RESEARCH TO ACTION**  
**Utility Data Analytics Project Makes Molehills out of Mountains**  
Enter the Electric Power Research Institute's (EPRI's) Distribution Modernization Demonstration (DMD). The initiative aims to identify what can be done with existing data, gain insights from the data that were previously unknown or perhaps not yet conceptualized, and assist utilities as they become more versatile with big data analytics and associated activities.

**26 Surveying for Electrical Losses**  
UK Power Networks (UKPN) is on a mission to reduce system losses and is considering some unconventional means. Conventional wisdom is that electric distribution system losses are primarily from two sources; resistive losses and transformer excitation losses.

**29 How to Build a Smart Control Room**  
As electric utilities face ongoing demands for better service and fewer, shorter outages, they look to include the latest 'smart' technology in their operation centers.

**31 Electricity Storage Reaches New Heights**  
In modern power systems, energy storage has become imperative because of the increasing penetration of renewable sources, distributed generation and microgrids.

**34 Legacy Thinking: How to fix outage communication and gain operation efficiency**  
A recent visit with a utility customer provided an opportunity to tour their newly renovated 60+ terminal call center, designed to serve a population of more than four million.

**37 Big Data: Enabler of an Intelligent, Sustainable Grid**  
Beginning with Thomas Edison's Pearl Street Station in the late 1800s, persistent economies of scale, declining prices, exponential growth in demand, and steady improvement in technology supported the development of an electric utility grid architecture and industry business model that continued largely unchanged for almost a century.

**40 Optimizing Performance across Operations, Maintenance, and Engineering with Connected Asset Lifecycle Management**  
Once upon a time, data gathering was the problem; utilities had no way to see the big picture. With the advent of now-ubiquitous software systems and the rapidly growing convergence of IT and OT, there is plenty of data.

**43 Expanding from Smart Grid to Smart City**  
In the United States, nearly all municipalities have deployed or are considering deploying smart grid initiatives to deliver intelligent energy services to their citizens.

**44 BIGGER PICTURE**  
**Getting to ZERO: One Task at a Time**  
The electric utility continues to come to grips with achieving ZERO injuries. It's a journey that people at all levels in T&D organizations have their eyes on.

**46 SECURITY SESSIONS**  
**Don't make me do it, I can't do it, it's too hard!!**  
In spite of regulatory pressures and government mandates and reading about cyber attacks and data breaches in the news almost daily there are still a surprising number of industrial facilities that have not implemented an effective cyber security program to protect their critical digital assets.

**50 GUEST EDITORIAL**  
**Bringing Renewable Energy to the Grid**  
Bringing renewable energy to the grid is no easy achievement. Even with the savviest team of experts and a strong balance sheet, it takes a wealth of patience and resources to navigate through each project's complex roadmap.



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# POWERPOINTS

## Justin Time for this Optimist



If a biographer were to ask me to name one of the more dominant traits I possess, I'd have to say that I'm a true optimist. I have an inherent trust in the goodness of people. I know what you're thinking – that in this day and age with the pervasive nature of the Internet and other questionable forks in the road that I am naïve. That may be true but given the last decade with the Harper government, I have cringed and gritted my teeth as I watched and learned how one federal government steam-rolled over an entire country. How could one party seemingly dislike Canadians so much? Now that we have a modern, made-in-Canada-for-Canadians federal party I think I owe it to myself to once again think fondly of the future.

One thing I do know is that I do not want to be part of the vilified generation that did not act to try and change the human attitude to saving the planet. It can't simply be a case of us retreating in a sustainable way. I recently viewed again the BBC TV series entitled *Planet Earth*. I shuddered every time the narration spoke of how we may be witnessing this scene or that one for the final time due to climate change. The scary part is that the series was made in 2006 – just about the time our then federal government came into power. The following ten years Canada had an appallingly bad record on global warming in an already environmentally stunted, carbon hungry world. Canada was in Paris at the United Nations climate change conference among thousands of international observers participating in one of the most promising international meetings ever held to tackle the global threat of climate change. For the first time in a long time, we as Canadians are optimistic as we infuse a new sense of energy brought on, in large part, by our three levels of government that were in attendance.

A December 5, 2015 article in the *Toronto Star* caught my eye under the title 'Corporate Canada has important role to play in climate change.' It was written by columnist Jennifer Wells and read as follows:

It was a poke in the eye and, appropriate given the venue, delivered with a great sense of élan.

Faux employees of JCDecaux – the French company that is No.1 in the world of 'street furniture' – fanned across the streets of Paris in the wee hours placing 600 'corporate' posters in Decaux's pretty glass transit shelters.

At first glance most of them looked like real live advertisements. An exception would be the funereal image of Japanese Prime Minister Shinzo Abe with nuclear reactors sprouting out the top of his head.

The Air France poster, featuring a flight attendant pressing a finger to her lips could have been a retro 'come fly with me' advertisement.

Except the new ad lines read: 'Tackling climate change? Of course not. We're an airline.'

The guerrilla campaign was the brainchild of a U.K. outfit calling itself Brandalism. And it worked. It had verve.

Critics can mock the collective's 'revolt against corporate control of the visual realm' mantra, and specifically its challenge to the 'corporate takeover' of the Paris climate talks.

But corporations have long taken control of the street as a means to sell stuff. (Witness those sight-blocking ad pillars in Toronto, not to mention the ad-wrapped streetcars.)

The Brandalists merely reclaimed, albeit temporarily, the public realm as a place for artful, possibly incendiary, conversation.

The question for business becomes, what is the counterpoint?

In the age of the great awakening – in which Canada re-emerges as a country that cares about global warming – Prime Minister Justin Trudeau echoes the likes of U.S. President Barack Obama in asserting that economic growth and a safer environment are no longer mutually exclusive.

This is the new political mantra.

But he has yet to prove the point.

As Trudeau stood on stage alongside Bill Gates in Paris, championing the launch of Mission Innovation, a global partnership that pledges to support green energy innovation, the point was driven home that American business is front and centre on the climate file.

The launch of the Breakthrough Energy Coalition spreads the net to global business, a bevy of billionaires George Soros to Nigeria's Aliko Dangote (Africa's richest man) to Richard Branson to Alibaba's Jack Ma. The absence of a Canadian voice is quite striking.

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Back in the U.S. the American Business Act on Climate pledge announced on Tuesday that 154 American corporations including Apple, UPS, and GE, have now signed on representing \$4.2 trillion (U.S.) in revenues with representation in all 50 states. While the goals are not mandated – they are not insubstantial, from reducing emissions by as much as 50 percent to achieving zero waste-to-landfill.

Any of these initiatives can be picked apart. But they do illustrate, to use another of Obama's overused phrases, that business, at least in some spheres, is taking a seat at the table. Social impact is the story of the day.

Yet Canadian businesses have assumed a curiously, and disappointingly, low profile. Perhaps they lie wounded in the trenches of the Harper years. Perhaps they haven't quite caught on to the fact that it's time to speak up now.

Instead, the voices we hear are those of governments – federal, provincial, municipal – and NGOs. Trudeau says there can be no 'laggards' this time round. He's speaking to all Canadians when he says that. Corporate Canada is no exception.

The stars have aligned for the global community to secure an ambitious, enforceable – and desperately needed – climate agreement. The world cannot afford more delays on real climate action. In the constellation of global climate action, Canada is one of the stars that moved the furthest: The past month alone has seen tectonic shifts in Canada's position on critical issues, from carbon pricing to climate financing.<sup>1</sup>

That change continued right through the Paris talks. Over the past decade Canada often undermined global progress with backroom ducking and diving aimed at blocking climate solutions. These types of moves only served to blacken our international reputation. With a new federal government at the wheel, Canada arrived in Paris with a positive attitude and all the necessary fixings to be influential and constructive at the negotiating meetings.

Now that this historic Conference of the Parties (COP21) is behind us, I'd like to take a look at the general action items made by the committee.

- Welcoming the adoption of United Nations General Assembly resolution A/RES/70/1 – 'Transforming our world: the 2030 Agenda for Sustainable Development,'
- Recognizing that climate change represents an urgent and potentially irreversible threat to human societies and the planet and thus requires the widest possible cooperation by all countries, and their participation in an effective and appropriate international response, with a view to accelerating the reduction of global greenhouse gas (GHG) emissions,
- Also recognizing that deep reductions in global emissions will be required in order to achieve the ultimate objective of the Convention and emphasizing the need for urgency in addressing climate change,

- Acknowledging that climate change is a common concern of humankind, Parties should, when taking action to address climate change, respect, promote, and consider their respective obligations on human rights, the right to health, the rights of indigenous peoples, local communities, migrants, children, persons with disabilities, and people in vulnerable situations. The right to development, as well as gender equality, empowerment of women, and intergenerational equity must also be respected,
- Also acknowledging the specific needs and concerns of developing country Parties arising from the impact of the implementation of response measures and, in this regard, certain decisions as indicated in this document,
- Emphasizing with serious concern the urgent need to address the significant gap between the aggregate effect of Parties' mitigation pledges in terms of global annual emissions of GHGs by 2020 and aggregate emission pathways consistent with holding the increase in the global average temperature to well below 2 degrees Celsius above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 degrees Celsius.
- Also emphasizing that enhanced pre-2020 ambition can lay a solid foundation for enhanced post-2020 ambition,
- Stressing the urgency of accelerating the implementation of the Convention and its Kyoto Protocol in order to enhance pre-2020 ambition,
- Recognizing the urgent need to enhance the provision of finance, technology and capacity-building support by developed country Parties, in a predictable manner, to enable enhanced pre-2020 action by developing country Parties,
- Emphasizing the enduring benefits of ambitious and early action, including major reductions in the cost of future mitigation and adaptation efforts,
- Acknowledging the need to promote universal access to sustainable energy in developing countries, in particular in Africa, through the enhanced deployment of renewable energy,
- Agreeing to uphold and promote regional and international cooperation in order to mobilize stronger and more ambitious climate action by all Parties and non-Party stakeholders, including civil society, the private sector, financial institutions, cities and other subnational authorities, local communities, and indigenous peoples.

Mr. Trudeau has alerted all and sundry that Canada is ready to cut carbon pollution at home, and will provide financial assistance to vulnerable countries dealing with the effects of a dangerously warming planet. This is a remarkable and refreshing change. And the feds brought to Paris something it has never had before: meaningful leadership from powerful provincial and municipal governments.

More than ever, Canada's federation is presenting a united front on climate change. I'm not at all surprised at how truly optimistic I've begun to feel.

<sup>1</sup> Tim Gray, Sidney Ribaux, Ed Whittingham, "Canada returns to climate leadership in Paris," Toronto Star (December 5, 2015): IN6



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## Hydro Ottawa recognized as one of Canada's Top Employers for Young People

January 2016

For the third year in a row, Hydro Ottawa has been recognized as one of Canada's Top Employers for Young People.

At Hydro Ottawa, young workers benefit from career development opportunities, community involvement initiatives and a culture that focuses on the safety and well-being of each employee.

With more than 40 percent of its workforce set to retire in the next ten years, Hydro Ottawa is preparing for the future by strategically reaching out to young talent early thanks to its educational partnerships and focus on the student experience. Currently, employees under the age of 30 represent 16 percent of Hydro Ottawa's workforce.

### Quick Facts

- Hydro Ottawa's partnership with Algonquin College provides training to students enrolled in the two-year Powerline Technician diploma program.
- Hydro Ottawa offers in-house apprenticeship programs for its trades workers and also manages an engineer intern training and development program.
- In 2015, Hydro Ottawa hired 55 students, growing its workforce by nine per cent.
- Hydro Ottawa delivers The Student Apprentice - a full-day program that offers students an opportunity to present "value-added" ideas to the organization.
- Hydro Ottawa's outreach strategy includes awareness at the elementary school level, and leveraging deeper connections through partnerships at the secondary and post-secondary level. The goal is to capture the imagination of young workers early while they're still considering career options.
- Giving back to the community is an important part of Hydro Ottawa's culture. Employees are encouraged to get involved in workplace charity events, and afforded one paid volunteer day a year.

### Quotes

*"Every day, the next generation of talent continues to define and shape the Hydro Ottawa of the future: passionate about the environment and the community, excited about innovation and technology, and motivated to share ideas that will make a difference in the world. We want young people entering the workforce to choose Hydro Ottawa because we are as enthusiastic about the future as they are."*

**-Bryce Conrad, President and Chief Executive Officer**

## Eversource and National Grid Complete Major Upgrade to New England's Electric System

January 2016

Cleaner, competitively priced electricity now has a new way to reach customers in southern New England due to the completion of the Interstate Reliability Project (IRP). Eversource and National Grid partnered on the approximately \$483 million project, which included station upgrades and the installation of a new 345-kilovolt (kV) transmission line along 75 miles of existing, contiguous rights-of-way in Connecticut, Massachusetts and Rhode Island. The new line and related improvements will enhance reliable delivery of power to customers throughout New England and strengthen the regional electric grid.

"The Interstate Reliability Project improves the efficiency of the grid by eliminating system bottlenecks and improving the flow of power within our region," said David Boguslawski, Vice President of Transmission Strategy & Operations at Eversource. "The project also supports the region's economic growth and environmental goals through greater access to newer, more efficient, and cleaner generating plants."

By strengthening the backbone of the regional grid, the project delivers environmental benefits such as enabling broader regional access to future renewable energy resources and allowing existing renewable resources to reach previously constrained areas. Additionally, farmland was protected as conservation land and critical wildlife habitats received special care during construction. Once the work was complete, the restored rights-of-way added hundreds of acres of important new wildlife habitat that has been shrinking in New England.

"As we look to connect new energy sources, stabilize costs for customers and maintain the reliable service needed to underpin the economic vitality of our communities and our region, a robust, resilient transmission system is a must," said Rudy Wynter, President and Chief Operating Officer of National Grid's FERC-regulated Businesses. "The completion of this project marks a major step towards achieving that goal."

Along with the system reliability and environmental benefits, the IRP will also produce millions of dollars of new, annual property tax revenues to 18 municipalities in the three states where the project was constructed. Additionally, hundreds of workers were employed to work on the IRP that began in early 2014.

The completion of the IRP caps off the New England East-West Solution or "NEEWS" - a suite of projects designed to strengthen the reliability of the regional power grid by improving its efficiency and eliminating crippling congestion that can be very costly for customers. Collectively, the NEEWS projects are the largest upgrade to the regional transmission system in many years. During the past 10 years, while the NEEWS projects were being planned, sited and developed, New England experienced an unprecedented wave of power plant retirements, which made these robust, long-term transmission improvements even more important.

### Project Details/Stats

- Rights-of-way miles: 75
- States: Connecticut, Massachusetts and Rhode Island
- Number of towns along the route: 18
- Miles of wire: 679 miles; enough to stretch from Providence, RI to Durham, NC
- Number of tubular steel structures: 899
- Total weight of the steel: 18.4 million pounds
- Amount of concrete for structure foundations: 22,446 cubic yards (equivalent to 2,244 mixer truckloads); enough cubic yards to fill a 21-story building more than 50 square feet





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## Avista Receives Commission Decision in Washington General Rate Cases

January 2016

Avista's (NYSE: AVA) electric and natural gas general rate cases have concluded, with an order from the Washington Utilities and Transportation Commission (Commission or UTC) that will change electric and natural gas rates, beginning Jan. 11, 2016.

The Commission approved rates designed to provide a 1.6 percent, or \$8.1 million decrease in electric base revenue, and a 7.4 percent, or \$10.8 million increase in natural gas base revenue. The Commission also approved a rate of return (ROR) on rate base of 7.29 percent, with a common equity ratio of 48.5 percent and a 9.5 percent return on equity (ROE).

Throughout the rate case process, certain circumstances and costs changed, causing Avista to revise its overall proposed rate requests downward,

especially for its electric operations. Avista's need for electric rate relief was reduced primarily due to a decrease in power supply costs of approximately \$24 million, largely driven by the continuing decline in the price of natural gas used to run the company's gas-fired generation, as well as other cost updates and revisions.

The natural gas revenue increase approved by the Commission is related to Avista's ownership and operating costs to run the natural gas business. Changes in the commodity costs of natural gas for natural gas customers are reflected in Avista's annual Purchased Gas Cost Adjustment, which is generally effective November 1st each year. On Nov. 1, 2015 natural gas customers' bills were reduced approximately 15 percent related to the decline in the market price of natural gas.

"We are pleased with the Commission's decision and its recognition that Avista's investment in utility infrastructure and its operating expenses are increasing at a faster pace than revenues. This is a positive outcome that provides us the opportunity to continue to recover the costs of serving our customers and investing in our systems while maintaining a fair return for our shareholders," said Scott Morris, chairman, president and chief executive officer of Avista Corp.

"In addition, we are pleased that our Washington electric customers will receive the benefit of Avista's reduced power supply costs going forward."

Avista anticipates issuing 2016 earnings guidance during the fourth quarter 2015 earnings call in February 2016.

### Low Income Rate Assistance Program (LIRAP)

Recognizing the impact of rising prices on customers, especially limited income and senior customers, the Commission approved a multi-year funding plan for Avista's Low Income Rate Assistance Program (LIRAP). LIRAP provides direct energy bill assistance for limited income and senior customers. LIRAP is funded through a separate tariff. The increase in LIRAP funding results in a \$320,000, or 0.1 percent increase in electric revenue and a \$391,000, or 0.3 percent increase in natural gas revenue for these programs.

### Expiring Customer Rebate

Avista's electric customers in Washington are currently receiving benefits from a rebate related to the Energy Recovery Mechanism (ERM) that has been reducing customer bills by 1.6 percent, totaling approximately \$8.2 million on an annual basis. This rebate will expire effective Jan. 11, 2016. The expiration of the rebate will result in a 1.6 percent increase in customer bills.

### Residential Customer Bill

As a result of the Commission's decision, including the changes in LIRAP and the expiring ERM rebate, residential electric customers using an average of 966 kilowatt hours per month would see an increase in their monthly bill of \$0.15, or 0.2 percent. There is no change to the residential monthly basic charge.

Residential natural gas customers using an average of 68 therms per month would see a total bill increase of \$4.63 per month, or 7.9 percent, for a revised monthly bill of \$62.96. There is no increase to the residential monthly basic charge. This increase includes the change in LIRAP.

For more information about the general rate cases, visit [www.utc.wa.gov](http://www.utc.wa.gov).

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## Black Hills Announces Major Expansion of Opower Customer Engagement Program

January 2016

Opower (NYSE: OPWR), the global leader in cloud-based software for the utility industry, announced that Black Hills Energy is expanding its successful customer engagement program to deliver Opower's Big Data-powered energy insights to 30,000 additional households across Pueblo, Colorado. The expansion includes Opower's Digital Engagement offering and its Energy Efficiency offering with Home Energy Reports. The expansion gives thousands of Black Hills customers a full set of tools to manage their energy use.

"Opower's energy efficiency program has received a tremendous reception from our customers, who now have more control over their energy use than ever before," said Steve Jurek, Director of Energy Efficiency of Black Hills. "We're excited to expand this program to even more customers. Black Hills' increasing investment in these programs demonstrates our strong commitment to delivering a modern utility experience for our customers."

Opower first partnered with Black Hills Energy in February of 2015, delivering personalized energy insights and an upgraded web portal to 45,000 gas customers across Colorado.

"Black Hills joins an ever-growing group of leading utility companies that have seen strong results from Opower's platform," said Dan Yates, co-founder and CEO of Opower. "Nothing underscores our value proposition better than client expansions, and we look forward to our growing partnership with Black Hills."

## Midcontinent Independent System Operator (MISO) Issues RFP for First Competitive Transmission Project

January 2016

MISO issued a formal Request for Proposals (RFP) for its first competitive transmission project - the Duff-Coleman 345 kilovolt (kV) project in Southern Indiana and Kentucky, crossing the Ohio River. The project was approved by the MISO Board of Directors on December 10, 2015, as part of the MISO Transmission Expansion Plan 2015 (MTEP15). The project is expected to be in-service on January 1, 2021.

MISO conducts an extensive process to qualify transmission developers who are eligible to prepare and submit competitive Proposals for the Duff-Coleman project. To date, 48 entities are qualified to engage in the MISO competitive transmission process.

"Through extensive work with stakeholders to develop the competitive transmission process, MISO is ready to engage in a fair process to select a developer for Duff-Coleman," said Priti Patel, Regional Executive for the MISO North Region. "Today's RFP will help MISO evaluate developers' proposals in terms of certainty, specificity, risk mitigation and cost."

Proposal submissions are due on July 6, 2016. Following the submissions, MISO will review the Proposals and announce the selected developer no later than December 30, 2016.

For more information about the RFP, [www.misoenergy.org/Planning/Pages/TransDevQualSel.aspx](http://www.misoenergy.org/Planning/Pages/TransDevQualSel.aspx).

## Kissimmee Utility Authority Energizes New Substation in Downtown Kissimmee

January 2016

The Kissimmee Utility Authority energized its new \$17.2 million Roy E. Hansel Substation which replaces the Power Plant Substation that served Kissimmee's downtown and business district for more than 40 years.

The new substation carried some customer load over the holidays as part of its operational testing phase. Utility technicians switched out the last transmission circuit serving the old Power Plant Substation at 9:27 a.m. today (1/4). The remaining two transmission lines will be brought into the Hansel Substation by January 22, completing the new substation energization sequence.

The new substation is a Sulfur Hexafluoride (SF6) gas insulated design -- the first of its kind in Osceola County, the second in Central Florida and the fourth in Florida. Unlike the open-air design of traditional substations, much of the new facility and supporting equipment is housed inside a building to minimize the visual impact. In addition, transmission lines and distribution feeders enter the substation underground, improving overall aesthetics while reducing some of the exposure to outages from animal life.

The old substation, constructed in the early 1970s, will be dismantled over the next several months, and the vacant lakefront property will be returned to the city of Kissimmee for future development.

The substation is named in honor of Roy E. Hansel, a third-generation resident of Kissimmee who ran the electric utility from 1943 until 1972.



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# THE GRID TRANSFORMATION FORUM

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

**How Operational Analytics can bring clarity and aid decision making for the smart grid**

We are in conversation with Dr. Neil Rothwell, Director of Business Development, AssetWise Analytics with Bentley Systems.

**EET&D:** What is Operational Analytics?

**Dr. Rothwell:** Operational analytics is an industry-recognized emerging business process that focuses on improving day-to-day operational performance with the power of sophisticated analytics. It is a process that converges information technology, operational technology, and engineering technology by transforming historical and real-time data into actionable just-in-time data for improving operational efficiencies using predictive techniques. Data aggregation and analysis tools are used to provide clarity and context for decision making and business planning, as well as to provide a platform for organizational strategy. The software that enables the process is configurable and provides day-to-day visibility into the performance of existing assets. It also offers predictive analytical opportunities for utilities to improve their operations. This can be used in conjunction with an existing model to extrapolate relevant information as and when it is required, extending asset performance modeling capabilities for real-time operations.

**EET&D:** How does OA differ from other types of analytics that are available?

**Dr. Rothwell:** There are many forms of analytics that perform well within their own right. Descriptive and diagnostic analytics provide insight into what happened and why it happened, but nothing about what will happen in the future. Predictive analytics takes that a step further. Traditional business intelligence provides users with conventional and dashboard reporting in near to real time. What is needed is a

solution that combines the level of reporting for management, the data mining capability to look closely at what happened and what is currently happening in real time, and the predictive capacity offered to forecast events and opportunities. Software such as Bentley's Amulet, offer descriptive, diagnostic, and predictive analytics for a complete analytical solution.

**EET&D:** Why is Operational Analytics important to the Grid?

**Dr. Rothwell:** T&D organizations generate a lot of data. This has been accelerated with the arrival of the Energy Internet of Things and the explosion of Big Data, where the deployment of millions of smart meters and other grid devices is generating a huge amount of data. Managing, interpreting, and turning this data into actionable information is where operational analytics comes to prominence, giving utilities the ability to collect, analyze, and act on the information they receive. Gartner predicts that by 2021, 1 million IoT devices will be purchased and installed every single hour\* – so the need to start harnessing the IoT starts now. Not only will data grow in volume and size, but it will also vary in type due to the large variety of data sources. This is why aligning operational technology (OT) with information technology (IT) (and also engineering information technology, or ET) is so important. Operational analytics can bridge the gap between these different technologies by bringing them altogether into one place to realize benefits such as cost and risk reductions and enhanced performance and flexibility.

*\* Top Strategic Predictions for 2016 and Beyond: The Future Is a Digital Thing, G00291252, 2 Oct 2015*

**EET&D:** How can the Convergence of IT/OT present opportunities to the grid?



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**Dr. Rothwell:** On the whole, operational intelligent platforms can be used to collect data across all sources by interfacing to a wide range of operational technologies, such as smart meters, sensors, SCADA systems, energy management systems, and field equipment, as well as by importing data from the back office, including customer information systems, asset inventories, maintenance planning, energy planning, and demand response systems. It can provide meaningful analytics showing the patterns and relationships to different groups of people on dashboards across the entire organization for better informed decision making.

**EET&D:** How can Operational Analytics help the Electric T&D (Transmission and Distribution) sector?

**Dr. Rothwell:** Operational analytics can help utility companies drive operational efficiency by providing a broader view of their assets and how they are performing. With assets spread over a wide geographical area, it's important to have all of the available information in one place to give you a clear and concise picture of health, condition, and performance right down to the component level. By monitoring a variety of parameters connected to health and condition, decisions can be made earlier via analytics that help to determine how likely it is that a failure or significant event will occur, so a contingency plan can be activated before it happens.

**EET&D:** What areas within utilities operations can operational analytics help with?

**Dr. Rothwell:** Amulet's operational analytics capability has been used to help users gain extra visibility into their assets' performance, effectiveness, and efficiency across transmission and distribution. Within substations, operational analytics has been used to monitor the condition of transformers using sensors to measure a variety of parameters, alerting engineers to any problem that may arise due to oil temperatures, dissolved gas anomalies, and more. In the field, the lifecycle of transmission towers can be extended by calculating and modeling the life span using

corrosion, environmental, geospatial, and maintenance history data, to name but a few. Additionally, line inspections can be improved by using handheld devices to upload and download inspection data live from the field. Asset health indexing empowers utilities with the proof to make defensible asset investment decisions, formulating asset life extension strategies where possible to do so safely and reliably.

**EET&D:** How do T&D companies reduce costs with operational analytics?

**Dr. Rothwell:** The risk of failure increases due to age and condition of T&D assets. It is essential to know how assets are performing at all times. For example, monitoring the level of dissolved gasses and the temperature of the cooling oil that circulates within transformers 24/7 identifies potential problems quickly. This allows assets to be taken off line or operated in a safe window, reducing costly failures and unplanned maintenance expenditure, ensuring the integrity and availability of the grid.

**EET&D:** Finally, what advice can you give to those in the T&D industry on operational analytics?

**Dr. Rothwell:** Operational analytics is generating a lot of interest and with good reason. For those who lack operational visibility across their assets, need to reduce operational and maintenance costs, and need to make smarter and more informed business decisions, I would recommend they give serious consideration to operational analytics. It can help them manage all these challenges and achieve clarity and confidence in the data they have at their disposal.

**EET&D:** We can't thank you enough Dr. Rothwell for taking time out of your busy schedule to share with our readers the benefits to electric utilities of operational analytics of their T&D assets. Improving the smart grid is the way going forward.





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# GREEN OVATIONS

Innovations in Green Technologies



## There's some Super-Hero in all of us

By Dave Bryant

If you're reading this magazine, there's a fairly good chance you're old enough (but not too old) to remember the phrase "Holy Cow, Batman!" The reason I bring this up is because the world of energy in whatever city, Gotham or otherwise, you happen to live in is more exciting, daunting, and incredible than any of us could have ever imagined. Whether you believe it or not, you are one of the most important super heroes of our time. Why? Because you are part of the world's 'energy team.' Guys and gals like you and me are not only working hard to provide affordable, reliable, and efficient power to support our information-based society, build viable economies, and even pump water to grow crops, we're also being called upon to save the planet. This is the work of super heroes and there is much work to be done.

At the end of last year, despite a tragic attack on the City of Paris, over 40,000 representatives of the 'energy team' got together in the 'City of Lights' to discuss climate change and energy. While these discussions essentially began in 1992 at the Earth Summit in Rio de Janeiro, where the United Nations Framework Convention on Climate Change established an environmental treaty to 'stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system,' it took several years for many of us to fully appreciate the magnitude of the task at hand or the impact the use of fossil fuels actually has on our climate.

Looking back, earlier scientific discussions about 'global warming' seemed rather academic. It really wasn't until we witnessed the impact of superstorms Katrina and Sandy before 'climate change' became more real. Exactly one year after Sandy hit the eastern shores of the United States, typhoon Haiyan, the strongest typhoon in recorded history, slammed into the Philippines. No matter what your current feelings are regarding climate change, you have to admit, we own it now.

Like anything else, if we own it, it will cost money and require management. This would be relatively easy if it weren't for the magnitude of the problem and that fact that some countries and economies are more capable than others. The good news is that the world is getting smaller and there is generally good collaboration between those who have and those who need. Think about all the investment USAID, EXIM Bank, World Bank, Asia Development Bank, China EXIM, JICA, MCC, OPIC, and other government banks are

making globally. Add to that the regional investments being made by large privately held investment banks. As policies and mechanisms evolve, the money will certainly become available.



Power line upgrade

With that said investors and utilities like to see good returns on their investments. Over the years, this included spending money to improve the efficiency of generators. It was also common to see utilities spend more money on higher quality more efficient transformers and other devices, all of which served to reduce fuel consumption and improve life cycle costs and, at the end of the day, save money. These investments, in many cases also offered environmental advantages. As the permitting process to build new conventional generation became more daunting, many power companies turned to the demand side for help. This represented opportunity for innovation.

While the train took a fairly long time to leave the station, it is moving at a good pace today. A few examples to come, but first, think about the good old fashion incandescent light bulb. It didn't look much different in 1905 than it looked 100 years later in 2005. Then – out of seemingly nowhere – we jumped to fluorescent lightbulbs and, more recently, fast forwarded to LED. The train is moving faster today, but earlier mandates and financial incentives provided to consumers to improve demand side appliances such as refrigerators, simply moved these appliances out of the kitchen and into the garage. Raise your hand if you're guilty. I certainly was.



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The latest efficiency trend in electricity has more to do with broader collaboration between the generators and the end-users. We call this 'smart grid.' The U.S. Department of Energy (DOE) defines 'smart grid' (see if you can read this in one breath):

*As a class of technology people are using to bring utility electricity delivery systems into the 21st century, using computer-based remote control and automation. These systems are made possible by two-way communication technology and computer processing that has been used for decades in other industries. They are beginning to be used on electricity networks, from the power plants and wind farms all the way to the consumers of electricity in homes and businesses. They offer many benefits to utilities and consumers -- mostly seen in big improvements in energy efficiency on the electricity grid and in the energy users' homes and offices.*

I think the smart grid can be more easily defined as "leveraging communication technology and controls to ensure that electric generation can satisfy electric demand."

This is becoming increasingly more important as we work to convert or shut down many older base-load coal plants. Though we are working hard to make the transition to cleaner sources of generation, in much of the world the electric grid is substantially aged and limited, and the development of new lines is very difficult. The grid, not unlike the incandescent light bulb, looks much the same today as it did over 100 years ago.

Have you heard about 'high-capacity, low sag' (HCLS) conductors? The reason I ask is because many 'energy team' people I speak to (that includes policy makers and regulators) never have. A number of line designers may have, but they generally call these 'high-temperature, low-sag' (HTLS) conductors and only consider them when faced with NERC sag violations or similar challenges. After all, higher conductor temperatures equate to higher line losses. The news is that while the HCLS conductors such as Aluminum Conductor Composite Core (ACCC) are capable of operating at very high temperatures during emergency conditions, they are actually about 30 percent more efficient than conventional Aluminum Conductor Steel Reinforced (ACSR) conductors of the same diameter and weight under any load condition. This is because they use higher-strength, lighter-weight composite cores that mitigate conductor sag and enable the incorporation of up to 30 percent more aluminum. More aluminum translates into reduced electrical resistance and decreased line losses.



Sag comparison ACSR and ACCC

You're probably thinking "so what, HCLS/HTLS conductors are two or three times more expensive than ACSR conductors and line losses are a drop in the bucket." You're certainly right about cost, but we'll talk about value and the significance of line loss reductions shortly.

Recall that we discussed the importance of generation efficiency, transformer efficiency, demand-side appliance efficiency and smart grid, but we didn't talk about the efficiency of the grid itself where two to twenty percent of all energy generated is lost due to the electrical resistance of the conductors. In the United States, most experts will peg line losses anywhere between three and seven percent. Obviously many lines that don't carry much current (and operate cooler) exhibit lower losses. Remember I2R? While line losses in the United States and other developed countries are relatively low, the Indian government pegs line losses in their country at 22 percent (not including 'commercial' losses). Even if you're in the 'three percent club' you'd be surprised at how much energy we lose to line losses.

To put this in perspective, let's consider a 100 mile (160 km) 345 kV line. My good friends at one of the larger US utilities just completed 240 circuit miles (386 km) of a similar project, so we will 'borrow' a few of their assumptions and clip the project down to a bite sized chunk for our example. Not unlike the real project, the case study considers the need to increase the capacity of an existing ACSR line using ACCC conductor of the same diameter and weight to avoid the need to reinforce or replace existing structures.

While the primary goal is to increase the line's capacity to serve growing demand, the use of the high-capacity, low-sag conductor reduces line losses by 30 percent in this example. Using a load factor of 62 percent and the US national average carbon dioxide emission of 1.372 pounds (0.623 kg) per kWh (which combines all sources of generation including wind, solar, geothermal, muni-waste, hydro, natural gas, coal, oil and nuclear), the net reduction of carbon dioxide in our example would be well over 200,000 metric tons per year.






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# GREEN OVATIONS

Innovations in Green Technologies

This is the equivalent of removing over 42,000 cars from the road. That's a lot of Teslas needed to replace them! A regular gas powered car in the US emits ~4.75 metric tons of CO<sub>2</sub> per year.

On the financial side, line loss reductions in our example at a load factor of 62 percent would save over 300,000 MWh per year. At \$60 per MWh this would reflect a savings of over \$19 million dollars per year. The cost of the wire is a fraction of that.

While line loss reductions offer attractive financial and environmental advantages, a less obvious advantage is that the generation capacity that is otherwise wasted supporting line losses is now available for deployment elsewhere, or in some instances, doesn't need to be built at all. My back of the napkin calculations (using IEEE 738 equations) for the 100 mile (160 km) 345 kV example at a 62 percent load factor penciled out a 49 MW generation savings.

In the United States, home of the newly established EPA's Clean Power Plan, all 50 states are working hard to figure out ways to reduce carbon dioxide emissions substantially. For the most part the EPA is allowing individual states to formulate their own plans, but they set the bar fairly high and change takes time. In Europe, similar efforts are underway and many options are being considered. Transmission line efficiency will certainly be playing a major role on every continent.

While coal plants are being mothballed, left to idle as spinning reserve, or completely shut down, and new wind, solar, geothermal, and other projects are being developed to support climate initiatives, it's very important to consider the efficiency and capacity of the electric power grid itself. Historically, this is relatively ignored territory that offers tremendous opportunity for a very cost-effective means of reaching our climate initiatives, while preparing for the onslaught of electric cars we are about to see parked in our neighbor's driveways.

A final point: to date, more than 20,000 miles (32,180 km) of ACCC conductor is currently in service in more than 35 countries. The cumulative carbon dioxide savings considering a number of variables suggests that this technology has reduced those emissions by over 50 million metric tons over the last ten years. Currently, on an annual basis, ACCC conductor is saving ~12.2 million metric tons per year – the equivalent of removing 2.6 million cars from the road. I think Batman would be impressed. What do you think, fellow superhero?



## About the Author

**Dave Bryant**, Director Technology, CTC Global was one of the original developers of the Aluminum Conductor Composite Core (ACCC) conductor and ancillary hardware components. His background in composite materials, testing and industrial design helped expedite the commercialization of the ACCC conductor.



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# From Research to Action

## Utility Data Analytics Project Makes Molehills out of Mountains

By Doug Dorr and Jared Green

Big data, little data, AMI data ... all as good as the back end analyses.

Enter the Electric Power Research Institute's (EPRI's) Distribution Modernization Demonstration (DMD). The initiative aims to identify what can be done with existing data, gain insights from the data that were previously unknown or perhaps not yet conceptualized, and assist utilities as they become more versatile with big data analytics and associated activities. Through this initiative, EPRI and its collaborators will develop and maintain a data repository where analysts can get the data sets of interest. They will prioritize a wide variety of data-driven use cases, define the necessary data sets, define action plans, and identify valuable lessons learned in order to deliver the best possible value from big and little data.

The EPRI Data Repository and Data Mining Initiative has evolved out of the DMD. It's a demonstration set forth to assist utilities with conquering three primary challenges associated with the mountains of data coming from intelligent communicating devices on the distribution system and other supporting data sets. The more than twenty utilities that are participating in this initiative are looking to receive actionable insights from disparate data sets; they want to move closer to predictive analytics – being able to meet a customers' need before it becomes urgent – and they seek to better understand impact en masse – how changes in technology and end use are impacting their system as a whole.

Through the initiative participants will learn what can be done with existing data; they will identify insights from the data that were previously unknown, and they will become more versatile with big data analytics, strategy, and activities. As the concept of the "prosumer" continues to grow, as more renewable energy enters the grid, and as other distributed energy functions such as demand response and behind-the-meter energy storage take shape, EPRI's Data Repository and Mining Initiative becomes ever more important as the industry drives from a "smart" to an "optimally integrated" electric power system.

### Building the repository

The amount of time, effort, and financial investment required to evaluate data and derive meaningful analytics is considerable. Therefore it makes sense to coordinate a single place where data sets and data analytics cases can be vetted by EPRI and its research partners for the most benefit. EPRI is creating that portal and seeding the fertile soil of the data farm with rich sets of real power system data that can be used by researchers in the project.

The data repository is set up to contain an unprecedented diversity and quantity of time series data from member utilities. The data sets include data from advanced metering systems, supervisory control and data acquisition (SCADA) systems, geospatial information systems, outage management systems, distribution management systems, asset management systems, work management systems, customer information systems, and intelligent electronic device databases. Other supportive data sets, such as weather, social media, forestry, and imagery information will be included to bolster the primary data sets. Although the bulk of the data is expected to be loaded into the repository in the first quarter of 2016, a steady stream of data will continue to flow into the repository through 2016-17 as the electric service providers complete the data collection phase OF their demonstration project(s).

### Analyzing the data

Over the next two years, the initiative will provide a test bed for data exploration and innovation and seek to solve the top challenges, identified as data analytics cases in the initiative, faced by the utility industry.

The data analytics cases, also referred to as use cases, will help utilities answer some of the most common questions they face. EPRI is categorizing the data analytics cases by the type of issue addressed and ultimately the benefit provided by the aggregation of additional datasets: how can outage awareness be enhanced; what additional knowledge can be ascertained on the health of assets; how can situational awareness be improved; how can better awareness of loads augment present operational practices; and what impacts and benefits can be leveraged from emerging data analytics technologies and practices?





# From Research to Action

Once identified and developed, the data analytics cases are ranked based on a scale of low, medium, and high priority as designated by EPRI and the electric service providers. Each case has a supporting document that explains the challenge to be addressed; existing method(s) being used to tackle the problem; potential methods to improve upon current solutions; desired outputs of an upgraded or a new, innovative solution; and the likely costs and benefits of implementing the resulting algorithm or application. As new ideas are thought of and additional challenges identified, EPRI will work with the electric service providers and research partners to document each in a data analytics case report.

Research partners also will be invited to demonstrate their analytics capabilities, leveraging the data repository to attain data for their test cases. Each of them will be provided an opportunity to share their findings in order to demonstrate fully the present state of capabilities that exist in the market.

## Driving no hyphen

Demonstrations of the creative data analytics tools will start in 2016 and continue through 2018 as EPRI and the research partners report on their successes in addressing the challenges documented in the data analytics cases. During this time project participants will have ample opportunity to explore, recommend, and identify additional data analytics cases for evaluation.

As more datasets are added and more participants join in the effort, this initiative will provide an opportunity for them to virtually move in and out of disparate data sets brought together in the repository and ascertain the 30,000-foot view of what's going on in the power system today, such as how distributed energy resources impact reliability, delivery, and end use. Additionally, the data sets will support innovative solutions that have a specific objective, such as fault waveform identification, electric vehicle charging profile detection, and many other answers to common utility challenges.

Finally, this collaborative initiative will foster a better understanding of industry needs, capture leading data analytics practices, allow knowledge transfer from industry experts, and accelerate ideas (solutions) to the market.

To learn more about the initiative and becoming a research partner, or to find the latest on the Data Repository and Data Mining Initiative, visit the EPRI Data Mining Initiative at <http://smartgrid.epri.com/DMD-DMI.aspx>.



## About the author



**Douglas S. Dorr** is a program manager at the Electric Power Research Institute (EPRI). His major area of focus is data acquisition and analytics for electric power systems. In this position he manages EPRI's Distribution Modernization Demonstration research initiative. Mr. Dorr has 25 years of industry experience related to analytics for distribution power systems and energy utilization areas. Mr. Dorr is an IEEE Senior

Member and a member of CIGRE. He holds two U.S. patents for power system sensor technologies and has published many industry documents on power system analytics, power quality, distributed resources, grounding, stray voltage, and lightning protection. He received a BSE degree in 1989 from Indiana Institute of Technology in Ft. Wayne, Indiana.



**Jared Green** is a technical leader in EPRI's Information, Communication and Cyber Security team. In this role he addresses prevalent challenges associated with integrating Distributed Energy Resources (DER) and fully applying them in industry demonstrations for system-wide interoperability and integration. Green's educational background includes a Bachelor of Science degree in electrical engineering

from the University of Alabama. He is a registered professional engineer, a certified energy manager and a certified carbon & ghg reduction manager.

# Surveying for Electrical Losses

By Jeremy Wright

UK Power Networks (UKPN) is on a mission to reduce system losses and is considering some unconventional means. Conventional wisdom is that electric distribution system losses are primarily from two sources; resistive losses and transformer excitation losses. Of course a lot of that conventional wisdom is confirmed by the detailed abilities to monitor and measure power flows on medium and high voltage systems. But UKPN considered another source of losses, leakage on the low voltage distribution system. Ultimately, all distribution systems leak, and some leakages are easier to detect than others. For example when a water distribution system leaks flooding in the street often makes the location of the problem apparent, when natural gas distribution systems leak the odorant in the gas alerts the public to the potential leak; but what about when an electric distribution system leaks, there is no odor or visual indication of the leak.

UKPN recognized that their more than 19,000 km of low voltage distribution cables could result in measurable losses, but was uncertain of how best to pinpoint those leaks. Consider that the low voltage cable is expected to provide decades of reliable service with little attention and certainly with little monitoring. In fact the only alert that something may be amiss comes from customer outages, the result of a defect.

When the insulation system on low voltage secondary cable fails, conductive pathways are formed from the conductors to the earth. Quite often these leaks are high impedance faults. These faults draw relatively small amounts of current compared to the load on the cables; as a result fuses and cable limiters do not operate and thereby eliminate the fault. Because protective systems do not exist to detect and interrupt the current from these failures they can persist for very long periods of time. And the robust nature of the low voltage conductors allows them to continuously supply current directly into the earth.

One significant characteristic of these faults is that they can energize street level objects, a condition known as contact voltage. The voltages measured at the surface can range from just a few hundred millivolts to full line voltage. The energized objects can present a public safety hazard under certain conditions but, the energized objects are also key to finding the leaks that feed them. Anytime a street level object becomes energized, it emits an electric field signature that can be detected in the local vicinity.

In search of a method to uncover these leaks, in early 2015 UKPN partnered with Power Survey Company, a provider of contact voltage testing services, to explore possible solutions to this interesting problem. Power Survey uses extremely sensitive electric field measuring equipment integrated into their fleet of mobile contact voltage detectors, known as the SVD-2000, to identify contact voltage conditions. Essentially a tailor made solution to the problem of finding leaks from the low voltage distribution system.



Utilities traditionally employ mobile contact voltage detection to optimize low voltage asset management programs by identifying incipient faults and to address the safety concerns associated with energized street level objects. After rethinking these faults as leaks it became clear that the faults normally identified during mobile contact voltage surveys were also the source of significant losses. Although Power Survey has identified more than 120,000 contact voltage faults for clients around the world, no one had ever attempted to quantify the losses associated with these faults.







To prove the concept, a pilot scan was initiated in areas of UKPN's low voltage network. During the survey technicians traversed the streets in the SVD-2000 searching for instances of voltages on street level objects such as sidewalks, street lamps and bus shelters. When voltage is detected by the SVD-2000 audible and visual alarms alert the operators to the presence of an electric field anomaly. To pinpoint the fault location the technicians follow a formalized site assessment process outside of the vehicle.

There are number of steps along the path from detection to measurement and mitigation. The first step to identify an underground cable failure starts with localization of the area where the offending cable may be located. When the truck mounted detection equipment signals an alarm, technicians exit the vehicle equipped with a very sensitive hand held electric field detector to center the investigation on a point where local electric field signature peaks. The next step is to measure the voltage on the objects and surfaces identified in the previous step. This requires a volt meter with a shunt resistor and some additional effort to identify a qualified ground reference point.

A qualified ground is typically a nearby metallic object such as a fire hydrant, stand pipe, or other earth connected conductive structure. Steps to qualify that ground include using the hand held electric field meter to verify the candidate ground is in fact not energized. When this is complete, a voltage measurement is made on all of the surfaces and structures above and around the suspected leak. Finally a record of the voltage is created.

Low voltage readings, often below one volt, when found in the vicinity of buried service or distribution conductors are a key indicator. The analysis of the facts at hand is the path to finding the offending cable. Referencing system schematics and maps can be helpful, but often records are incomplete. In fact, some observation skills and experience with the local system are often very beneficial.

Finding the actual leak requires careful excavation and repeated voltage measurement as excavation proceeds. If the process has successfully identified a buried leak, then by definition there is a live conductor nearby and all of the safety and precautionary measures associated with excavation will be required. Since we are interested

in quantifying the leaks, it is important when possible to measure current on the conductors nearby before excavation commences. Current measurements taken before and after repairs will be useful in gauging how much current was leaking into the earth.

Proving the concept started with performing a pilot scan in the distribution territory. Using the scan data, several sites were selected for further investigation and measurement. Sites were selected primarily based on the ease of excavation and the proximity of the fault to UKPN's LV network, based on a review of system schematics and GIS data. A team of engineers, technicians and scientists unearthed the failures responsible for the power leaks, made current measurements and collected data on the underlying fault conditions, the results surprised everyone.

Prior to actually finding the leaks and performing measurements, some estimates of the possible outcomes were made. Initial theoretical models of the average impedance of the earth were around  $120\ \Omega$ , and using the system supply voltage as a source, we calculated losses of approximately 437 watts per fault or about 3.8 MWh/year. But with the benefit of measurements made in the field, we found the actual earth impedances were much lower, often between  $20\ \Omega$  and  $45\ \Omega$ , lower than many standards for earthing rod installations. At one site a failed joint had formed a conductive pathway to the earth and was continuously leaking over 10 amps into the ground.



The benefit in repairing these types of leaks can be significant. Annual losses at the location sourcing 10 amps into the earth were 21 MWh/year. The carbon dioxide emissions associated with the energy losses are approximately 12.8 tonnes. To put the emissions into perspective, according to the World Bank, the average UK citizen is responsible for approximately 7 tonnes of carbon dioxide per year by addressing a single leak UKPN was able to offset the emissions of nearly two citizens.

Forensic analysis of the excavated cables provided some additional interesting facts. The fault and associated current flow can generate significant heating of the cabling. It was apparent the heat flowed from the fault along the conductor and further damaged insulation. A section of cable 25 meters in length was excavated. The photo on the previous page shows the extent of the damage. Insulation is cracked and eroding and the protective steel cable sheath has disappeared. The service life of this length of cable has been ended by the long term heating provided by the fault current.

The pilot scan clearly demonstrated that the SVD-2000 is effective at identifying sites where low voltage cables are leaking voltage into the surrounding environment. In every case where voltage was measured

on the surface and a site investigation was conducted the source of the voltage was determined to be a leaking low voltage underground cable. The ability to quickly and accurately locate these electric system leaks represents a paradigm shift in low voltage cable loss strategies.

Whilst conventional losses strategies focus on the tricky and costly practice of reducing resistive losses in conductors and optimizing transformer designs and ratings; this innovative strategy is centered around addressing leaks in low voltage cables. Repairing these leaks in a targeted manner not only reduces losses and system load, it also enhances the customer experience by improving grid resiliency and minimizing power quality concerns by efficiently removing failing sections of cable from the system.

### About the author



**Jeremy Wright** BEng (Hons) MBA (Open) MIET MIAM MCIM is an award winning Electrical Engineer who works for UK Power Networks (UKPN) in London and is a member of both The Institute of Engineering and Technology (The IET) and The Institute of Asset Management (The IAM). He has a passion for continued innovation within the electricity distribution network in the UK and has achieved recognition for his work both as an individual and from leading a team by both The IET and The IAM.

Since 1984 Jeremy has undertaken a number of senior operational and non-operational roles. His current role is to ensure that assets installed on the UKPN electricity distribution networks are operated and compliant with current policy and procedures often engaging with stakeholders and regulatory bodies.

The latest project Jeremy is pioneering within the UK is with Power Survey Corp. and the SVD-2000 contact voltage Mobile Asset Assessment Vehicle (MAAV). This platform has the potential to revolutionise how cables are managed and replaced ahead of failure which is not currently considered by network operators. This is one of many revolutionary systems that Jeremy is or has pioneered in his career to the benefit of both customers and network operators.

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# How to Build a Smart Control Room

Moderated by  
Don Kreski

As electric utilities face ongoing demands for better service and fewer, shorter outages, they look to include the latest 'smart' technology in their operation centers.

We've asked three industry experts what factors utilities should consider as they build or remodel control rooms. Gary Werner is the Director of the Mitsubishi Electric US – Data Wall Group. Gregory Fechner is Director of U.S. Government Markets for Crestron. Carlos Lerma is Director of Engineering for the AVI-SPL Control Room Group.

**EET&D:** Why is Operational Analytics important to the Grid?

**Lerma:** One of the biggest reasons is to enhance situational awareness. The operators, their supervisors and other stakeholders need to work effectively together, not only to handle day-to-day operations, but to tackle issues and emergencies as they arise within the utility or on the power grid.

Given that need, an intelligent platform consisting of the workstations, network infrastructure, video wall and simplified controls is paramount for their success. The video wall is a crucial tool, because it allows everyone to monitor and share key information.

**EET&D:** What information sources are typically shared on a video wall?

**Werner:** As technology designers and integrators, we need a list of everything that's available to the operators, even content that you may not expect to display on the video wall.

In an electric utility, that will typically include output from your SCADA applications, outage management systems, energy management software, geographical information systems (GIS), and dispatch, plus information required for NERC and FERC regulatory compliance. We will want to monitor weather channels and lightning computers as well, since weather can have a direct effect on operations.

Once the inputs are determined and prioritized, we can help you create sensible video wall layouts with the following in mind: What goes where during normal operations? What sources should be displayed during an emergency? Who decides when it's time to override the standard layouts, or are they overridden automatically? We do have a finite canvas to work with, but since the display wall is dynamic, we can easily switch to different layouts and drill down into the different data fields as needed.

**EET&D:** What are the network and control requirements?

**Fechner:** Beyond understanding the content available, we will need to know the number of sources you will want to display on the operators' workstations and the video wall at any given time, as well as the native resolutions of each. We also need to know if you will securely stream information to overflow rooms or to other control centers. With all that in hand, we can start to design a switching and distribution infrastructure based on your requirements, one that will accommodate a wide range of sources, connection types and resolutions.

One of the most critical factors is an appropriate, intuitive user interface. We will want to add presets on a touch screen for any given scenario, so the proper information can be routed to the wall for each type of event. Should there be an outage or other emergency, the most appropriate layout can be chosen quickly, or it can automatically appear on the video wall, so that operators can ascertain the situation without delay and take appropriate measures.

**EET&D:** What are the requirements for the video wall?

**Werner:** Compared to content, network and control issues, the choice of the video wall technology and its layout becomes relatively easy.

There are three main technologies in use today. A video wall may be made up of flat-panel displays using LCD technology and LED backlights. Rear projection cubes use DLP technology with an LED light source. Making its entry into the market is narrow pixel-pitch, direct view LED, where individual pixels are formed by individual LEDs. You've seen this technology if you've ever been to a stadium with a video scoreboard, although narrow pixel-pitch displays use a much smaller, tightly-arranged LED matrix to produce the image.

Ranking these, LCD flat panels are the lowest in cost, with the shortest expected life at about 50,000 hours. Maintainability is an issue, since models change frequently, making it difficult or impossible to find a match for a defective unit after only two or three years. Direct-view LED is by far the highest in cost with an expected life, depending on the product, of roughly 50,000 – 100,000 hours. For now, there are even larger concerns about parts availability down the road.

DLP cubes fall somewhere in the middle in terms of cost, with a lifespan, in Mitsubishi's case, of up to 100,000 hours, which is over 11 years of continuous service. This is a proven technology intended primarily for the control room, and issues with maintenance and spare parts are rare. For those reasons, cubes remain the first choice for nearly all utility control rooms, especially those used 24/7.

The displays that make up the video wall are available in a variety of sizes and resolutions, but the optimal must be determined mathematically. Keep in mind that higher-resolution displays are not always better, given that the video wall will be some distance from the operators, and that it's made up of many smaller displays that combine to form the finished wall. It's best to let your design team recommend the best technology, size and resolution for your situation.

**Lerma:** That said, we do generally recommend that our clients make the video wall canvas as large as possible given the room size, viewing distance and budget. Once you start using your video wall, you will almost certainly wish you could include more content: more detail on an outage, more information from your GIS, more applications from your SCADA system.

**EET&D:** What factors affect the reliability and longevity of your new technology?

**Lerma:** When we start talking about expected lifetimes, we often put the electronics and the infrastructure into separate categories.

Many users expect to refresh their computers and related equipment every five years or less. Upgrading servers and storage can result in significant gains in processing power.

Most want the infrastructure, however, including the cable plant and the switcher to last 20 years or more. We tend to look at the video wall as part of the infrastructure, since its performance is limited not by processing power, but by the acuity of the human eye. A display that will last 10 years or more with little or no maintenance is thus very attractive.

**Werner:** In order to achieve that long-term quality and reliability, we recommend that you keep some number of spare displays on hand. With direct-view LED, you will want to keep at least 15% of your video wall surface on hand in spare parts, in order to ensure that parts will be available as needed. With flat-panel displays, you will definitely want some extras, to ensure that you have exact replacements down the road. Even

with cubes, we suggest you have one or more extra engines on hand. If you do have a problem, you can replace a DLP engine in the cube in about four minutes, and then send the defective unit out for repair.

**Fechner:** Within the network and switching infrastructure, long-term reliability becomes less of a concern. The most critical applications will run redundant primary/secondary networks, but in many cases that's not needed.

Crestron, for example, uses a chassis-based switcher in our DigitalMedia solution. It's populated with dual power supplies and individual cards or blades. Should one fail, the rest of the system will continue to work uninterrupted. Having a card-based chassis also creates flexibility that greatly extends the life of the system. While today you may need video cards for VGA, HDMI, and DisplayPort, you can be confident that, when new standards are introduced, Crestron will offer the appropriate cards.

The best control systems, including those from Crestron, will last a decade or more. If you decide you need new functionality within your control room, add workstations or video sources, normally you can upgrade the controls through programming.

**Lerma:** It's important to understand that, when a professional integrator like AVI-SPL designs your control-room technology, we focus on purpose-built equipment that is meant to run in 24/7 environments. These components are extremely reliable. We have control rooms that we built 15 years ago, still using the Mitsubishi and Crestron products we originally installed.

While you do need to be careful when you choose your suppliers, that is the level of quality and support you can expect from using our products and services.

### About the moderator

Don Kreski is president of Kreski Marketing Consultants Inc. The company provides writing and creative services to key sectors of the industry.

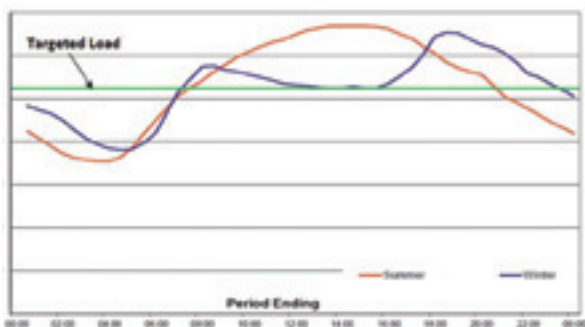


# Electricity Storage Reaches New Heights

By Bala Venkatesh and  
Mohamed Awadallah

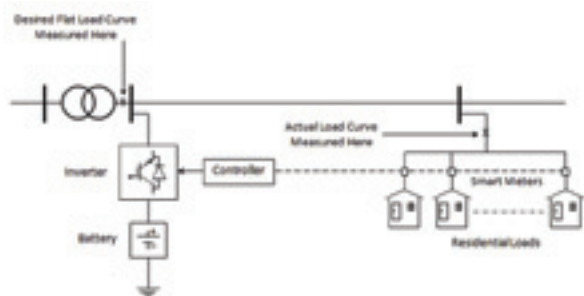
In modern power systems, energy storage has become imperative because of the increasing penetration of renewable sources, distributed generation and microgrids. Energy storage elements, such as supercapacitors, flywheels, batteries and pumped hydro, help increase energy sustainability and improve supply reliability. Lithium-ion batteries provide an excellent compromise between performance, cost and lifetime among other storage technologies. Batteries can generally represent outstanding solutions for short-, medium- and long-term energy storage requirements.

On the other hand, fluctuations in the daily demand profile of almost all types of loads have been a hindrance to distribution system operators and planners. The system is usually designed based on the maximum load demand, but such capacity is not utilized all the time. Distribution transformers, feeders and substations are accordingly rated at a higher level than the average load they serve. Therefore distribution system personnel have always sought to have a flat demand profile for the sake of better employment of system capacity. This goal has recently become achievable via new developments in the field of energy storage technologies.



This objective is clearly defined as to reshape the daily load profile to a flat curve without the classical hills and valleys. Reshaping the load curve in such a way is possible if an energy storage element charges during off-load periods and discharges during load periods. An excellent candidate to undertake this function is a lithium-ion battery, which is known for its high energy density, low self-discharge rate and long lifecycle. An ongoing research project at Ryerson University's Centre for Urban Energy (CUE) aims to

find a technical solution to the problem of load curve fluctuations using lithium-ion battery systems. The solution is intended to be mounted on a distribution pole at the secondary side of a 50 kVA transformer that is feeding residential customers.



The research project involves the design, development, testing and installation of a technical solution based on lithium-ion batteries for the reliability improvement of local distribution companies (LDCs). An energy storage system based on lithium-ion batteries will be interfaced to the distribution network through an inverter/charger unit. The inverter will allow bidirectional power flow. The battery will be optimally scheduled to produce a new transformer load curve that is as close as possible to the absolute flat curve. The practical limitations on the battery power and energy capacities make it difficult to attain the absolute flat load profile. Therefore, the result is that the overall load curve incorporating both the residential customers and the new energy storage system together will look more uniform.

From the distribution network point of view, the discrepancy between minimum and maximum load values over the 24 hour period of the day will be minimized. To achieve such a goal, an intelligent controller is developed on a PC which communicates with peripheral devices, including the smart meter at the load terminals, in order to continuously acquire load data. The system is developed in a laboratory environment on a single-phase basis. Extensive laboratory testing will be carried out before a prototype is installed on an actual distribution grid. The solution will be monitored for daily operation and data acquisition for reasonable time before the technology gets marketed.

Partners on this project are Ryerson University, eCamion, and Toronto Hydro. Researchers at CUE will develop the intelligent control algorithm and test the system in the laboratory at commercial scales. Technical staff at eCamion will design and produce the casing and HVAC unit in addition to providing the battery packs required by the system. Toronto Hydro will advise on a suitable installation site, where the final prototype will be mounted on a pole top, and will monitor the performance of the system over a prescribed testing period. Finally, eCamion will be responsible for the marketing of the new technology after field testing assures the technical feasibility of the final product.

With minor modifications to the system ratings and control algorithm, the final prototype will be able to serve other distribution system purposes as well. A sample list of such purposes includes:

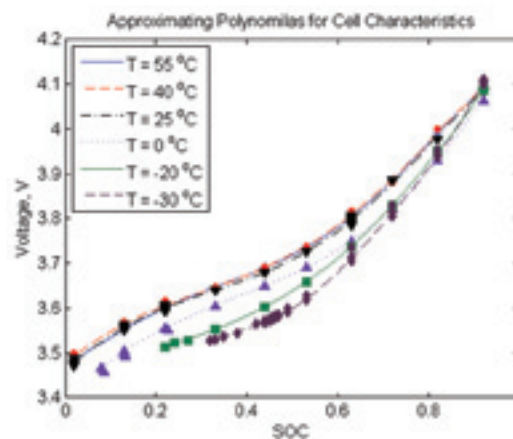
- Enhancement of the supply reliability
- Operation in isolated microgrid mode
- Grid frequency support
- Voltage sag compensation
- Enhancement of system stability

The system under consideration comprises a lithium-ion battery interfaced to the distribution network at the secondary terminals of the transformer through an inverter/charger unit. The solution also requires online monitoring of the load condition and a smart algorithm which utilizes the available energy of the battery in an optimal manner. Online load monitoring is possible through communication with the smart meter at the load terminals. Information about the status of both battery and inverter is also available through communication with both devices. Then, an intelligent algorithm can decide on the required operational parameters in order to optimally utilize the available energy in the battery at a given time. A proper command will be issued and communicated to the inverter. A host PC will communicate with all system components and run the smart control algorithm to schedule the battery 24 hours ahead of time. The scheduling job requires a reliable load forecasting technique to be developed in order to anticipate the load profile of the following day.

Due to the complex behaviour of lithium-ion battery cells, a battery management system (BMS) is typically required to regulate the performance. Accurate estimation of the battery state of charge (SOC) is vital for appropriate operation of the BMS. The industry uses

standard methods to monitor the SOC such as Coulomb counting and open circuit voltage (OCV). The Coulomb counting method depends on estimating the SOC at an initial point, then integrating the charging or discharging current with respect to time in order to account for the added or subtracted charge. The method is inaccurate because of the accumulating error of the Coulomb counting process. On the other hand, despite the higher accuracy, measurement of the OCV is impossible until a rest position is reached where the battery is in an idle mode. Nevertheless, both methods usually neglect the effects of cell imbalance and temperature, which adds to the inherent inaccuracy.

To estimate the SOC of a lithium-ion battery pack, it is strongly believed that working at the cell level will increase the estimation accuracy. The cell characteristics which relate the OCV to the SOC at different temperatures are normally provided by the manufacturer. Testing of an individual cell at different temperatures yields discrete measurements of OCV versus SOC. The challenge is to use the manufacturer supplied characteristics to develop an intelligent model which yields the cell SOC at any given OCV and temperature. This work involves the design, development, training, and testing of an intelligent cell model based on adaptive neuro-fuzzy inference systems (ANFIS) which will eventually serve to enhance the estimation accuracy of the battery SOC. The new ANFIS model of cell characteristics as employed in the estimation of the battery SOC is one of the contributions of the present project.





The technology developed in this project provides many advantages to distribution utilities. A straightforward gain will be the reduction of capacity of distribution system components used to feed residential customers including pole-top transformer, feeder cable, voltage regulators, distribution substation and switchgear elements. The capital cost of future distribution grids will be reduced accordingly. In addition, network components will be operating at or around their nameplate ratings such that reduced-capacity operation will be avoided. The technology makes use of the communication strength of smart grid elements such as smart meters which are already deployed in Ontario. The site testing results are expected to gain the trust of other distribution utilities leading to mass production and eventual cost reduction of the product.

## About the authors



**Dr. Bala Venkatesh** is both founding Academic Director and head of the Ryerson Centre for Urban Energy (CUE). He currently serves as a Professor of Electrical Engineering at Ryerson and has also taught at the University of New Brunswick, Multimedia University (Malaysia), and Anna University (India). He has published more than 100 articles in journals and conferences and has supervised 34 MSc and PhD theses. In total, his extramural funding is more than 10 million dollars. He is a registered professional engineer in Ontario and, in the last two decades, has worked on over 10 consulting projects in India and Canada.



**Dr. Mohamed Awadallah** is a research fellow with the Centre for Urban Energy (CUE) at Ryerson University. He works on government- and industry-funded research projects related to power distribution systems, with emphasis on renewable energies, energy storage and smart grid. Before joining CUE in July 2013, he was Head of Electrical Power Engineering Department, Yanbu Industrial College, Saudi Arabia. He has more than twenty years of academic experience along the research, teaching and leadership axes. He authored and coauthored more than fifty research publications. He is a member of the honour societies of Eta Kappa Nu, Tau Beta Pi, and Phi Kappa Phi. He is a Registered Professional Engineer in the Province of Ontario, Canada.



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# Legacy Thinking: How to fix outage communication and gain operation efficiency

By Matthew Ockwell

## The White Elephant of Outage Management

A recent visit with a utility customer provided an opportunity to tour their newly renovated 60+ terminal call center, designed to serve a population of more than four million. A snowstorm the prior year prompted this expansion from their original 15 terminals. During that storm, the utility experienced 159,000 calls during the first 24 hours. That call number only includes the calls they were able to successfully answer, which means hundreds of calls were missed because the utility was unprepared and understaffed for that type of customer response. They reported the same customer calling back up to 10 times in search of an update. But viewing the new call center prompted the question—why is this legacy process to manage customer queries still the norm? These 1-to-1 interactions with customers are costly, and far from the most efficient communication channel the utility can use.

Two-thirds of the public prefer self-service/automated channels—and that number continues to grow. This article sheds light on how utilities can leverage this trend by upgrading their current method of outage communication while significantly increasing operational efficiency.

## Consumer Demands Prompt New Outage Plan

*“When consumers experience an interruption in service, the first thing utilities need to get better at is providing comprehensive information about the outage – including the cause and extent of the outage, when power will be restored, and status of work crews and any equipment that needs to be replaced,”* says Jeff Conklin, vice president of J.D. Power’s utility practice. *“And the best utilities are now getting proactive with outage information by providing it to the consumer at the contact point of their choice.”*

Customers focus on two concerns during an outage: **how long until power returns?** and **how will it impact my life?** These questions lead to thoughts of “Will my medication in the fridge be safe?”, “Do I need to pick my child up from school?” or “Will the elevator work at my apartment or am I climbing 16 floors?” This is the new world of consumer engagement, where the customer seeks—and expects—immediate gratification with an immediate response.

The most reliable line of communication to the public during an outage is their mobile phone. The simplest phone can call and send a text message, but nearly eighty percent can access channels such as mobile web, mobile applications, social media, news, etc. Follow that trend, and we will see a near complete saturation of mobile phones with full internet access in North America within thirty six months. For the utility company, this means the customer looks for answers

on the channels they interact with daily, especially during an outage. The Baby Boomers and Silent Generation make up thirty percent of the current US population. This group tends to be most comfortable using call centers and IVR as means of communication, but that trend is fading. Forty seven percent of the population make up Generation X and Millennials, who prefer automated or social channels, and consider calling on the phone an old technology. Imagine what the next generation will think. As emerging population’s age, more people will reject call centers and IVR. Instead, stakeholders will elect to use self-service channels, which should be music to the ears of utility personnel. **The public wants what utilities want, an efficient and easy way to communicate.** Proactive and rich two-way communication offered through interactive channels, voted by customers as the preferred method to communicate, allows the utility to automate the lion’s share of customer engagement so they can shift resources away from customer management and towards restoration efforts. Addressing consumer priorities and preferences defines the goal of the new outage communication plan: to keep all stakeholders apprised of rich, relevant, and timely data so they can react accordingly and provide feedback. To understand how this fits into an outage plan, the new role of each communication channel and the classification and capability of customers as they move through the channels must be addressed.

## Prioritizing Communication

Prioritizing communication channels is an easy way to see how customer engagement should flow. If the utility already has some of these channels, like a call center or IVR, it is not necessary to remove them. The same goes with utilities who subscribe to third-party call centers to handle overflow traffic. The objective is to move customers away from costly and inefficient channels and towards those that are self-service and interactive. A large portion of utility customers will naturally find the new interactive platforms either on their own or with a little marketing and direction, but the channels we want to move customers from will still need to migrate those who are familiar with using them. Each call into a call center can average \$6 in cost to the utility. The interactive alternative costs pennies per transaction. The new plan reclassifies channels like the call center, IVR, and social media to be used as a funneling tool to the preferred self-service channels. The legacy channels will perform their normal functions, but then suggest the customer sign up for a more automated approach through a web portal, SMS text service, or mobile application. The legacy channels will migrate their customer base, which increases the level of engagement and satisfaction.



# Legacy Thinking: How to fix outage communication and gain operation efficiency

The more rich, relevant, and real-time information you serve to the customer, the more answers you provide and the fewer additional questions (callbacks) occur. When customers do not have to spend time locating an Estimated Time of Restoration to decide if dinner will be homemade or fast-food, they can spend time either leaving the utility alone or offering rich data back to the system. Thus begins classifying the customers.

*Communication side note: Priority one is building a two-way proactive outage channel to all customers. If limitations prevent you from offering multiple channels, focus on an outage map integrated with SMS text reporting and alerts. SMS can reach even the simplest mobile phones, and outage map links can be shared across nearly all platforms. A mobile optimized outage map is essential, since routers and personal computers typically will not have power or internet access.*

## Classifying Customers

As customers graduate through the communication channels, they gain additional information and interaction. The three customer classifications are: uninformed, informed, and engaged.

### Uninformed Customer

If the utility does not have any type of automatic communication system that pings affected customers during an outage, then 100 percent of their customers are uninformed, and no proactive measures are being taken. That leaves 100% of all affected customers searching to find “how long will the outage last?” and “how will that timeframe affect me?”, but with little knowledge or ability to find the answer(s). The initial engagement between the utility and the customer is typically through the call center, mobile website (because the internet router is down), or social media account. These channels are funnel sites that are used to answer the first question and encourage the user to move to a self-service platform. When users opt-in or naturally find the preferred platforms, such as SMS text, mobile application, or even IVR to an extent, they are considered informed customers and the process is advanced.

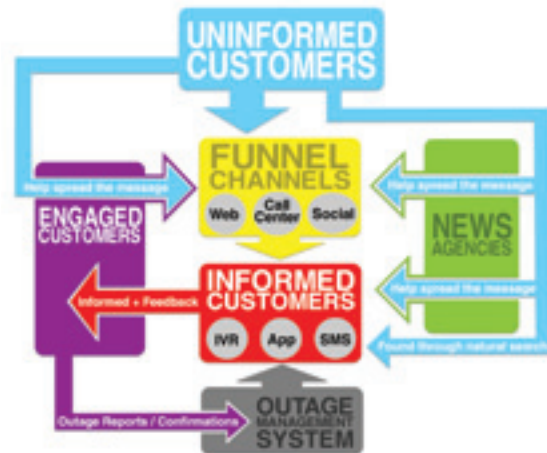
### Informed Customers

When the lights go out and a customer receives an alert either through SMS text, mobile application, or proactive IVR, those customers are considered informed customers. Proactive IVR is not considered a strong informed channel because the customer can only receive information during the call, and has no history or supporting content. In contrast, SMS texts offer a readable history and the ability to report outages with an embedded outage map web link. An outage map web link gives the customer an additional layer of answers they can review before deciding to call the utility. It is important to exhaust all self-service approaches—especially when we still have utilities sized at over 100,000 meters that must leave all customer calls to the OMS operator after hours because of the lack of manpower. Obviously, smaller utilities have it worse. Once all these customers are on interactive platforms, it is easy to collect information from them. This new layer of real-time information is called customer telemetry. It is how engaged customers are established, and a new communication channel is awarded to the utility.

## Engaged Customers

Those who are sharing outage updates with others or providing additional information unknown to the utility (such as reporting damaged field equipment or responding to restoration confirmation alerts) are known as engaged customers. This group is only found on SMS text, mobile applications, or web outage map channels and they have the ability to increase the engagement of uninformed customers by sending easily shared links to their friends and family. These shared links can be set up to customize their content based on the location of the user's phone, so there is no need to worry about inaccurate information being shared if it goes from one side of the service territory to the other. A large engaged customer base is a great milestone for utilities to achieve.

The changing climate of consumer engagement can be leveraged to increase operational efficiency. The customer channels necessary to realize an appropriate outage communication response and improve customer engagement increase as they migrate to more interactive platforms. As the outage plan unravels, remember the goal: to keep all stakeholders notified with rich, relevant, and timely information so they can react accordingly and provide feedback.



## Customer Focused Outage Plan Pre-Outage Phase

The pre-outage stage is predominately consumed with encouraging customer adoption of outage communication channels (building the informed and engaged crowd), educating broadcasting agencies how to access and disseminate information, and upgrading utility procedures to support an effective outage communication plan. The best approach to customer adoption of outage channels is to incorporate them with blue sky functions such as billing, budget, and energy efficiency solutions. Local news and radio agencies are great disseminators of information and should be brought into the communication conversation early. Offering benefits for participating and providing easy to find information, such as an interactive outage map, provide incentives to customers so that when outages occur, they become an extra voice pushing the channels that feed back to the utility. Within the utility, it is advantageous to make sure employees understand the benefits that comes with the new approach.

The steps to accomplish the pre-outage phase include:

1. Developing informed and engaged customers through marketing
  - a. Push the public towards adopting proactive outage update platforms such as SMS, IVR, and mobile application
2. Developing 3rd party funnels
  - a. Direct 3rd party funnel sites, like broadcast agencies, to self-service channels so they can spread adoption
3. Change Management Culture (implementing internal change)
  - a. Rewrite operational procedures to follow the channel flowchart
  - b. Explain the benefit of the new procedures to employees
  - c. Train utility personnel on new responsibilities and emphasize the importance of outage management roles

## Outage Phase

During an outage, the utility's goal is to keep all stakeholders informed so they can react accordingly and provide feedback. This also includes keeping all funnel channels available to find uninformed customers and pull them into the communication flow. Especially during extended outages, frequent and personal content is key to containing public nerves. A typical outage contains three alerts: outage confirmation, estimated restoration time, and restoration confirmation. Encouraging the informed crowd to share an outage link with friends and family or report any damaged field equipment is a great platform additive. This time should be taken to manage all the channels so they are used to their maximum capability/reach. Routinely checking into 3rd party funnels and encouraging them to share the interactive channels is also necessary during an outage.

To successfully implement the outage phase:

1. Update and encourage sharing and reporting with an informed crowd
  - a. Send proactive information to informed customers to keep them satisfied
  - b. Encourage informed customers to share alert links with friends and family
  - c. Educate customers on self-reporting, including the value of responding to restoration confirmation alerts and reporting damaged equipment
2. Create an informed user
  - a. Find uninformed customers looking for outage information on funnel sites and encourage them to adopt self-service channels
3. Check in with 3rd party funnels

## Post-Outage Phase

It is important to gauge channel adoption after an outage and calculate how many utility customers have graduated to self-service platforms. Then utilities can look back to see what actions produced the most interactive channel adoptions. Post-outage also involves

studying the utility response and fixing any problems or adding new found solutions. A personal touch is to also offer a post-outage summary via email that describes the steps taken by the utility to restore power, including amount of damaged equipment, man hours used, and customers out. This helps customers understand why the outage occurred and why it took as long as it did to restore power. Doing this within 24 hours after the storm will improve customer satisfaction. The last step is to incorporate any new findings into the pre-outage or outage phase and continue marketing and encouraging self-service channel adoption until you reach 100 percent.

To measure the success of channel adoption:

1. Benchmark channel adoption with other outages and marketing initiatives to see which tactics are most effective
2. Study what the utility did well and what needs to be improved
  - a. Look for any issues faced during the outage and take action to prevent them next time; ask employees what they would change or improve
3. Create a Post-Outage Summary for customers (optional)
4. Update pre-outage and outage phases

## Summary

Change is difficult. However, in cases like this, it is necessary and many would agree that this change is essential. Society's dependency on electricity is foundational to our way of life and is becoming more critical as demand steadily outpaces supply. This will give rise to increased reliability concerns, resulting in outages being even more disruptive in the future. The ability to manage these issues must be planned into the customer systems. Demand for easy and interactive engagement is on the rise as well. The internet has created an expectation of receiving near instantaneous results, and this expectation has bled into nearly all other forms of interaction. Better understanding customer engagement is key to both customer involvement and the operation of the smart grid. The utility of the future will have to integrate new interactive communication channels with previously isolated focal points to achieve the greatest benefits that all can share.

## About the author



**Matthew Ockwell** has spent most of his professional career understanding customer behavior and motivators. Prior to joining Advanced Control Systems (ACS), he worked in the mobile and web realm for over a decade and holds a Google certification in advanced search & marketing. Before receiving his B.S. in Marketing Management from the University of Central Florida, from 2007-2012, he successfully founded and grew a mixed media marketing company that created collateral for Fortune 100 companies. He started with ACS as a mobile and web consultant and helped utilities develop solutions to better engage the public. He currently serves as Product Manager for OMS and Mobile Solutions at ACS.



# Big Data: Enabler of an Intelligent, Sustainable Grid

By Steve Collier

## Big Data: Enabler of an Intelligent, Sustainable Grid

Beginning with Thomas Edison's Pearl Street Station in the late 1800s, persistent economies of scale, declining prices, exponential growth in demand, and steady improvement in technology supported the development an electric utility grid architecture and industry business model that continued largely unchanged for almost a century. The OPEC oil embargo in 1973 marked an inflection point after which both grid adequacy and the traditional business model began to erode. A new, profoundly different grid model is emerging, involving new technologies, topologies, techniques, traders, and, transactions. This modern, intelligent grid brings with it massive amounts of data (i.e., 'big data'). Managing and exploiting this data poses great challenges but offers even greater benefits for utilities, non-utility providers, and consumers.

The legacy U.S. grid is a patchwork of several loosely connected synchronous AC grids. Some 10,000 power plants containing about 20,000 generating units supply power and energy. Energy flows one way from these resources over high voltage transmission lines to remote load centers where it is distributed and delivered to electric consumers through some 150 million meters. Almost all of the generation, transmission, and distribution facilities, the marketing and sales, and the metering and billing have been owned and operated by regulated electric utilities who operated as monopolies within defined service areas. The post OPEC embargo industry has seen economies of scale and declining prices eroded by risk, rising costs, stalled growth (even reduction in demand), and concerns about environmental and economic sustainability.

Electric utilities began struggling with a relatively modest introduction to big data as they moved from monthly ex post facto meter reading and billing to more frequent meter reading via 'smart meters.' The goal was to facilitate customer demand response programs that would relieve some of the pressure on the electric utility grid and business model. The usual 12 monthly meter readings for each customer multiplied to 730 hourly readings or more each month. In addition, other data points were being created including power on/off status, voltage, power quality, meter base temperature, meter tampering, etc.

So, the industry went from a handful of data points per customer per year to ten thousand or more. Over less than a decade nationwide the industry went from less than 2 billion data points per year to more than a trillion. And this was just the beginning.

In essentially every technology based industry, disruptive enabling technologies change the landscape. This happens even in thriving industries, and the struggling electric utility industry is even more susceptible. New ways of producing and using products and services emerge. New providers bring them to market. Existing infrastructure and industry incumbents are challenged. A new electric grid model is resulting from just this phenomenon. There is a profusion of distributed energy resources (DER) occasioned by exponential improvement in technologies along with innovative, entrepreneurial business models. These include renewable and conventional energy production, electrical / thermal / mechanical energy storage, energy monitoring / management systems, smart end use devices, electric vehicles, microgrids, smart buildings, even smart cities. A plethora of non-utility companies are entering the market as providers of DER and related products and services.

As the penetration of DER increases, utilities, customers, and non-utility providers require more monitoring and analysis of more things. Suppose for example that every retail customer has on-site generation, storage, energy management, and independently monitored end uses (e.g., smart thermostat, smart end use devices, smart home / building, EV, et. al.). The volume of data would grow from a monthly meter reading and bill to thousands of new data points for monitoring, analysis, and control. The potential number of data points nationwide could grow to trillions annually! Now add retail transactive energy markets which already exist to some extent in nearly twenty states. With their physical real-time and forward derivative transactions, additional orders of magnitude of complexity and data volume are added to the mix. Now we are truly talking big data. Acquiring, analyzing, applying that data is and will be ever more crucial to ensuring a steady, safe, secure, and sustainable electric energy economy.

There is another strong motivation for big data and analytics. It is the need to plan, operate and manage the grid in the presence of adverse circumstances, all outgrowths of the foundational erosion and new industry developments discussed above.

The legacy grid is aging like most of the public infrastructure in the US. The American Society of Civil Engineers gave it a grade of D+ in its *2013 Report Card for America's Infrastructure* saying:

*America relies on an aging electrical grid and pipeline distribution systems, some of which originated in the 1880s. Investment in power transmission has increased since 2005, but ongoing permitting issues, weather events, and limited maintenance have contributed to an increasing number of failures and power interruptions.*

New capital investment by utilities declines as demand growth stalls, non-utility supplies proliferate, costs and risks increase, revenues decrease and sustainability concerns prevail. The grid is wearing out. As a result, major outages are on the increase, practically doubling every five years for the past several decades. As outages increase, the ability to detect, locate, analyze, and timely remedy them becomes ever more important. This requires more data, better data analytics, and improved operations and management applications.

As if an aging infrastructure were not challenge enough, the weather is getting worse. Severe weather events are growing in frequency, duration, and severity. And they cause more outages. They would do so even if the grid itself were not in decline. Approximately half of the growth in major grid outages over the past several years has resulted from severe weather events. Again, as these events increase as do their adverse effects on the electric grid, the ability to anticipate, monitor, analyze, and respond to them becomes ever more important. This is all about big data analytics.

The physical security of the grid is a growing concern even apart from weather issues. One of the greatest weaknesses of a centralized synchronous AC grid is this. If you disturb part of it enough (e.g., take a major power plant or substation or transmission line out of service) the entire grid is affected. In the limit removing critical generation or transmission facilities from operation for significant periods of time can mean the entire grid or substantial portions of it can be out of service. It goes without saying the adverse impacts of a prolonged system wide power outage as we recently learned from Hurricane Sandy and the derechos. As the possibility of physical attacks by terrorists increase, the ability to anticipate and deter or detect and respond becomes ever more important. This is all about big data analytics.

Rapid growth in renewable energy sources, both utility scale and distributed, also stresses the electric grid and business model. Wind and solar are not dispatchable and they can't automatically follow load. Grid generation must be dispatched to accommodate

their output, or load must be controlled to match their output, or energy storage must be utilized to time shift their output. This requires new kinds of data and applications. This is all about big data analytics.

Advancements in information and communications technologies have created opportunities for more data to be acquired, analyzed, and applied to improve the reliability, efficiency, security, and safety of the grid. New monitoring devices such as power measurement units (PMUs, aka synchrophasors) can sample the AC waveform hundreds, even thousands of times per second. With on board GPS and atomic clock, they can provide a time and location synched picture of the performance of the grid locally and system wide. Advanced computer algorithms can detect incipient problems with the grid from voltage and current variations. Or they can help monitor and control the grid more rapidly, accurately, and flexibly in the face of increasing complexity and uncertainty. A special case of this approach known as distribution fault anticipation (DFA) is being pioneered at Texas A&M University. Incipient faults can be detected and prevented. The traditional 'run to fail' mode for transmission and distribution can now be anticipated and avoid preventative maintenance to avoid failure and consequent interruptions of service. This can mean a dramatic improvement in the reliability, safety, security, and efficiency of the grid. So, think about moving from metering a customer once a month to metering 730 times a month to sampling points on the grid thousands of times per cycle. That's two trillion data points per device per year! Now we're really talking big data analytics.

How can this tremendous new volume and complexity of data be handled with adequate speed, reliability, and security? How can it be acquired, analyzed and applied effectively? In an unusually serendipitous circumstance, disruptive enabling information and communications technology (ICT) is paving the way. The ICT infrastructure and industry is already going through the erosion, disruption and transformation that the electric grid is just beginning. Just think. What else in the technology world has grown from a multiple of the number of people in the world to tens of billions? The Internet of Things (IoT) has. The number of things connected to the Internet surpassed the number of people in the world in 2008. Oft quoted Cisco has suggested that by 2030 there will be 50 billion things connected to it. That might be a tremendous underestimate given the discussion above of just the smart grid by itself?

In the presence of big data, the electric grid will become a hybrid electric, information and telecommunications grid. It will become part of the IoT. It will be an Enernet as named by Bob Metcalfe, a convergence of the smart grid with the IoT.



## Big Data: Enabler of an Intelligent, Sustainable Grid

What about cybersecurity? As the grid becomes an Enernet, cybersecurity becomes of paramount concern. A recent book by reporter Ted Koppel paints a cautionary picture of a grid that is part of the Internet of Things. Without being naive or overly simplistic, this problem is its own solution. The entire world, government / business / daily life, is becoming a part of the Internet of Things. Like electricity, the Internet has facilitated improvement in the quality of life, productivity of business and national economies unparalleled in the history of man. We would not abandon it any more than we would abandon fire or electricity. So, the entire world will endeavor to ensure its security and sustainability. It is already way more reliable than the electric grid, having not been out of service in any substantial way in decades. It is the very definition of an intelligent, resilient, self-healing, sustainable grid. Will the cybersecurity challenge ever be eliminated? That is unlikely. Will it be manageable? That is likely. As inscribed on the Guardianship statue at the National Archives in Washington, DC, "The price of liberty is eternal vigilance."

Big data will get bigger. Big data analytics will get better. The energy business will improve. Customers will benefit.

### About the author



**Steven E. Collier** is Director of Smart Grid Strategies at Milsoft Utility Solutions. Operating from his office in Austin, Texas, he assists Milsoft with corporate business development and industry relations. Since starting his career at Houston Lighting & Power in the early 1970s, he has worked as a consultant or executive with energy, telecom, and technology companies in the United States and abroad. He has degrees in electrical engineering from the University of Houston and Purdue University, and is a designated IEEE smart grid expert. Besides blogging as SmartGridMan, he writes and speaks widely on new and emerging energy, telecom, and information technologies. For more information on Big Data and Smart Grid, please visit <http://bigdata.ieee.org> and <http://smartgrid.ieee.org>.

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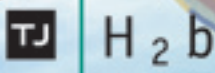
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# Optimizing Performance across Operations, Maintenance, and Engineering with Connected Asset Lifecycle Management

By Rick Nicholson  
and Chris Rittler

## Why Connected ALM?

Once upon a time, data gathering was the problem; utilities had no way to see the big picture. With the advent of now-ubiquitous software systems and the rapidly growing convergence of IT and OT, information technology (IT) and operations technology (OT), there is plenty of data. Utilities can see the big picture, but can't make sense of it. To capitalize on this convergence, utilities need to be able to leverage the information from these diverse sources to get (near) real-time views into the actual conditions of assets on the network. The real challenge is two-fold:

- 1) Consolidating information into a single view of the assets fleet-wide, and
- 2) Extrapolating experience-based performance models and analytics that can alert you to assets trending toward failure and offer guidance on how to best to mitigate the trend before catastrophic failure occurs.

A truly optimized asset lifecycle includes seamless integration of the processes and tools employed to monitor the assets, deploy resources to repair or replace them, and manage the history of the assets and work performed on them (including the associated costs for equipment, spare parts, etc.). This is the very heart of the Connected Asset Lifecycle Management™ (ALM) approach: bringing together individual technology solutions such as asset performance management (APM), workforce management (WFM), and enterprise asset management (EAM) to deliver a holistic view of the asset lifecycle (see Figure 1).

And, of course, usable data are like gold; the more you have the better. As these massive amounts of information are captured, stored and analyzed in a multi-step process that constantly rides the Internet or a private network, it fuels the need for greater bandwidth. And as the adage goes, "you're only as strong as your weakest link," so those utilities that have not upgraded their field area networks (FANs) will find themselves at a competitive disadvantage.

Connected ALM is more than the sum of the individual work and asset management systems – although each of these components plays a vital role:

## Connected Asset Lifecycle Management



Figure 1: Connected ALM (Source: ABB)

Asset performance management solutions enable utilities to evaluate assets at the intersection of criticality to the business and the probability of failure, then effectively act on prescribed scenarios that are optimally prioritized to capture game-changing value. These solutions can seamlessly extract data into one enterprise environment, compare the critical nature of assets against experience-based probability models, and enable utilities to act on prescribed intelligence to boost asset-, plant- and fleet-level performance and efficiency.

Workforce management solutions provide resource optimization capabilities so that field resources are dispatched with all the required tools, information, and parts at the promised time based on asset condition. Advanced WFM products ensure that schedules are optimized based on customer or asset demands, travel times, service level agreements, technician skills requirements, and internal costs.

Enterprise asset management solutions allow for the effective management of assets, work orders, inventory, and purchasing – all within the confines of safety and regulatory compliance. These solutions consider the skills needed, processes required and dependencies for parts, equipment, and documentation. In this case, decisions are driven by asset condition, availability of spares, project risk, and financial considerations.



# Optimizing Performance across Operations, Maintenance, and Engineering with Connected Asset Lifecycle Management

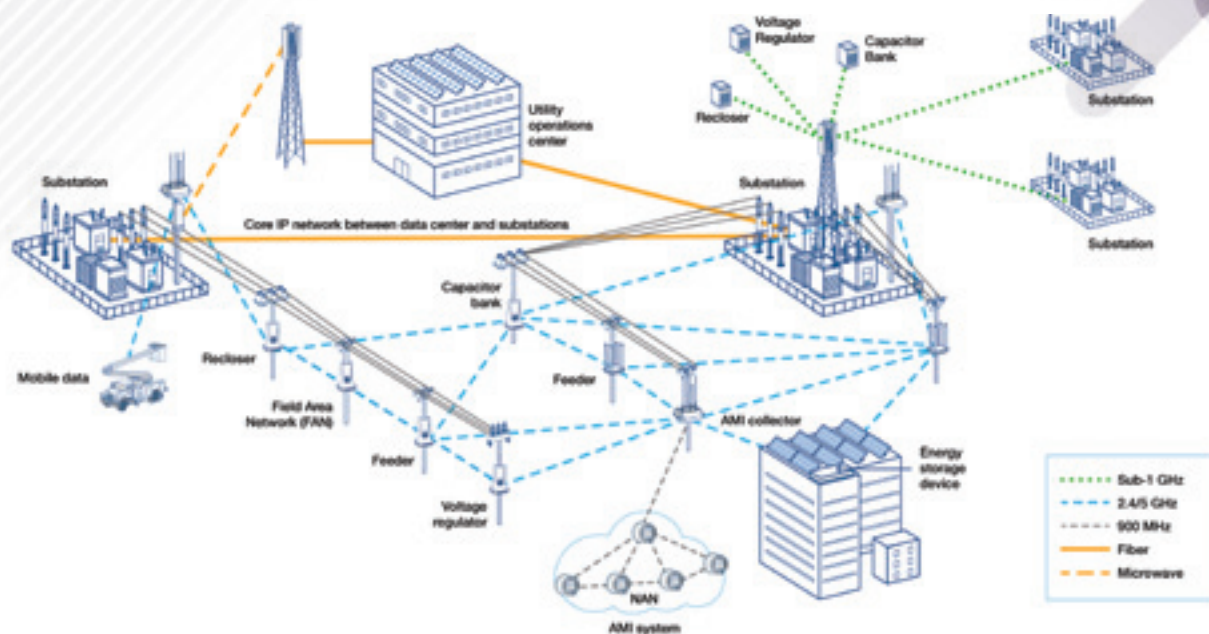


Figure 2: A full range of communications solutions is required to enable a truly Connected ALM approach. (Source: ABB)

Modern Wireless Communication Networks can replace siloed communications links or organize them into a two-way communications network that is reliable, secure, and addresses the spectrum of IT/OT convergence use cases from advanced meter infrastructure (AMI) to distribution automation (DA); enabling utilities to build for the bandwidth demands of today and ensure the sustainment for the next decade (see Figure 2).

All of these solutions optimize critical functional requirements very effectively – but they do it individually. The Connected ALM approach leverages their individual strengths to achieve transformational performance by eliminating disjointed workflows, organizational boundaries, and information silos, thereby enabling electrical distribution utilities to:

- Better manage risk and safety
- Leverage the cloud and mobility
- Enhance asset integrity, maintenance and reliability,
- Ensure regulatory compliance

## What differentiates Connected ALM from other work and asset management approaches?

To comprehend the power of the Connected ALM approach, it's important to understand that Connected ALM includes all aspects of "service." Connected ALM considers the broad context of managing the customer, asset, and workforce business processes – including design and construction, maintenance, wide area network (WAN), and FAN channels, as well as critical organizational reporting and utility metrics.

What differentiates a true Connected ALM approach is the ability to enable (near) real-time performance management (RPM) – the capability to push key analytics at the right time so that critical decisions can be made in an automated and intelligent manner.

RPM provides a series of performance metrics around customer loyalty, asset optimization, workforce efficiency, supply chain optimization, and financial management. With RPM, users view and analyze key performance indicators to proactively – even predictively – improve efficiency and minimize costs throughout the operation. Without a platform that connects the information and processes in a seamless manner, RPM is not possible.

## How does Connected ALM work?

Perhaps the best way to communicate the transformational benefits of the Connected ALM approach is to consider an example scenario at a transmission and distribution (T&D) utility. Our subject is a large electric utility with thousands of miles of transmission lines and thousands of substations across several states. Much of the infrastructure is aging, with many assets (e.g., transformers, circuit breakers, batteries, etc.) a mismatched collection of brands, topologies, and Field Area Networks (FANs) nearing their end of life.

This has led to a drastic increase in complexity for the utility, creating big challenges when it comes to management, security, scalability, and cost efficiency:

- Making decisions to replace or repair the assets
- Determining how to move beyond time- and usage-based inspections
- Attaining visibility of near real-time operating conditions of vital assets
- Meeting evolving compliance requirements
- Managing retirement of skilled technicians
- Holding down operations and maintenance (O&M) costs

With a Connected ALM approach, seamlessly integrated APM, EAM, and WFM systems enable a highly efficient workflow (see Figure 3).

# Optimizing Performance across Operations, Maintenance, and Engineering with Connected Asset Lifecycle Management

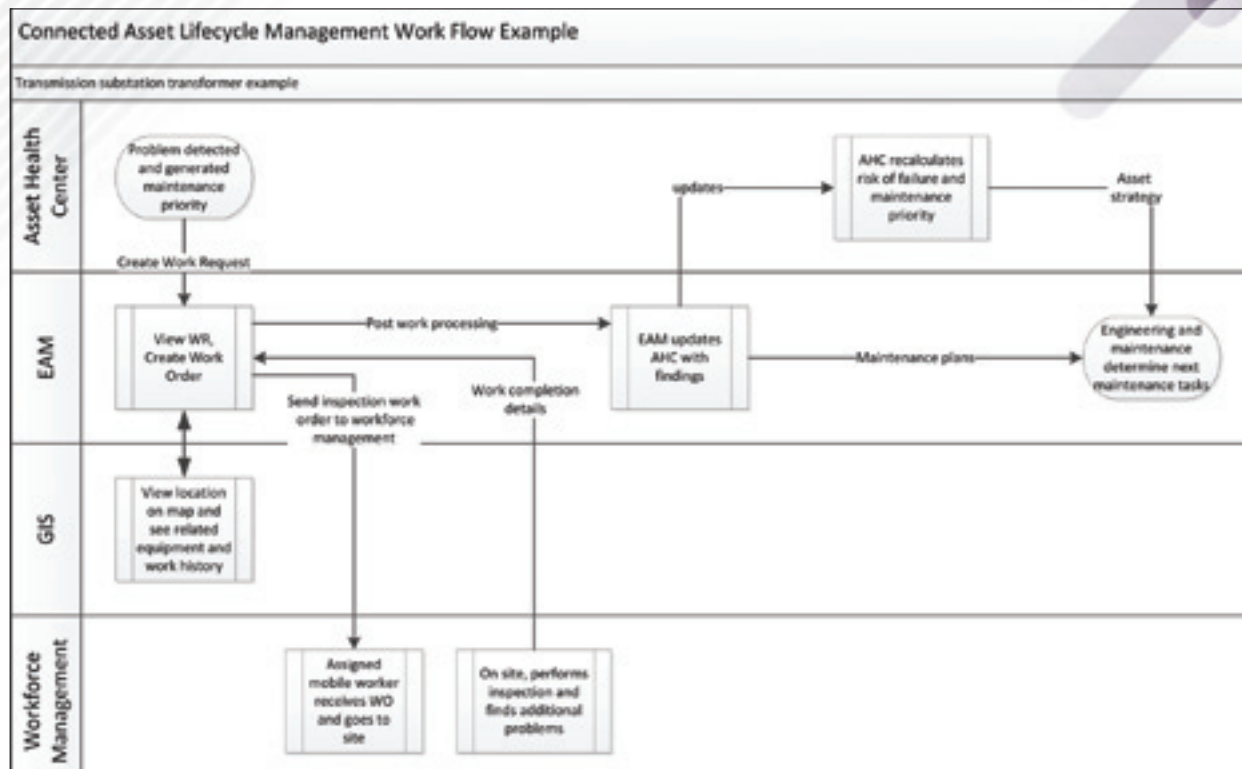


Figure 3: Connected ALM optimizes cross-functional processes by enabling efficient workflows across integrated, interdependent systems. (Source: ABB)

As you can see from this example workflow diagram, a fully integrated Connected ALM approach enables efficient workflows across the various systems used to monitor, manage, and continuously optimize the process and people that keep the assets up and running. The value derived from enabling such a seamless workflow can include such benefits as:

- Reducing catastrophic equipment failures through timely asset condition visibility, predictive analytics, and risk modeling
- Prioritizing maintenance and replacement to reduce both failures and O&M costs
- Optimizing asset investment strategies through comprehensive and accurate asset condition information
- Improving maintenance prioritization and planning, delivering greater productivity from both people and equipment
- Enhancing safety for workers, the public, and the environment
- Improving regulatory compliance and reporting with automated data capture, analysis, and report generation
- Increasing operational efficiency by linking operations to predictive maintenance and mobile workforce management systems

## Is a Connected ALM approach possible today?

Absolutely. The only thing standing in the way of bringing the Connected ALM approach to any organization is the decision to do it. It is an investment – of money and time, certainly, not to mention the critical underlying network – but, the real investment is in the health of your business.

It is important to remember that Connected ALM is not just about systems but also people and processes. Implementing Connected ALM requires deep domain expertise and an understanding of the complex workflows across a T&D organization in order to build the necessary integrations. When you make the decision to take the Connected ALM approach, look for partners who have both expertise in electrical distribution and in integrating APM, WFM, EAM and utility communications solutions; this will help facilitate a smooth implementation to achieve the benefits of connection.

## About the authors



**Chris Rittler** is responsible for leading the global ABB Wireless business. Mr. Rittler was Vice President of Carrier Sales and Business Development for Tropos Networks from 2002 to 2008, prior to the company's acquisition by ABB. He was most recently Senior Vice President Sales, Marketing and Business Development for Deluxe Digital Distribution and has also held leadership positions at Frontier Communications, Cambia Networks and Motorola.

Mr. Rittler has led teams responsible for delivering to market industry-leading, high-technology products for telecommunications, including wireless communications for cellular voice, broadband wireless data and IPTV. He has more than 20 years of leadership experience building successful global businesses through a blend of strategic, technological and operational strengths. He holds an MBA from Kellogg Graduate School of Management, Northwestern University, an MSEE from the University of Wisconsin-Madison and a BSEE from Marquette University.



**Rick Nicholson** has over 30 years of experience with the intersection of business and technology in the energy industry. He is a recognized and highly respected expert in the alignment of business and technology strategies and the successful deployment of technology to enable business process improvement. Rick has worked with clients in North America, Europe and Asia. His career has included positions with market research, consulting and technology firms where his responsibilities included business development, marketing, strategy, competitive analysis and project delivery. He is currently responsible for global product management and marketing for ABB's Enterprise Software product group. Rick is a contributing writer and blogger for a variety of energy industry publications, is a regular speaker at industry conferences, has been quoted in mainstream business publications and has been interviewed on national television news programs.



# Expanding from Smart Grid to Smart City

By Jason Wilson

In the United States, nearly all municipalities have deployed or are considering deploying smart grid initiatives to deliver intelligent energy services to their citizens. The attributes of reliability, operational efficiency, security and sustainability are the pillars of a smart grid solution, and should be carefully considered when choosing a network technology. The same is true for the smart city.

In order to leverage smart grid technologies for a smart city, the network should have the ability to scale, be able to interoperate with other systems, and remain operational for years or even decades in order to support the devices it serves.

Case in point, the small island of Aruba initiated a project to implement a smart grid network across its entire geography. The enhanced grid was used to streamline electricity distribution processes and provide customers with access to usage data, which resulted in more efficient use of power and services.

Although the initial network deployment was designed for smart electric meters, the utility needed the ability to scale the network at any time, to add a host of smart city applications. After evaluating an array of technologies, the utility selected RPMA®, a low-power, wide-area (LPWA) communications technology, which provided ubiquitous coverage, outstanding reliability and simple scalability for its smart city network. The initial smart grid rollout took place with a handful of smart electric meters running advanced metering infrastructure (AMI). Mere months later, distribution line monitors, transformer pressure sensors and smart streetlights were added to the network without additional network investment. The utility is also considering the addition of water and other applications to this network in the future.

Connecting devices across a smart city network can be challenging to say the least. Smart devices are constantly collecting data, but if the information is never shared, how can municipalities make well-informed decisions about infrastructure or resource allocation? A cohesive network management solution can provide support for multiple communication technologies, such as cellular, mesh and/or LPWA. These smart platforms can aggregate data from disparate technologies and provide valuable insight into network operation through a unified interface.

For instance, a city may have a smart grid in place which uses mesh technology to connect its electric meters. Later, it may add other technologies such as RPMA to monitor underground assets or cellular

to connect parking meters. This has driven smart grid management platforms to develop solutions which can connect all of these diverse applications under one technology umbrella.

Longevity is perhaps one of the most important factors in choosing a network for smart grid and smart city applications. Because most of the devices on these networks require very little power and virtually no maintenance, they can operate for several years or decades without the need for service. Sensors, electric/gas/water meters, street lights and parking meters fall into this category. The network, in turn, should operate with similar longevity, so it is important to select a communications technology that is not beholden to network sunsets or is not field upgradable.

For instance, currently, there are millions of devices running on 2G cellular networks. But, 2G technology is quickly being re-farmed and will become obsolete in a matter of a few years, which will leave all of these devices stranded without connectivity. The devices may still be useful, but the network they run on will cease to exist. The result is a costly upgrade to the next-generation network, but which one, as the exact scenario is sure to take place with 3G, 4G and beyond. Therefore, it is important to consider a network technology that will stand the test of time and will support devices throughout their useful lives.

What truly makes a city 'smart' is the ability to appropriately manage technology to deliver the most useful services to its citizens. Choosing the best network based on scalability, interoperability and longevity will ultimately help reduce costs and increase operational efficiencies in delivering services such as energy, water, waste management and transportation.

## About the author



**Jason Wilson** comes to Ingenu (formerly On-Ramp Wireless) with years of experience in product and program management in the telecommunications, defense, electronics and wireless industries. Prior to joining On-Ramp Wireless, he was vice president of product management at Ostendo Technologies, where he executed the development of an innovative immersive, curved screen display and secured a major DOD contract win for advanced imaging technologies. Prior to Ostendo, Mr. Wilson served in various product and program management roles at large companies and start-ups including L-3 Communications, TollBridge Technologies, and Nortel Networks. Early in his career, he served as an officer in the United States Air Force as a program manager for the Delta IV and Atlas V launch vehicle systems. Mr. Wilson has an M.S. in Systems Management from the University of Southern California and a B.S. in Astronautical Engineering from the United States Air Force Academy.



# THE BIGGER PICTURE

BY CARL POTTER, CSP, CMC



## Getting to ZERO: One Task at a Time

### The Vision of Zero

The electric utility continues to come to grips with achieving ZERO injuries. It's a journey that people at all levels in T&D organizations have their eyes on. More than a decade ago I began a campaign of keynote speeches and leadership seminars and workshops feeling like Don Quixote. Continually running headlong at the windmills of the ZERO injury safety culture. Leaders and workers pushed back making statements like:

- "It can't be done!"
- "This is a dangerous business and injuries just happen."
- "People are going to make mistakes!"
- "Leaders are only interested in getting a bonus!"
- "Isn't safety someone else's responsibility?"
- "How can you make a workplace that safe?"
- "Do you really think it's possible to have zero injuries?"

Setting the bar high for safety performance is a noble cause. We all like to talk about the seemingly elusive target of 'zero injuries.' That's a vision of what could be, what we hope to accomplish in workplaces across the country. People generally line up in one of two sides of this goal. There's the 'it's impossible to have zero injuries' camp and then there's the 'why would we target anything less than zero' camp. Admittedly, 'zero' is something to strive for and you will need to set goals to accomplish the target. The alternative is that you state a number greater than zero as your vision. Do you envision that 'X number' of people will get hurt in your workplace? If so, something is wrong and you better get to work! And, there's a dark side to the vision and target: I actually know leaders who set numeric goals for injuries because of a bonus plan. "Hmmm, let's see, we typically have five injuries in the department each year. I'll set my annual target at no more than five injuries so I'll get my bonus." What does that do to morale in your workplace? Is everyone on board?

### BALANCING ACT: PEOPLE, REGULATIONS, NUMBERS

*Nothing is particularly hard if you divide it into small jobs ~ Henry Ford*

What tends to happen in industrial safety programs – particularly in the electric utilities – is that the focus either on numbers

(statistics), compliance (rules and regulations), or people (performance). Achieving zero injuries requires balanced values for people, regulations, and numbers. Otherwise, things get out of whack! And the safety management process is not sustainable and injuries occur.

*"We don't work in a dangerous environment. We work in a hazardous environment that we make dangerous by not following safe work procedures and wearing our PPE."*

*-Brad Miles*

When we understand what it takes to create an injury-free workplace, we are able to hit the target of zero injuries more often than not. Hazards are the reason people get hurt, without the hazard there is no injury. When we fail to follow safety procedures and or wear our personal protective equipment, we increase the risk of an injury. A hazard-free workplace is created by actively identifying hazards, evaluating the risk, and applying controls to physically protect employees.

### Make it More Difficult to get Hurt

Anything that seems to be impossible or just plain difficult must be broken down into steps. Learning the process of recognizing and controlling hazards takes time mitigate hazards. Some clients understand what we are trying to accomplish and deliberate focus to make sure everyone is not just seeing and reporting hazards but also taking steps to mitigate the hazard to a lower level of risk. What we are attempting to do is create a workplace where it is more difficult to get hurt. Effort is required to hit ZERO; it does not happen just because we say it will.

### Eight Concepts to Achieve ZERO

1. Break the job of hitting ZERO injuries down to macro and micro work areas
2. Look at your overall location (think macro: big picture) and see it as a workplace
3. Identify what is in your workplace that can cause injury. (identify hazards in the form of: material, conditions, or activity)
4. Take action to mitigate the hazards in the workplace to a lower level of risk, then





5. Take a look at your worksite (think micro: local or where you are completing tasks)
6. What is in your worksite that can cause injury? (this is a close-up, focused look)
7. What controls can be employed to mitigate the risk of injury (decrease the exposure or impact of the hazard), and remember
8. Ask yourself, "Do we want to reach ZERO injuries in our workplace and are we willing to put out the necessary effort?"

## Courage and Tenacity Required

It takes courage and tenacity to set the goal at zero. Courage is required because there will be 'naysayers' – those who say it's not possible. We've witnessed some very strong debates – more like arguments – when it comes to shifting the corporate philosophy to one of zero injuries. Tenacity is essential because it's hard to change a culture. It takes work for a safety culture change to be sustainable.

The big danger in changing to a zero injury culture is that human nature wants to return to the old culture. Corporate cultures tend to be elastic, springing back to the original, unless there is a significant, long-term effort. That's why it takes unwavering management commitment to get a groundswell of employees who believe in and will do what it takes to 'get to zero.'

The worst thing that can happen is that company leaders will set an expectation of meeting a target of zero injuries and then abandon the goal. That will only result in a loss of credibility, reinforce a belief that safety is not important, and give the 'zero naysayers' a victory.

## Avoid the Worst Case Scenario

Sure, you could avoid the worst case by not declaring zero as a goal. But where does that get you? Nowhere.

Here are some things you can do to make zero a sustainable goal in your organization:

1. Set specific goals that support a zero-injury culture such as involving all employees in at least three non-routine safety activities each year. These can include working on a safety committee, investigating an incident, participating in work practice or technical training development, and any number of other tasks.
2. Establish cardinal rules with specific consequences. Many companies have identified safe work practices and safety rules that will lead to life-saving activity. The consequence for lack of adherence to the rule is termination in these companies. While this may seem a bit harsh to some, it sends the undeniable signal that employee safety is the highest priority.
3. Establish documented safe work practices and develop the expectation that all affected leaders and employees know and follow the processes.

These are just a few of the things you can do to build a zero injury culture that sticks. Remember it takes time, tenacity and courage. Do what it takes for the long-haul so everyone can go home every day without injury.

## ABOUT THE AUTHOR

**Carl Potter** is a nationally known speaker, author, and consultant in the electric utility industry. He is the author and facilitator of the Hazard Recognition and Control Workshop, delivered to thousands of people in hundreds of workplaces in the United States and Canada. He has authored eight books and his newest book Conquest for Safety: Leadership Required is now available. Information on his work and presentations can be found at [www.carlpotter.com](http://www.carlpotter.com)

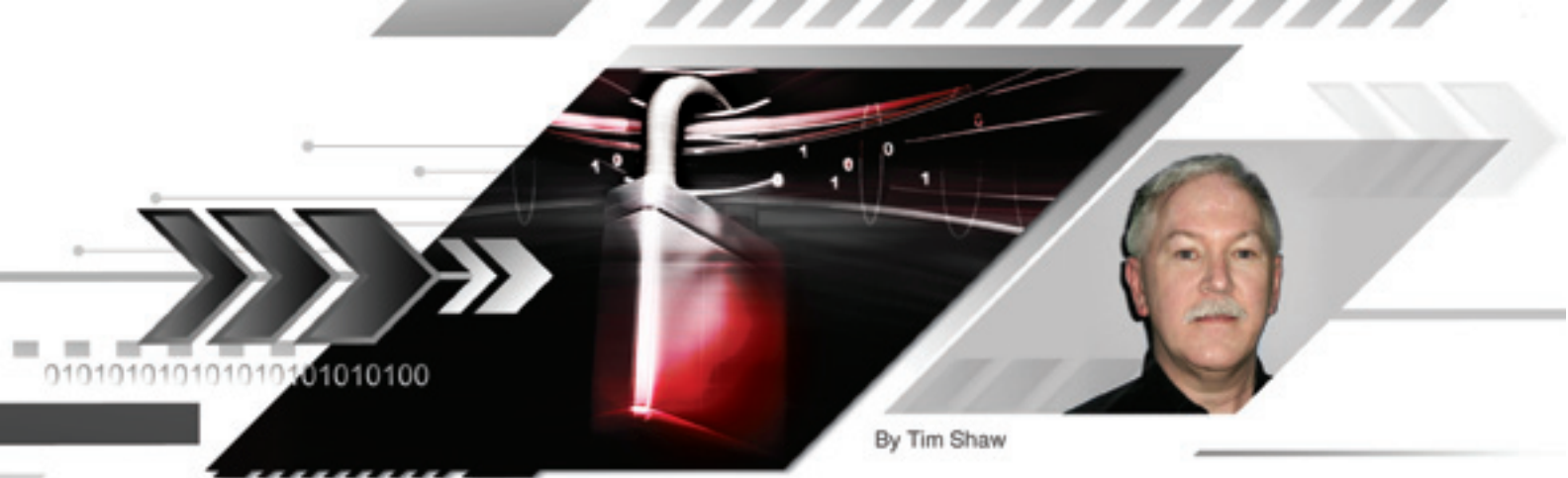
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## SECURITY SESSIONS

### Don't make me do it, I can't do it, it's too hard!!

In spite of regulatory pressures and government mandates and reading about cyber attacks and data breaches in the news almost daily there are still a surprising number of industrial facilities that have not implemented an effective cyber security program to protect their critical digital assets. Just as worrisome are the plants where they think they have provided adequate protections; but in reality their digital assets are actually still vulnerable. IT consultants and product vendors are willing to provide all sorts of advice and cyber toys (for a price); and yet time passes and industrial facilities continue to be inadequately protected. Is there any logical reason why this is so?

I have worked with many industries ranging from pharmaceuticals and refining to power generation and steel production and over the years I have been involved with cyber security efforts at a good number of such industrial facilities. I will be the first to admit that establishing and maintaining adequate cyber security in an industrial setting is MUCH more complex and difficult than for a typical IT operation. To an outside observer it may not be obvious why this should be true. After all computers are computers and networks are networks so why not just have the corporate IT staff just show up one day, loaded-down with security appliances, and cyber-secure the plant? In a moment I will try to explain why that usually won't work, but the frightening thing (to me at least) is that many corporate IT departments would/do actually agree with that proposition.

Now don't misunderstand me, I am not excusing the owners of critical industrial facilities from their obligation to protect their critical digital assets from cyberattacks. Their lawyers and insurance underwriters should explain to them the risks associated with such a failure in governance. No, I am merely pointing out that establishing adequate cyber security is harder than it might seem due to a

number of factors that are unique to industrial facilities, be they continuous or BATCH processes or even discrete manufacturing plants.

- Not every digital asset/system in a facility needs the same level of cyber protection, and many don't need any cyber protections at all, the trick is in knowing which is which. Unlike an IT operation where you have servers, PCs and network elements (all of which are 'computers') an industrial facility has a range of digital assets including smart instruments and control elements, digital protective relays, PLCs, digital MCCs, digital analyzers, data acquisition systems, workstations and so forth all the way up to large and complex DCS and SCADA systems. I have seen plants where the I&C group identified several hundred (or more) digital assets but had no idea of how to go about classifying them by their importance to plant operations and safety and their need for cyber protections (or lack thereof). Faced with what seemed to be a manpower intensive (and hugely expensive) task of protecting everything they had identified, some groups just choose a wait-and-see (and hope nothing happens) posture.
- A one-size-fits-all approach to cyber security (such as many IT organizations use) merely leads to unnecessary complexity and frustration in an industrial facility. In the IT world there are not that many types of digital assets and many IT organizations standardize on a handful of software and hardware platforms, so it is possible to devise a cyber security approach that standardizes the technical controls and countermeasures to be applied to all digital assets. An example of this is the government's FISMA cyber security standard for their IT systems which can be met by applying the NIST SP 800-53 standard and its huge list of cyber security measures.

# SECURITY SESSIONS

Also, most IT departments regularly update their assets every few years to keep them current with computer and networking technologies. In an industrial facility taking such an approach usually ends up creating a massive (and totally useless) paperwork nightmare where I&C personnel have to waste time documenting all the 'exceptions' to the standard policy – such as why they could not (and still have not) installed firewall software on the PLC that controls the steam generator and why they have not been 'patching' the digital trend recorder in the main control room. Also a lot of digital IACS and I&C equipment in industrial facilities is quite old and not even close to being up-to-date with current computer and networking technologies and so often incompatible with standard IT cyber security technologies.

- Many of the automation systems in operating facilities are required to run continuously 24/7 until such time as the plant reaches a scheduled shutdown or outage – which might not be for several years. Many security approaches, such as installing patches and updating (or eliminating) applications and installing specialized countermeasures such as a host-based intrusion detection system require at least rebooting of the systems to which they are applied, if not actually temporarily requiring removing those systems from operation. This is usually not a big deal in the IT world but, due to potential adverse safety and production impacts they may not be possible to implement in a plant environment until the next outage. Adding to the problem, during an outage the plant personnel are usually busy supporting the plant/process/automation changes in order to get the facility back up and into operation again and have little time left to support cyber security activities. Some of the more complex automation systems may be fully redundant, and so it would seem obvious that you could do your cyber security work on the standby portions of the system and then switch over and work on the primary portions. Sounds good on paper, but in reality only a plant with a low-risk, stable process, would likely consider taking the risk. Making redundancy just work as advertised has always been a challenge to system vendors and few plants would want to mess with a properly functioning automation system.
- Many of the plant systems are categorized as being 'legacy' and have little if any vendor support (and spare parts have to be found on EBAY) and thus are considered as 'no touch' (following the ancient wisdom which recommends that "if it ain't broke, don't fix it!"). Such orphan systems may be running on hardware and operating system platforms that are semi-modern and might even use Ethernet networking. But no one at the plant has in depth technical knowledge of the system and IT would probably laugh (or put a lot of 'lol's and smiley emoticons in their email response) if asked to support the system (and would probably ask why it hasn't just been replaced with something modern?) I feel sure that the plant manager can probably explain to them the reason that has not happened better than I ever could.
- IT strategies for convenience may actually degrade plant cyber security. Corporate IT people don't generally like to go to industrial facilities. They (plants, not IT folks) are dirty and smelly and loud and things occasionally go boom. So a typical IT approach is to provide site support and administration of networks and cyber security countermeasures via remote access. Establishing a network/cyber DMZ (a term borrowed from the Korean War and the no-man's-land established between the armed forces of the north and south) is one way of providing remote access to systems. In a DMZ strategy you place selected systems into a special, restricted LAN segment that is 'visible' from both the 'inside' (other plant systems and users) and 'outside' (corporate IT and hackers). You plan on the fact that systems in the DMZ are visible to bad guys and will be attacked and you strip them down to the basics (something called 'hardening') and put monitoring measures in the DMZ with them. The DMZ provides an early warning system of sorts and delays an attacker thus giving the plant the chance to respond by taking actions ranging from totally shutting off the external connection or at least making changes to the plant's external firewall. But I have been at plants where everything except the drinking fountain and their DCS was placed into their DMZ, just so corporate IT could support them remotely. Most of these systems in the DMZ were not even given any special protections against cyberattack. The focus seemed to be on making life convenient for the IT folks. The plant was wide open for a cyberattack because of this, but they actually thought they were cyber secure. Their only true cyber protection came from the fact that the plant DCS was somewhat old and obsolete. Mind you, I understand why many corporations have had to resort to remote support, keeping IT folks at each plant is expensive and sending people to site takes time. But there are ways to make remote access secure; putting everything into a DMZ is not one of them.
- Many of the digital assets and systems have no test/support environment on which changes can be tested. As has already been mentioned a lot of digital assets in an industrial facility are legacy. The plant may have originally purchased enough spare parts to build a test and support environment for such a system, but by now, because the vendor either doesn't exist or no longer supports the system, that support environment has been cannibalized for spare parts or for parts to expand the original system. This means that the only way to test a change, a patch, a new application is on the production system. Most plants would really, really resist the suggestion to put untested changes onto a running production system. This is less of a safety issue in a discrete manufacturing environment or even a BATCH production environment; but it is still not in any way a practice I would personally recommend.



# SECURITY SESSIONS

- Many digital assets in an industrial facility are not 'computers' (even though they contain microprocessors and executable program code) and most (if not all) conventional cyber countermeasures can't be applied to many of them. In fact many of these digital assets do not need to be protected against cyberattack. Many low-functionality digital assets are actually nearly immune to cyber compromise but, not knowing this, efforts are often made to protect them anyway. Part of the problem here are the vendors/manufacturers. They publish spec sheets and manuals that give a lot of information about their products, but almost never provide information about the cyber vulnerabilities (or security) of their products – possibly because they don't know? I sat on the phone with a vendor's engineer one day asking question after question in order to finally determine that indeed, their device would not be vulnerable to an infected USB 'thumb drive' being inserted due to limits in their USB port support software. It would have been nice to find that data in one of their manuals. Vendor documentation rarely tells you if their 'smart' device uses ROM, EEPROM or flash memory to hold their program code; yet knowing this can tell you if a device is essentially immune to any form of cyberattack (and therefore requires no protections). IT folks generally don't have to think about such issues since everything they deal with tends to be a computer with a bootstrap BIOS program, lots of RAM, possibly a file system and hard drive, Ethernet ports and a COTS operating system – and that pretty much guarantees that the device is vulnerable to some form of cyberattack, and will need to be protected. I have seen far too many plant personnel wasting time and money trying to figure out how to put cyber security protections around a digital asset that actually didn't need any and which wasn't getting any benefit from the effort.
- IACS often use industrial protocols and vendor-proprietary protocols that are unknown to IT products. Most of the early local area networking protocols devised prior to the widespread acceptance of Ethernet (and eventually TCP/IP) have been ported as 'ISO-Layer 7' (application layer) protocols that can be transported using Ethernet-TCP/IP networking. Many DCS systems have been converted to use Ethernet, and possibly TCP/IP, in place of their older, vendor-proprietary networking technologies. But the protocols and message types used by IACS and I&C devices are not always supported by commonly-used IT protective and detective mechanisms such as firewalls and NIDS (network intrusion detection/protection systems). It's not that such mechanisms don't 'see' such message traffic. After all it is carried in Ethernet frames and possibly IP datagrams. The problem is that those tools either can't interpret, or have a limited capability to interpret, and decode such message traffic and thus determine which of those messages are allowed and which might be malicious/unauthorized. IT personnel usually know nothing about those 'industrial protocols,' and it might not be their fault; if it's a vendor's proprietary system messages they might not actually be documented anywhere.
- Older plant networks may still incorporate legacy communications and LAN technologies that pre-date Ethernet and TCP/IP. First and even second generation DCS systems mostly used vendor-designed LAN hardware and software. Early PLC based systems used vendor-designed LAN hardware and software. A lot of that stuff is still out there running in plants. Also communications interconnectivity between digital systems and devices originally was established using low-speed, minimal-functionality, point-to-point (or multipoint) 'serial' communication circuits with a range of legacy industrial protocols. This was particularly true with SCADA systems. There are few if any products available to monitor or secure such communications. On the other hand it may be overkill to attempt to do so based on the potential (limited) consequences of such communications being compromised.
- Some industrial facilities are highly unlikely to be the focus of a targeted cyberattack but still move forward on implementing excessive cyber security protections out of fear and ignorance. The government, in the form of the department of homeland security, has tried to identify industry segments that are important to the nation and economy and thus are much more likely to be a target for cyber terrorists. Facilities that make glass, dog food and shoes (ok, we don't have shoe plants... so maybe toothpaste) are not going to be grabbing headlines if they are shut down, and probably no one would be killed in the process and the economy would be largely unaffected. This does not mean that an ad hoc cyberattack could not occur. Someone can always unknowingly bring an infected laptop into work and connected it to a plant network. But protecting against that kind of attack does not require the levels of protection and detection as would say, a nuclear power plant or a large refinery, where an adversary would likely target them and be willing to expend significant resources in an effort to create a headline-catching catastrophe. One of the challenges with industrial facilities is picking the appropriate level of cyber security based on cyberattack risk and likelihood. Most IT organizations assume that all of their assets are important (after all the business couldn't keep running without them) and therefore need to be given equal protection. On the other hand individual industrial plants, and specific areas/units/trains within those plants, need to be assessed to determine how much (if any) protection is adequate and how much risk is tolerable and cost-justified.

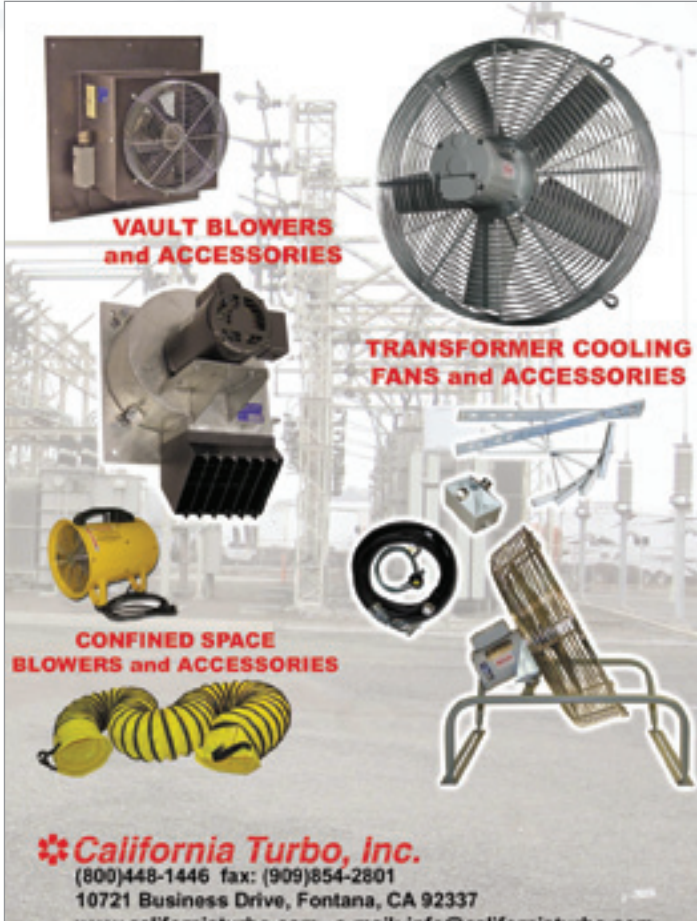
# SECURITY SESSIONS

- Some industrial facilities believe that their physical security measures (fences, gates, video surveillance and guards) provide adequate cyber protection for critical digital assets, especially since they probably also believe those assets to be 'isolated' and thus impossible to attack, and therefore don't think they need anything further. The definition of the term 'isolated' would seem to be clear; you can look it up in a dictionary (anyone remember those?). I thought I understood the term, and I have had plant personnel swear up and down that a critical system was 'isolated.' Except of course when Engineering Lead Fred X needs to dial into it from home (or connect to it across the Internet) during an emergency. Oh, and of course when the system vendor needs remote access to diagnose a problem and download a 'fix'. And of course any of the technicians can walk up to the system and connect a laptop or insert a CD at any time, because all of them are totally trustworthy. Possibly we need a new term such as 'usually isolated' or 'somewhat isolated' or even 'hardly isolated' in order to more accurately describe the actual status of such systems? Maybe the plant management team is unaware of the Stuxnet attack on the really well isolated Iranian fuel enrichment facility? Maybe they are unaware that hackers can locate and attack remote access connections, both dial-in and cross-network? Maybe they are unaware that insider sabotage is one of the leading (and growing) causes of unplanned plant outages and plant system failures – and we are not talking about radicalized followers of ISIS. Most malicious insiders are just Bob from the instrument shop who got a crappy review, was just informed that he has to pay more for his medical insurance next year and who got no cost of living raise this year, and he feels like a little payback is in order. (My apologies to any actual 'Bob' who works in the instrument shop.)

So, establishing and maintaining a cyber security program at an industrial facility is challenging. Not impossible, but definitely challenging. There are a number of factors that need to be considered that are outside the realm of expertise and experience of most IT organizations (as well as most plant I&C organization). But it is not impossible and it is important and many industrial plants HAVE implemented cyber security programs. There have been cyberattacks on industrial facilities, both domestically and internationally, and there is no reason to believe this will stop. Fortunately none have resulted in major catastrophes (just a few minor ones). There are actually strategies and approaches for every one of the challenges that I listed above, many that don't cost a fortune and some that are quite innovative.....but that will have to be left to a future column.

## ABOUT THE AUTHOR

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



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## Bringing Renewable Energy to the Grid

By Jacob Susman

Bringing renewable energy to the grid is no easy achievement. Even with the savviest team of experts and a strong balance sheet, it takes a wealth of patience and resources to navigate through each project's complex roadmap. By way of 7,782 MW developed in North America, we undoubtedly know a little something on the topic of greening North America and bringing renewable energy to the grid. In addition to our own development, we are particularly strong in Operations & Maintenance where we operate and maintain 10.5 GW of renewable projects for our own accord and third parties.

Our goal is to meet utilities' need for reliability and also those of corporations, who want sustainability. New investments in transmission and distribution are helping to facilitate these wants and needs. Coupling all that with EDF RE's experience brings it all home to green the grid in a reliable manner.



### Utilities Buying into Renewables

Utilities have to consider new strategies for integrating increasing amounts of renewable energy into the power system, while maintaining economic and reliable operation of the grid. Although utilities have been progressively installing wind and solar power systems to provide larger rations of electricity generation, many utilities also express concerns about possible

impacts of clean energy on electric power system operations, because of the natural variability of the wind and sun. Our goal is to help operators find ways to reliably integrate renewable energy into system operations. It's important to manage that integration in a way that also enables these clean energy projects to improve the power quality of the electric grid.

### It's all about monitoring and technology

With the advances in technology today we are able to monitor all aspects of operating projects so we can improve economic and reliable operation of the grid. Our state of the art Operations and Control Center (OCC) provides 24/7 remote monitoring and basic trouble shooting. The facility is staffed around the clock, 365 days a year, with trained and experienced operation technicians. From the OCC we evaluate project performance via the SCADA system (Supervisory Control and Data Acquisition), conduct remote restarts, and dispatch service technicians to the fault site as necessary. In addition, the OCC has the ability to provide off-hours curtailment response, reporting, and warranty notice documentation. The OCC uses advanced technology to optimize turbine availability and profitability and ensure projects increase revenue around the clock.





## Corporations Buying into Renewables

Selling power directly to the utility is not the only way we green the grid, EDF RE has signed Power Purchase Agreements (PPA) with well-known corporations: Google, Procter & Gamble, Microsoft, Walmart, Yahoo! and Safeway, to name a few. For the last decade, large companies have increasingly set sustainability targets. According to Ceres and World Wildlife Fund, two leading non-governmental organizations who have been encouraging this shift by corporations, 43 percent of the Fortune 500 have goals to reduce their carbon footprint, reduce their energy usage, or power a portion of their operations with renewable energy. Large companies, as for-profit entities, have naturally tried to find cost effective ways of meeting these goals.

With the 60 percent decrease in the cost of wind in the last five years, companies view renewable energy as a viable way to reduce their carbon footprint. But in a perfect world, the stars would all align; the grid would have capacity, the transmission line would be in a reasonable proximity, and the manufacturing facility or datacenter would be located in the middle of it all. In a not so perfect world, we overcome these obstacles in our goal to bring more renewable energy to the grid by working with the utility.

Electricity generated in one location cannot be directed to a specific user over the electricity grid. Our PPA's with corporations capitalize on this amorphous nature of electricity through a structure referred to as a 'Virtual PPA' (VPPA). Below is an example of how the VPPA works:

1. P&G buys electricity from EDF Renewable Energy in the form of a power purchase agreement (PPA). A PPA is a long term contract to buy power over a period of time at a negotiated rate from a specific facility, in this case, the Tyler Bluff Wind Project in Texas.
2. P&G will then sell that power back into the grid at the local, wholesale price. This may result in paying slightly higher prices now for the renewable energy if the grid power is cheaper, but as power becomes more expensive over time, the price P&G locked-in will lead to a profit relative to what they would have paid for grid power, whose cost is expected to rise. In the process the renewable energy credits (RECs) are retired such that no other party can claim credit for the green aspect of P&G's purchase.
3. Lastly, P&G will apply those RECs to the energy used at their manufacturing facilities.

We are all seeing the big corporate names in the headlines lately buying into renewables and we expect this market to continue and to significantly grow over the next few years. It just makes good business sense.

## Incentives

The United States is committed to improving the nation's electric grid and spurring the development of renewable energy by modernizing our electric transmission infrastructure. Recently, Congress passed a bill that includes provisions to extend federal tax credits for wind and solar generation. This action not only helps to continue the development of clean, stable energy in the United States but it also secures the careers of thousands of American renewable industry workers across all 50 states.

## In a nutshell

The nature of our business is to make a difference in the world by producing clean, renewable energy in the most economical, environmentally and socially responsible way possible. We take great pride in the jobs we are creating and the communities we are enriching. We are always looking for new ways to meet utilities' need for reliability and corporations' desire for sustainability. There is no secret formula to greening the grid but we do know for EDF Renewable Energy the foundation is built on commitment, patience, respect and talented people to get these projects online.

## ABOUT THE AUTHOR



**Jacob Susman** has been building businesses, investing, and developing projects in renewable energy since 1999. He led OwnEnergy from inception to its sale in August of 2015 to EDF Renewable Energy, including recruiting and managing its industry-leading team, raising capital, establishing a nationwide brand, sourcing new business, developing projects building customer relationships and generating revenue. Today, he serves as VP, Head of Origination where he leads EDF RE's relationships with both utility and corporate customers around the US for the Company's wind and solar portfolio.

Jacob is an active member of the Board of the American Wind Energy Association, where he serves as its Treasurer. Jacob also serves on the Advisory Board of the Business Renewables Center. In 2010, Jacob was named to Crain's New York '40 Under 40', and in 2012, he was named an E&Y Entrepreneur Of The Year Finalist. In 2013, Greentech Media named him one of New York's Top 10 Cleantech Leaders.

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Cigré HV .....	www.cigre-hv.ca .....	21
Cigré Paris .....	www.cigre.org .....	15
Copperleaf.....	www.copperleaf.com.....	33
CTC Global Corporation.....	www.ctcglobal.com .....	28
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Easi-Set Worldwide.....	www.EasiSetBuildings.com .....	52
Hastings Fiberglass Products Inc. ....	www.hfgp.com .....	1-52
Hubbell Power Systems Inc. ....	www.hubbellpowersystems.com.....	7
IEEE Power & Energy Society .....	www.tandd2016.org .....	17
Megger .....	us.megger.com.....	22
Power Survey Company.....	www.powersurveyco.com.....	11
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RFL Electronics Inc. ....	www.hubbellpowersystems.com.....	INSIDE BACK COVER
RTDS Technologies, Inc. ....	www.rtds.com.....	10
S & C Electric Electric Company .....	www.sandc.com/it-sg.....	9
Smart Grid Canada .....	www.smartgridcanadaconf.ca .....	19
Surplec HV Solutions.....	www.surplechv.com.....	13
Systems With Intelligence Inc. ....	www.SystemsWithIntelligence.com .....	5
TechCon .....	www.techcon.info.....	39



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