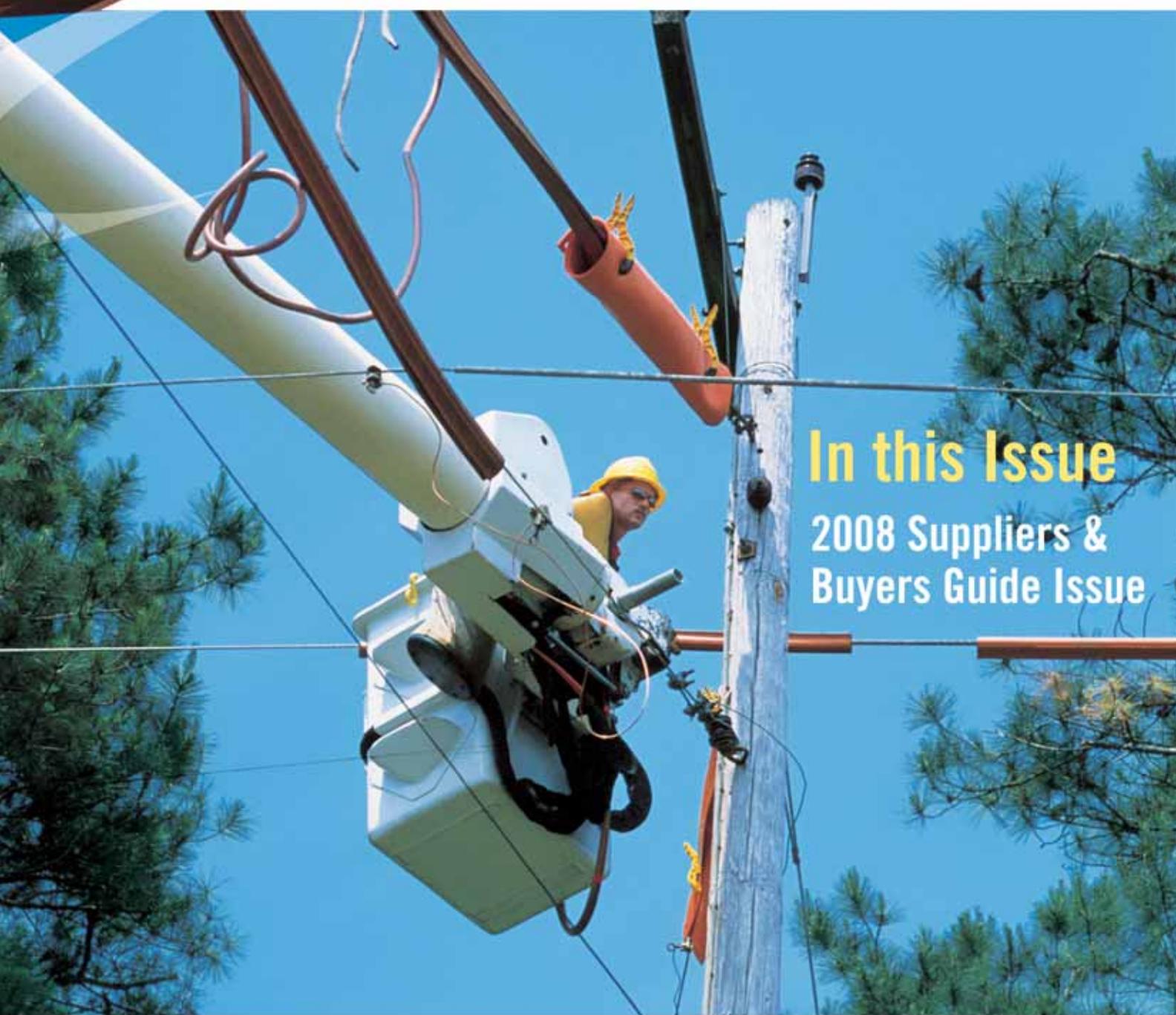




# Electric Energy T&D

MAGAZINE

JULY-AUGUST 2007 Issue 3 • Volume 11



**In this Issue**  
**2008 Suppliers &**  
**Buyers Guide Issue**

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# Electric Energy T&D

## MAGAZINE

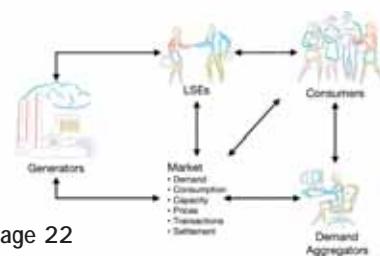
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# Industry News

## GARRETCOM EXPANDS CYBER-SECURITY SOLUTIONS FOR CRITICAL INFRASTRUCTURE NETWORKS

### Premier Hardened Industrial Networking Products Gain IP Firewall, VPN, VLAN and Secure Network Management Capabilities

Fremont, Calif. – Cyber security is a critical component of modern industrial networks, especially those serving Critical Infrastructure sectors such as power utilities, transportation facilities and pipeline operations. A set of new networking products software releases from GarrettCom™, Inc. enable advanced security capabilities to be integrated into new and existing industrial networks, including those facing extreme environmental conditions and close regulatory scrutiny. Rigorous network perimeter security via IP Firewall, IPsec VPN and serial-port SSL capabilities is now available in the company's Magnum™ DX40 and DX800 compact hardened security appliances. Secure network management using encrypted protocols is now available

across the Magnum 6K and DX product lines.

New software releases announced today include MNS-6K-Secure for Magnum Ethernet™ switches, and MNS-DX Release 1.3 for Magnum DX routers and terminal servers. These software releases continue GarrettCom's focus on the comprehensive Magnum Secure Network Framework (MSNF), which consists of six key elements, defined to promote best practices in network security:

- Secure Network Management
- Perimeter Security
- Serial and Ethernet Port Security
- Access Control
- Network Back-up and Recovery
- Legacy non-routable protocol secure transport

GarrettCom's Magnum Secure Networking initiative, including MSNF, is largely spurred on by the power utility industry's stringent NERC Critical Infrastructure Protection standards for cyber security. The new software releases are dominated by security-focused features, and also include other features more generally applicable to flexible, high-performance industrial networking.

MNS-6K-Secure is a new version of GarrettCom's MNS-6K network management software for Ethernet switches. It adds secure management via SSH to SNMPv3 and RADIUS/TACACS+ and SSL access security capabilities. MNS-6K-Secure also adds expanded system logging capability, increased concurrent network management users, DHCP server capabilities, and larger numbers of VLANs.

MNS-DX 1.3 expands IP firewall capabilities with NAT/PAT, DHCP server and filtering capabilities along with IPsec VPN support including X.509 certificate options. Also included is management security via SSH and SNMPv3, and support for ModBus-TCP to ModBus-RTU inter-networking.

For more information on MNSF and GarrettCom's MNS-6K-Secure and MNS-DX software see <http://www.garrecom.com/msnf.htm>.

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## Digital Voltmeter & Phasing Set with Capacitive Test Point Mode



HD Electric Company's NEW DVM-80T Digital Voltmeter & Phasing Set with Capacitive Test Point Mode is a new addition to our Digital Voltmeter line. This compact unit is designed to measure voltages up to 40kV and up to 80kV with a pair of add-on resistors, as well as the ability to take readings on Capacitive Test Points. The DVM-80 and DVM-80T incorporate Phase Accurate Technology, which makes all voltage readings, whether made from line-to-line or line-to-ground, accurate and repeatable to within 1%, and are the only available digital high voltage meters to include this technology for high accuracy voltage measurements. The two-stick design can be used in both overhead and underground applications. The digital meter displays the true RMS voltage on the conductor.

For more information on the DVM-80 and DVM-80T, as well as the rest of our product line, please visit our website at [www.HDElectricCompany.com](http://www.HDElectricCompany.com).

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## How Can We Do More With Our Existing Vegetation Management Budgets?

Utility vegetation management is more than just clearing vegetation from lines. To be effective, vegetation managers must be sure that budget dollars are allocated wisely, that varying conditions are taken into account, that crews are operating efficiently, and ultimately, that customers (and regulatory agencies) are satisfied.



By Henry King

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## Elster ships one millionth AMI system smart meter

Elster, a premiere provider of AMI systems and solutions for gas, electricity, and water, announced that it has shipped its millionth EnergyAxis® System smart meter. As the largest, true two-way, RF mesh deployment in the world, the EnergyAxis System installations span the globe from North America, Central America, and the Caribbean to Australia and New Zealand. The system supports multi-utility applications ranging from high-density metropolitan environments to lightly populated rural areas.

Flexible and adaptable for future applications and communications technologies, the EnergyAxis System enables customers to retrieve consumption, time-of-use, and interval data from residential, commercial, and industrial accounts on a daily basis. Its open and interoperable, standards-based architecture enables utilities to improve revenue cycle services, customer service, delivery reliability and workforce utilization, reduce non-technical losses, as well as implement demand response and conservation programs.

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# Industry News



An example of a tablet computer with work planning software  
(photo courtesy of Powell, Inc.)

So how do you make the most of your limited budget when there is only so much that can be done to make equipment and labor more productive? Trees keep growing, an aerial lift can only reach so far, so fast, and we all know how difficult it is to find qualified, productive tree workers.

The key to improving the efficiency and effectiveness of your vegetation management program is to invest in proven technology to gather information, streamline operations, reduce paperwork and effectively allocate your limited resources to maximum benefit.

The line construction side of the business has been doing this for a decade or more by using ruggedized PDAs, tablet computers and GPS devices along with specially-designed software to improve work planning. Some vegetation managers have adapted the technology to gather timesheet information or to inventory trees. There are a number of hardware and software vendors already in the market, ready to sell you something off-the-shelf or design something unique to your system. But many of these technologies are not designed for the unique needs of vegetation management programs.

## START LOOKING FOR HELP NOW

So, maybe you know that some of your processes are not very efficient, or your data is not adequate, but you don't know where to begin to fix these problems. Perhaps you have

heard how other utilities are improving their operations, and maybe you have seen examples of electronic solutions that work in other areas, but these options are not specific to the unique requirements of your vegetation management program.

The answer lies in finding a knowledgeable independent consultant who can help to pinpoint your problems, identify cost-effective long-term solutions and work with proven technology vendors to implement them. Truly effective vegetation management programs require a great deal of coordination between

utility and line clearance contractor staff, and software alone cannot accomplish this task.

The goal of hiring a consultant is to bring innovative ideas together with new tools and business processes to help a utility and its contractors improve the efficiency of their vegetation management programs. In addition to services that are tailored to your needs and budget, consulting firms can often provide expert work planning or quality control personnel to help improve the overall effectiveness of line clearance operations. Some consultants also team up with leading utility industry technology providers to address a variety of efficiency or software issues for their utility clients.

## WHAT CAN BE ACCOMPLISHED?

The following are examples of what a little innovative thinking and technology can achieve:

- Contractor and utility personnel in the field can electronically submit their hours, equipment and materials used, number of trees pruned or removed, etc., through ruggedized PDAs or tablet computers that transmit directly to a utility's accounting system. This allows for better tracking of productivity and reduced paperwork, as well as more accurate billing and budgeting.



Electronic data collection streamlines estimating, work scheduling and reporting  
(photo courtesy of ArborMetrics Solutions, Inc.)



## Power Utilities... It's A Whole **NEW** Ballgame

### New Challenges – New Line of Thinking

The nuts and bolts of power transmission and distribution may be similar, but nearly everything else has changed. The business environment is more competitive than ever and the stakes higher. Maintenance costs now affect everything from installation to operation. Theft of copper for scrap resale is suddenly one of the industry's biggest concerns. You're facing completely new challenges and, at CommScope BiMetals, we're responding with an entirely new line of thinking.

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- Utilities can reduce the use of paper maps and customer notification documents by automating the inspection and permitting process. Work planners in the field can assess the work, get a property owner's signature for permission or refusal, and send this data electronically to a centralized work planning database. This makes it possible to better allocate the work and keep track of potential problems with customers. In a storm emergency, if wireless service is available, this process can greatly aid in storm assessment and restoration work.

- By using the map layers of a utility's existing GIS (Geographical Information System), electronic data collection helps utilities and contractors avoid the tedious and expensive job of manually entering large amounts of data about vegetation and line conditions. This process can be used to streamline unit estimating or work planning and provides a more accurate means of reporting for compliance requirements.

- A utility can improve its response time to customer requests for trimming (a.k.a. trouble tickets) through an Internet-based customer call database. Instead of driving to an office to collect the tickets, a work planner ('ticket checker') downloads the trim request locations to a tablet computer, prioritizes them and conducts inspections to determine if work is required. Then the results are uploaded to a web-based reporting tool so that work tickets can be generated and scheduled more efficiently. This program saves on photocopying and fuel expenses, and frees up valuable utility and contractor supervisory time.

By investing in a knowledgeable independent consulting firm, utility vegetation managers can access proven technology and gain any necessary qualified personnel to improve overall operational efficiency. Streamlining notification procedures, creating more accurate workload forecasting, and generating cost analyses by work type, crew, or circuit are reasons enough to take a long look right now at how you can do more with your existing vegetation management budget.

### About the Author

Henry King, Business Development and Corporate Planning Supervisor of ArborMetrics Solutions, Inc., has more than 10 years of experience in utility, municipal and urban forestry. He holds a master's degree in forest resources with a concentration in urban forestry from Clemson University in South Carolina. An ISA Certified Arborist since 1998, he is a member of the UAA and ISA. ArborMetrics Solutions, Inc. is a subsidiary of Asplundh Tree Expert Co.

For more information visit our website at [www.arbometricssolutions.com](http://www.arbometricssolutions.com).

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### RECORD SETTING SUCCESS AT EUFMC

The 54th annual Electric Utility Fleet Managers Conference attracts a higher than ever level of participation by fleet managers

The Electric Utility Fleet Managers Conference (EUFMC), held from June 17-20, 2007 at the Williamsburg Lodge and Conference Center in Williamsburg, VA, attracted a record number of attendees. In total, 90 fleet managers from investor-owned electric utilities in the U.S. and Canada were in attendance at the 54th annual conference.

Attendance at EUFMC continues to grow annually. This year, the conference hosted 20% more fleet managers than in 2006, which follows an increase last year of 5% in attendance over 2005. In addition, the 2007 figure included 39 new members while in 2006 the event had 22 first-time attendees.

Rich Mento, Fleet Manager - Electric System at United Illuminating Company who is serving as this year's EUFMC President, attributes the growth of the annual conference to the value it has for fleet managers. "EUFMC allows veteran fleet managers to stay abreast of recent equipment and technology changes as well as new developments that apply to fleet operations," he stated. "At the same time, for fleet managers who are new to the industry the conference is a chance to network with experienced colleagues and suppliers, and share similar concerns. For the nation's electric utility fleet managers, EUFMC is an unparalleled opportunity."

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# Industry News

## Informative Sessions

Helping attract the record number of attendees to EUFMC in 2007 was a highly informative set of technical sessions on the theme "Managing Your Fleet for Operational Excellence". During the four-day event a range of speakers, including fleet managers and suppliers, offered valuable insights into effective fleet management practices, technology developments and industry issues.

Presentations by fleet managers at EUFMC covered several key topics. Included were "Measuring Fleet Value" by Alan McElroy, VP Enterprise Fleet and Meter Operations at Duke Energy and Bill Doggett, Manager-Corporate Transportation at Louisville Gas & Electric. Also addressed was "Boom Failure" by EUFMC Vice President George Survant, Director of Fleet Services, Florida Power & Light Company, while Wayne Farley, Manager of Fleet Services at American Electric Power teamed up with Jerry Tanner, Vice President, National Sales Manager at Diversified Inspections/ITL to cover "Managing Dielectric Testing" from fleet and supplier perspectives.

Suppliers on the EUFMC agenda this year included a group from Accenture's Integrated Fleet Management service led by Jack Young, retired fleet manager from Niagara Mohawk Power Company (National Grid) and an Accenture consultant. Discussing the subject of "Best Practice Fleet Sizing—The Proper Mix of Utilization, Allocation, Pooling and Rentals" were Robert Pitts, Manager, and Karen Welsch, Senior Executive.

Other technology and service provider presentations at EUFMC included "Vehicle Availability and Benchmarking Downtime" by Chris Shaffer, Partner, Utilimarc; "2007 Engines & Fuel Issues" by Jack Blanchard, former Chief Engineer, GM Diesel Engines and J. Alexander, President & COO, Mansfield Oil Company, and "Decision Parameters for Selecting a Software Provider" by Bryan Groden, Director, Gartner Consulting.

Industry issues were also on the EUFMC program. Presentations included "Negligent

Entrustment and Vicarious Liability" by Robert J. Murtaugh, Esquire, from Harvey, Pennington Ltd.; a "Washington Update" on legislative and regulatory issues by NAFA Legislative Counsel Pat O'Connor of Kent & O'Connor, Inc., and the latest news on "Hybrid Vehicles" by Bill Van Amburg, Senior Vice President, WestStart-CalStart. Additionally, Gary McAlexander, President, Intercontinental Equipment Co. and chairman of the ANSI/SIA A 92.2 Subcommittee on Vehicle Mounted Elevating and Rotating Aerial Devices presented a review of the latest developments in ANSI, ISO and IEC standards.

## Open Discussions

Two spirited and informative discussions took place during EUFMC as well. The keynote address by Gwen Ruta, Director of Corporate Partnerships at Environmental Defense, brought up various issues related to the topic, "Driving a Cleaner Future: Climate Change and the Utility Sector." Ruta's open conversation with fleet managers prompted many questions and a lively exchange with attendees. The annual conference also featured a Fleet Manager Idea Exchange highlighting vehicle issues and best in class fleet management practices.

Joining the record number of fleet managers at EUFMC were over 200 representatives from more than 70 manufacturers and service providers. An annual highlight of the event, the outdoor Equipment Demonstration and Display, included a drive by showcase of the latest mobile, mechanized, automotive, powered tools and equipment for the electric utility industry.

The objective of the Electric Utility Fleet Managers Conference is the dissemination of information pertaining to the procurement, application, operation and maintenance of equipment used by electric utilities. The meeting provides a forum where utility fleet managers can exchange information and discuss mutual problems. The conference promotes close cooperation between manufacturers, suppliers and fleet managers engaged in the development and design of vehicles and equipment associated with the electric utility industry.

EUFMC's 55th annual conference will be held June 15-18, 2008. Fleet managers of investor-owned utilities interested in learning more about EUFMC can call (757) 220-1795, email to [abrownhailey@cs.com](mailto:abrownhailey@cs.com) or visit [www.eufmc.com](http://www.eufmc.com).

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Those exposed to the risk of electric arcs or flash fires may select from a full line of Carhartt FR coats, jackets, jeans, overalls, shirts, sweatshirts, vests and more – including many that are ideal for warm weather.

Consider the Carhartt Flame-Resistant Chambray Shirt with Pocket Flaps. It blends 88% cotton and 12% high-tenacity nylon into a soft-to-the-touch, 5.5-ounce FR chambray. As useful as it is all-day-long comfortable, the shirt includes two chest pockets with flaps and FR melamine buttons.



The Carhartt Flame-Resistant Loose Fit Midweight Canvas Jean is another great choice. Constructed of 8.5-ounce FR canvas with triple-stitched main seams, the jean features an arc-resistant snap closure at the waist. A cell phone pocket, utility pocket and hammer loop add utility, while a loose seat and thigh ensure on-the-job comfort.



Workers can top off their first-layer selections with the Carhartt Flame-Resistant All-Season Bomber Jacket. Featuring a brass front zipper with Nomex® zipper tape and Nomex® rib-knit cuffs and waistband, it's built with 13-ounce FR duck and a 5.5- ounce, twill face cloth lining.

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## Electric Utilities Unplugged

**A**round the beginning of this year I read a particularly good article about deregulation and restructuring in the electric utility industry. Besides putting the current state of deregulation into a contemporary perspective, that article also reminded me that the utility deregulation process has been ongoing since the debut of FERC 436, 500 & 636 in the gas industry, now more than two decades ago. My own experience with deregulation began in the mid-1980s, when the very notion of deregulation was in its infancy. And, because the proposed unbundling of transportation (pipelines) and merchant services was central to our business, I watched with keen interest as this rather radical plan unfolded.

At that time I was working for an automation company focused primarily on oil and gas pipeline automation systems. In the early 1980s – and for decades before – gas pipelines had been integral parts of vertically integrated gas companies in much the same way that transmission and distribution are an integral part of vertically integrated electric utilities. But, for the most part, that's where the similarities between gas and electricity end, at least as related to deregulation. Let me explain...

For starters, one would think that someone at the regulatory level would have jotted a few things down on the "What NOT To Do" list as a result of their experience with gas pipeline deregulation. For instance, not directly engaging the major gas pipeline companies in the process early enough to jointly tackle the most complex issues – take-or-pay contracts, storage, etc. – before attempting to issue the rule, rather than after

FERC 436 proved to be unworkable. But instead of moving up the learning curve, they repeated many of the same mistakes by initially ignoring stranded assets, transmission limitations, reliability, security and other key consequences of opening the electric market to competition. Moreover, the electricity deregulation plan was based almost exclusively on econometric models, which essentially ignored technical and operational efficiencies of vertically integrated utilities as well as other power engineering limitations that are unique to the electric power industry – and that involve physics, not merely spreadsheets.

We all know that electricity cannot be effectively stored like gas and that unlike gas in a pipeline, it doesn't always move in the same direction and changes direction in milliseconds. Even more importantly, electricity moves at the speed of light, rather than in hours or days, the latter being the normal dynamic for gas transport. And, despite having spent millions on consultants and research to design the initial deregulation and restructuring model, virtually nothing was spent on engineering analysis to determine whether the plan was operationally sound or even feasible, given the (then current) condition of the grid.

Admittedly, a lot of utilities didn't take FERC's initiatives all that seriously at the beginning of the process, apparently hoping that if they ignored them long enough FERC would just give up on what was viewed as a pretty radical plan at that time. Regardless, foisting deregulation upon utilities without any substantial technical analysis being an integral part of the preparatory process was, in my opinion, flawed at best. Indeed, after nearly a century of operating in a regulated environment where reliability was clearly the top priority, expecting an entire industry totally unfamiliar with competitive business

models and behaviors to simply conform, one really has to wonder what they were thinking.

On the consumer side, the entire premise of competition has been extensively promoted as a rate reduction plan. Naturally, when ratepayers hear the word "competition" they tend to assume that it will eventually translate into a reduction in their electric bills. What they don't think about, however, is that while rates might be lowered by competition in historically high-cost areas, it will likely have quite the opposite effect on lower cost regions. (Just ask someone in Washington or Oregon what effect competition has had on their bills!) What competition actually does – when it works correctly – is balance prices, rather than lowering them across the boards.

Finally, the (apparently) prevalent notion that electricity is "just like any other commodity" is something I've never been able to get my head around either. For many obvious reasons, as well as others pertaining to the laws of physics and economics, reliable electricity has become a basic necessity of life. You can choose whether to use gas or not and even whether or not to have a phone; but try to survive without electricity. Sure, it can be done for a few hours or a few days – maybe even a few weeks as during ice storms or other temporary interruptions – but prolonged unavailability is simply no longer a choice in any industrialized region.

Let's face it, despite its cumbersome bureaucracy, myriad rules and stodgy resistance to change, regulation achieved its principal objective of reliability quite handily for the most part. Conversely, deregulation created new and abundant business opportunities for the utility market in general. Yet many of those seemingly lucrative opportunities - and the resultant distractions from core utility business - have arguably had

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a profoundly negative impact on reliability. Speaking as both a former supplier as well as a consumer who has seen the good, the bad and the ugly sides of it all, it still worries me that one day I'll turn on my bathroom light and get a message that says: Select the lowest cost provider: Press 1 for Nuclear; 2 for Fossil; 3 for Wind; 4 for Ethanol; or, simply wait while an energy source is selected based on the preferences in your profile... yikes!

So what are utilities doing to deal with this new way of conducting the business of providing safe, reliable electricity? Well, among other things, several IOUs are selling off transmission assets that are high risk, low return parts of their business while others are squeezing out inventories of spare transformers, switches and other apparatus in an effort to reduce costs, perhaps at the risk of not having replacement equipment immediately on hand in times of crisis. I can't speak for others, but this new austerity posture certainly doesn't give me a warm, fuzzy feeling about electricity reliability in a deregulated market.

But perhaps there is some good news in this otherwise bleak scenario. The problems and shortcomings have certainly gotten people fired up about re-inventing the grid in a far more modern and resilient form. In fact, just a couple of months ago I attended an industry seminar that was focused on the widely acclaimed Smart Grid (sometimes called Intelligent Grid) and the emerging technologies that surround and help to drive so called Smart Grid Initiatives.

There were several excellent presenters with stirring presentations extolling the virtues of the "Intelligent Grid" and all that it will mean for the future well being of the electric utility industry. Yet despite the genuinely stimulating discourse, I couldn't help but wonder how an industry just emerging from a self-imposed T&D investment moratorium that has persisted for more than two decades is going to suddenly embrace all of this new, bleeding edge technology - especially when there is so

much proven technology already available that has been so widely underutilized.

Call me cynical, but I just don't see how an industry that has been deferring all but the most critical T&D investments for twenty-something years is going to suddenly start drinking these Smart Grid technologies from a fire hose - it just doesn't make nearly as much sense as I would hope it would. I know that sounds terribly pessimistic, and I assure you that I'm not in any way suggesting that we shouldn't try. On the contrary, the electric utility industry still has great potential and the ability to move mountains when motivated to do the things that are necessary and prudent.

However, it seems to me that we've somehow managed to unplug utilities from their core mission and objective; that is, providing electric service safely, reliably and at an affordable price - at precisely the time when we need them to be focused on that the most. Coupled with a declining infrastructure and the oncoming exodus of our soon-to-be-retiring brain trust, failure to recognize - and accommodate - the grid's physical limitations in the regulatory process can only exacerbate the problems and the resultant challenges. Let's hope that we can get the plug back where it belongs and re-energize the system before it's too late.

- Mike ■

### **Behind the Byline**

*Mike Marullo has been active in the automation, controls and instrumentation field for more than 35 years and is a widely published author of numerous technical articles, industry directories and market research reports. An independent consultant since 1984, he is co-founder and Director of Research & Consulting for InfoNetrix LLC, a New Orleans-based market intelligence firm focused on Utility Automation and IT markets. Inquiries or comments about this column may be directed to Mike at [MAM@InfoNetrix.com](mailto:MAM@InfoNetrix.com).*

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# Platts/Capgemini Utilities Executive Study: The Industry Responds



By Jim Thomson and Joe DeCrow, Capgemini

**G**etting a read on the utility industry is no simple undertaking. No two utilities are alike in how they structure their business model, their sources of power or the enabling technologies they employ to run their operations.

So when Capgemini and Platts came together in early 2006 to discuss how they would survey the industry, they struck upon a seemingly novel idea: Let's let the industry tell us what it thinks, from the beginning. No preconceived notions. No loaded questions. Let's hear it straight, directly from the executives who are making the big-time decisions about the future of America's electric utilities.

Thus was created the Platts/Capgemini Utilities Executive Study, a two-phased study that generated some of the most authentic insights into the current – and future – condition of the North American utility industry. Some 33 senior executives at U.S. and Canadian utility companies were first asked to identify the top issues facing their companies. Once the top issues were identified, the survey team developed a web-based questionnaire that more fully explored the issues and some 90 executives were invited to provide their views. The questions and the responses were randomly rotated for each survey participant, to guard against front-loading.

As could be expected, the responses were intriguing and our read on the results are that utility executives are very concerned – in a positive way – about the future of their industry. Their concern is not fraught with worry or fear. Once moving past their day-to-day operating worries, the top-of-mind concerns of those executives responding are

big picture, forward-looking and proactive. We explain our assessment of their concerns in this essay.

## HIGH-LEVEL FINDINGS

Not surprisingly, the Platts/Capgemini Utilities Executive Study found that executives are very concerned with the day-to-day issues dramatically affecting them: regulation, infrastructure investments and the risks associated with volatile natural gas prices. They think that retail competition will move forward, but they anticipate major changes along the way. Utility companies will also make significant investments in their information technology, workforce training, new grid technologies and risk management systems over the next two years. And over the next five to ten years utility companies will also invest in workforce automation and renewable energy sources. Within the area of information management, cyber security is the area rated as most important.

Interestingly, given their expected investments in information management and workforce automation, the executives did not

rate business process outsourcing as a pressing concern. Our take on that is utility executives tend to rank their pain points – risk management, regulation, volatile fuel costs – as more pressing issues and BPO is not among them. In fact, our take is verified considering that they expect business process outsourcing to increase across the industry over the next five years in several crucial areas (see *Figure 1*).

## BEYOND TODAY

The utility industry sometimes gets a bad rap as being staid and stagnant because of its need to conform to regulatory strictures. And regulators aren't known for innovation and foresight.

But executives at North American companies are carefully focused on the future, seeing an increased reliance on information and other technology for deploying smart meters, securing the cybersphere, and implementing a smart grid. They are extremely concerned about their aging workforces and the challenge which retirements will place upon the ability of a younger, less experienced workforce to

## Areas for Future Outsourcing

### Most Likely Areas

**Call Center**

**Billing**

**Metering**

**Information Technology**

### Least Likely Areas

**Distribution Operations**

**Financial Business Functions**

**Generation Operations**

**Inventory Management**

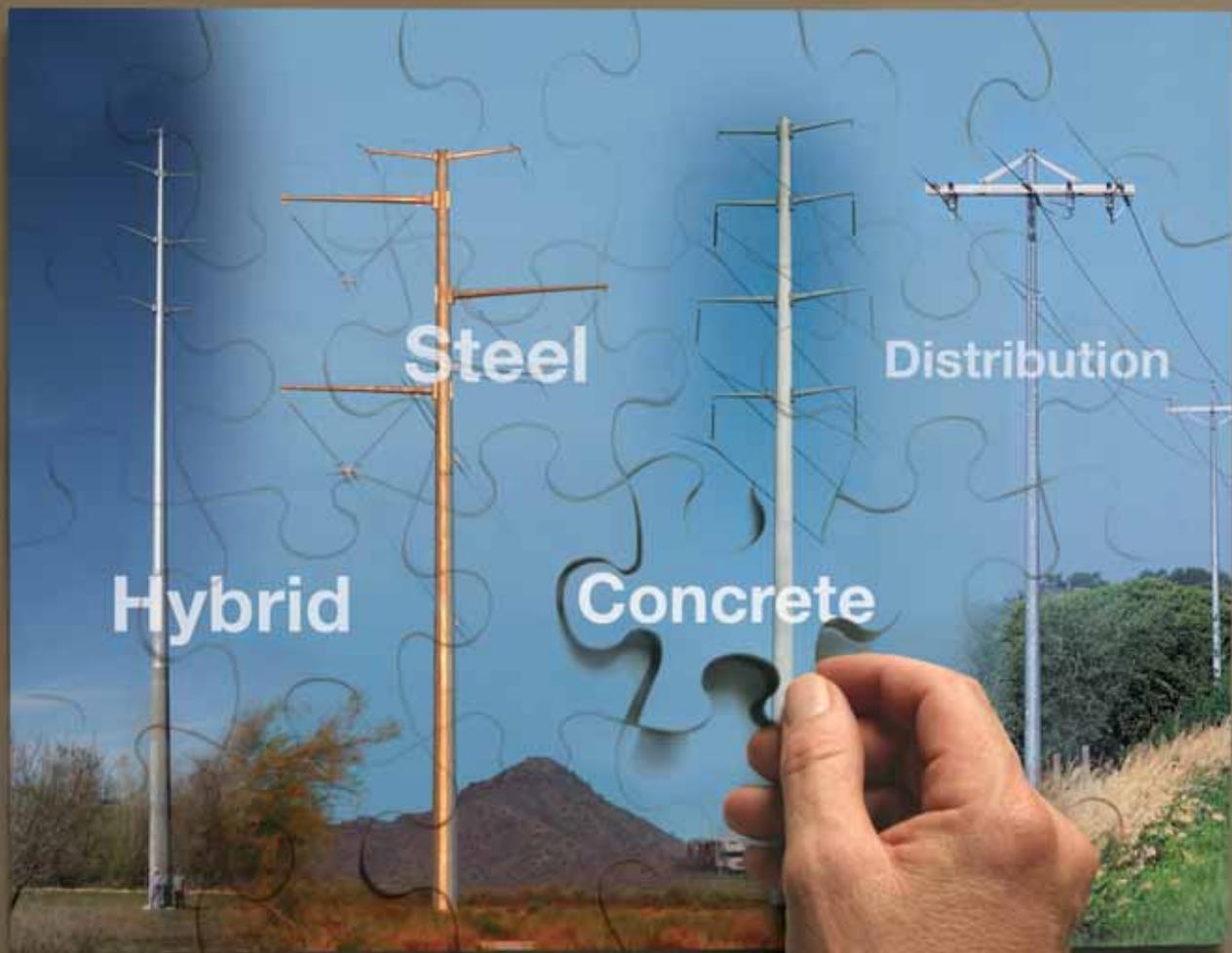
Figure 1

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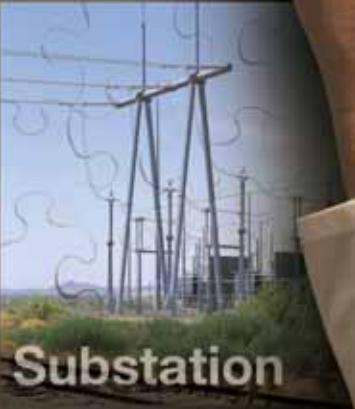
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operate, maintain and restore their transmission and distribution systems back into service following outages caused by storms and other unplanned events. Coinciding with their expected workforce depletions, the utilities foresee an increase in workforce enablement systems including scheduling, mobile-activity focused knowledge transfer and the extension of back office processes and systems to the field. And of course renewable energy will figure large in all their planning, as the industry is pushed – and pulled – away from fossil fuels and toward wind, solar, geothermal, nuclear, fuel cell, bio and other yet undefined sources.

Some other interesting extracts from the study include who will be investing in the technologies of tomorrow. Fifty-one percent of executives from companies with less than 100,000 customers report that their future resource allocations for new technology (meters, smart grid, etc.) will increase in the next 1-2 years. The mid-tier utilities are the most gung-ho, with 94 percent of the

executives from companies with 100,000 and 700,000 customers saying they will increase purchases of new meter and grid technologies. And 78 percent of executives from large companies – those with more than 700,000 customers – will maintain steady investment levels. Our take is that large infrastructure investments can sometimes be difficult for smaller utilities to make – and the possibility for acquisition and merger into a larger utility operating company may make large investment imprudent. By contrast, mid-size utilities possibly see the benefit of larger investments in their technology and infrastructure, possibly to achieve higher premiums in the event of acquisition. This has yet to play out, but the mid-tier's near unanimity is impressive.

The executives' opinions on retail competition are not so positive. The executives resoundingly feel that retail competition in the electric industry has yet to prove successful. Regardless, one-third believe retail competition will continue to grow in the next five to 10 years, while one-fourth think it will diminish and 40 percent say it will stay the same. In the view of some, competition will grow as lessons are learned and markets mature. We believe that in order to achieve the market maturity levels necessary to provide consumers with real choice, transparency is required. Transparency will be achieved when all market participants – generators, system operators and consumers – are linked in near real time, congestion is eliminated, marginal prices are no longer linked to gas prices and effective demand response systems are in place. Not only that but markets will demand competition and it's too late to put the

cat back in the bag. The executives see hope that regulators and utilities will continue to work together toward a solution – consumers want choice!

The more pessimistic executives think that retail competition will diminish because legislators and regulators are "too deep in the pockets" of industry participants. And, they say, regulators cannot distinguish between reliability requirements and generation competition, while consumers are indifferent to retail competition because the results have been so lackluster, with no proven benefits. Finally, a major force in the industry – merger and acquisition activity – will limit the ability of retail competition to be successful on a large scale because of rate concessions demanded by regulators as a condition for deal approval.

#### METERING

Some of the most interesting results of the survey came from executives' seeming widespread acceptance of the need to move quickly toward a working, efficient Advanced Metering Infrastructure. Indeed, AMI ranked first as their top "new technology" interest; demand response and smart grid technology followed in second and third place, respectively.

Indeed, the display of interest in AMI indicates where the industry's mindset is today. Give the recent history of pilot projects for automated meter reading systems, most people will now tell you that utilities are backtracking a bit, requesting proposals for new approaches for implementing the latest technology advances. Not only has there been



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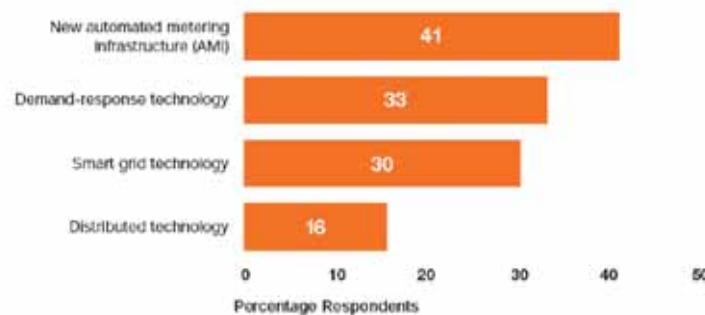
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#### New Technology—Most Important Issues



Source: Platts/Capgemini Utilities Executive Study

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great progress in the technology itself but also the range of possibilities for those advances has snowballed. The number of business cases for implementing AMI grow daily. Indeed, some of North America's largest utilities have embarked on AMI initiatives, providing evidence that investments in technology advances make sense when the regulatory environment is right. Utility executives must be seeing that AMI will improve customer service, enable demand response, improve reliability and serve as a critical first step toward addressing the limitations of today's grid design.

In our view though, AMI should be considered in the context of a smart grid transformation. There are several key AMI elements that enable benefits far beyond reading meters and calculating billing determinates. The communications infrastructure required to collect consumption data from meters can also be used to automate disconnect and reconnect activities and enable communication with grid monitoring and control devices. The meter data management system (MDM) that is typically part of an AMI enables grid operators to receive outage notifications from meters, query the status of meters, provide billing systems with the data they need to support complex rate plans and allow customers to view consumption and cost data they need to take action to impact their energy consumption and cost.

To satisfy a wide range of stakeholder expectations, utilities must be good at delivering their core product while also thinking creatively about the regulatory requirements – and the financing opportunities – that can make AMI and smart grid smart business decisions.

### BILLING

Our study also indicated that billing systems rank highly as an executive concern, second only to fears about cyber security. In the past, customer information systems embedded the billing function, so that it was costly and time-consuming to update them when tariff changes came along. Today, billing applications need separation from the CIS system. Modular billing systems are more flexible, user-friendly and capable of handling

the ever-more complex billing algorithms and orchestration parameters.

Flexibility is a key attribute of tomorrow's systems as they must meet the requirements of traditional, fully regulated distribution companies with end-to-end customer service responsibilities. New companies responsible for distribution, metering and retail functions will also have billing functions associated with the same set of consumers, premises and meters.

The focus on billing systems is even more understandable when combining market structure options with the new types of rate plans that are coming out. Market-based or time-of-use rates, that can be coupled with conservation credits or buy/sell plans for customers with local generation capabilities all will pose their own challenges. Executives' interest in billing systems offers insight into the possibilities for new forms of billing structures. They'll need to be easily configurable, allowing utilities to respond quickly to changing market demands.

### CUSTOMER CARE

Successful AMI installation relies on robust communications platforms. Farsighted companies know that platform should also provide new value-added products and services to customers. But the challenge will be determining the right combination of offerings and pricing for individual market segments – the exact reason that utility executives ranked Customer Relationship Management systems as a sixth topic of concern in the information management section. The ideal customer service system of tomorrow must do more than schedule service calls, restore service or enable a solid revenue management process. It must satisfy customers' more demanding expectations of more transparency into the utility. This transparency will be achieved by providing more information to customers, like the company's environmental track record, their own electricity consumption and costs, flexible rate and demand management plans that provide them the ability to make choices and take action to conserve and reduce their electricity costs. Customers must have interactive access to information to review and



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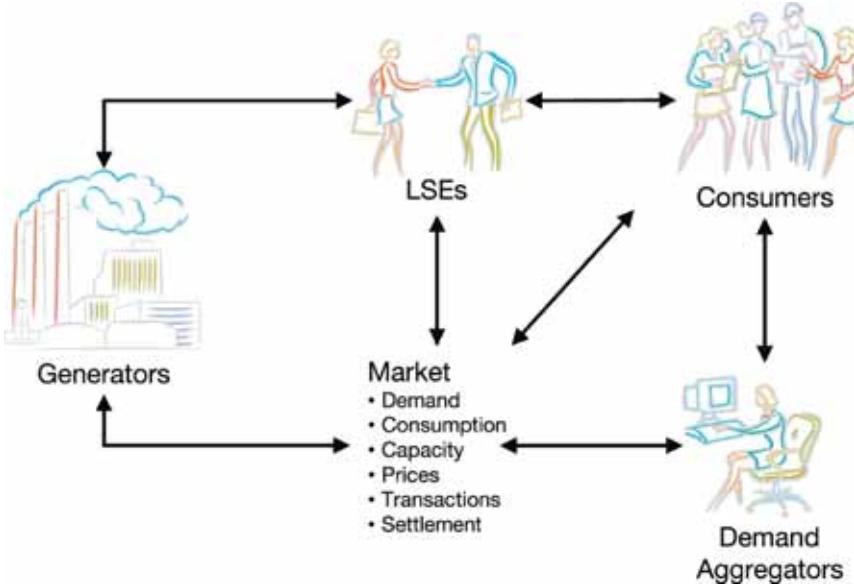
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Despite the skepticism shown by utility executives concerning the future of retail competition, wholesale electricity markets are well established and here to stay. These markets will continue to mature over time. Improvements in these markets will be driven by addressing the most important technology issues identified by executives in the Platts/Capgemini Utility Executive Study:

- AMI
- Demand Response
- Smart Grid
- Distribution Technology

Once addressed, these issues will allow critical market data to be shared between all market participants in near real time. Giving generators, consumers, load serving entities and other energy service providers access to capacity, demand and price information improves transparency and efficiency in the market.

Improved market efficiency will go a long way toward enabling consumers to make decisions that exert some real control over the cost and sources of electrical energy they consume.

#### INFORMATION IS KING

It does not matter which of the critical issues you focus on – Information Technology, AMI, Grid Technology, Customer Billing or Workforce Management – they all depend upon data. Large quantities of data that must be gathered, validated, stored, incorporated, provided control or decision support algorithms and presented in a useful form to asset managers, grid operators, field workers, customer service representatives or customers for their consideration and action. We believe there are three primary key issues that must be addressed across the utility enterprise in order to effectively manage information. First is a robust two-way communications infrastructure that touches every element on the grid and all the people that design, build, operate and maintain and interact with customers who consume electricity from it. Second is a data management system that validates, stores and distributes data in many dimensions and at varying time intervals to a large number of sophisticated control and decision support systems throughout the utility enterprise. Third is that set of next generation forecasting, billing, control and decision support systems.

There are a number of funding options available to utilities when it comes to building the assets necessary to address these information management issues. Creatively evaluating and acting upon these funding

alternatives will separate the winners and losers.

#### CONCERNED WITH THE FUTURE

The first Platts/Capgemini Utilities Executive Study affirmed that its participants are very forward looking. The industry focuses heavily on what's coming around the bend. The daily grind of regulation, fuel cost volatility and shareholder/stakeholder demands takes its toll, but tomorrow's utility company is being formulated today. This transformation, brought about by better technology and the data it generates, will become reality, sooner than we think. ■

#### About the Authors

**Jim Thomson** – As a leader in Capgemini's utility industry practice, Mr. Thomson drives the company's Advanced Metering Infrastructure (AMI) solution development in North America, spearheading Capgemini's go-to-market efforts in this area.

Jim joined Capgemini in early 2006 after a distinguished 14-year career at IBM and PricewaterhouseCoopers. He has over 22 years of systems development, systems integration and project management experience in serving the utility industry after starting his career at the National Security Agency. He has a bachelor's degree from Purdue University and a masters degree from Johns Hopkins University and is based out of Capgemini's Dallas office.

**Joe DeCrow** – Joe is part of Capgemini's utility industry practice and drives Asset and Work Management solution development in the United States and Canada. Joe joined Capgemini in 2006 after a combined 35 years of utility industry experience in project management, engineering and design, construction, maintenance and field operations with General Electric, PricewaterhouseCoopers and IBM. He has a bachelor's degree from Youngstown State University and a masters degree from the College of William and Mary in Virginia and is based out of Capgemini's Dallas office.



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Bahman Hoveida, President & CEO



**Bahman Hoveida**  
President & CEO  
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I'm very fortunate to have had the pleasure of knowing Bahman Hoveida as both a colleague and a friend for many years. During that period I've watched with interest as the co-founder and president of Open Systems International (Minneapolis, MN), led his company from a relatively small niche player into a widely known and highly respected force in supervisory control and data acquisition (SCADA), energy management systems (EMS) and distribution management systems (DMS) on a global scale.

Today, as the entire automation/IT landscape is undergoing what is arguably a makeover of potentially epic proportions, EMS is once again being redefined, this time from an operational standpoint in response to new regulatory, security and reliability factors. Bahman, clearly among the foremost experts in this crucial automation/IT market component, was kind enough to talk with me about where he feels the EMS market is today and where it is headed. His views and insights will be invaluable to anyone involved in the market settlement process, whether from a hardware, software, systems or operations perspective.

- Mike Marullo,  
Automation/IT Leadership Series Editor

**EET&D:** Let's begin by discussing the recent regulatory changes, such as the newly enacted FERC/NERC reliability rules and how they will affect the SCADA/EMS. Now that NERC has been given reliability enforcement authority, what role does automation play in that picture?

**Hoveida:** The new electric reliability standards contained in FERC's Order 693 are now mandatory for all U.S. owners and operators and are intended to eventually become applicable to the balance of the North American bulk power system by future agreements with Canada and Mexico. After all, as NERC noted in its incident report, the failure of a SCADA/EMS system was partially responsible for the Northeast Blackout on August 14, 2003, precipitating the enactment of these mandatory reliability standards by FERC.

In my opinion, these new reliability standards will have an immense impact on the way utilities operate and will undoubtedly affect the real-time operation of the power grid. Reliable and robust automation systems are needed to effectively monitor and control the power system, optimize its reliability, and avert potentially catastrophic failures. NERC mandatory guidelines for reliable control systems; disaster recovery and emergency control systems; operator training simulators; and systems designed to be impervious to cyber attacks are a few examples of the impact these reliability standards will have on the automation systems deployed by utilities.

**EET&D:** As you know, NERC also recently issued new security guidelines as well. What impact do you expect these will have on the market and again, what is the role of automation in securing the grid against cyber attacks?

**Hoveida:** As a result of the NERC CIP/Cyber Security requirements, utilities are scrambling to audit and certify their automation systems.

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This is an effort comparable to the Y2K initiative of the 1990s, which has created a plethora of activities on the part of consultants, vendors, and utilities. Ultimately systems should be subject to independent audits to certify they meet the NERC standards.

The DOE, through a voluntary initiative between suppliers and the Idaho National Labs, has been providing independent testing and certification of SCADA/EMS platforms from various suppliers, including ours. In my opinion, such voluntary measures will become mandatory in the near future due to the immense impact a critical system failure could have on grid reliability and the economy.

**EET&D:** Are more or different types of EMS systems needed because of the new rules and/or other factors?

**Hoveida:** The majority of the EMS system architectures in operation were designed in the early 1990s or late 1980s. Although they may employ new hardware architecture they are somewhat archaic, highly complex, and hard to use and maintain. In my dealings with the industry I often come across utilities that are unable to use their EMS systems and applications effectively due to complexity.

For example, the Security Analysis applications mandated by NERC for bulk power operation are too complicated, slow, and in many cases are hard to maintain and keep up to date, rendering them virtually useless. How can utilities cope with these imminent reliability standards if their main EMS systems - which are intended to be their "Security Radar" - are not fully functional or cannot deliver the required guidance? Utilities need to press their suppliers for much more reliable systems, systems that are easy to maintain and upgrade; systems that can handle hundreds of thousands of events and alarms without failure; applications that work properly without a large technical maintenance burden.

Additionally, the next generation EMS systems will have to incorporate advanced features such as 3D data visualizations, use of phasor measurement units, dynamic security analysis, on-line voltage stability analysis, etc. Pushing these new frontiers is absolutely necessary if we are to achieve the security and

reliability goals being set by regulators and promised to ratepayers.

**EET&D:** Does (or will) this mean that existing EMS systems are outdated and need to be upgraded or replaced?

**Hoveida:** Well, this depends on who you are and what system you are using. You would be surprised if you knew about the state of the systems used by some of the largest utilities in North America! Most of these systems are plagued with the same issues I mentioned in the previous question; namely reliability, maintainability, usability, and very high cost of maintenance.

Because of this cost burden and the cumbersome nature of software upgrades, these companies typically run on software releases that are at least five years old, or sometimes even older. In our customer community, we have been promoting annual upgrades and making sure the entire user base is on the latest releases of our software. We have been successful in cutting the time to

perform an upgrade to 2-3 weeks as opposed to months, which seems to be the industry norm.

In addition to the very fundamental issue of technology obsolescence, I believe it is time for a new generation of more intelligent systems, operating platforms and application software that proactively manage grid reliability and cyber security issues. For example, one initiative we are currently working on is an intelligent RTU communications front-end that uses pattern recognition technology to validate a request for switching operation, which would not permit a potential cyber attacker to switch critical components, or drop substantial load or generation. This is just one example of new intelligent technology that should eventually be moved down to the RTU and IED level.

**EET&D:** A lot of people are wondering whether new ISO/RTO EMS systems will be replacing those at the individual utility level, or are systems needed at both levels?

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**Hoveida:** I believe a hierarchical and multi-level system and control authority infrastructure is needed for enhanced reliability. The ISO/RTO needs to be responsible for the coordination of regional grid reliability via adoption of what I'll call "macro strategies," while the individual utility/control area should remain responsible for the operation and security of their own internal area employing "micro strategies." In addition there is this notion of keeping the ISO and RTO honest! Most utilities want to be able to monitor their own transmission and ascertain the state of their systems independent of the ISO/RTO. This would be even more amplified now with FERC/NERC imposing stiff penalties for reliability infractions.

EMS systems are definitely needed at both levels, but given the complexity and size of the grid monitored by the ISO/RTO, in my opinion the power system solutions at the control area level would be much more reliable and robust. Time skew, outdated data models, and of course, the sheer size of the network models themselves always add uncertainty in any

solution reached by an ISO/RTO. A case in point was the Midwest ISO operation during the August 2003 Blackout, which according to NERC's report, could not ascertain an impending grid problem until it was too late.

**EET&D:** Where do you think we currently stand with regard to SMD (standard market design) now that the whole restructuring issue seems to have wound down?

**Hoveida:** Simplicity and transparency are essential to successful markets. If structured and implemented properly, FERC's standard market design proposal would lead to a robust open marketplace for affordable and reliable wholesale energy, as well as jump starting much needed investments by ensuring regulatory certainty for investors. Of course, it remains to be seen in the near term how effectively the SMD is implemented in various markets around the country.

I really think that the PJM experience is probably the closest to the SMD model. It is also one of the most successful market experiments in balancing equal open access,

reliability, and predictable stable energy pricing. The counter to this, of course, is the California experiment, but it is understandable that initiatives of this complexity often must go through difficult and sometimes painful trials.

**EET&D:** Are there any new dimensions of market settlement either as a result of new reliability guidelines or SMD that you'd like to discuss?

**Hoveida:** Yes, I think that demand response must be an essential component of a well-functioning market. After all, we see very effective demand response programs implemented by smaller utilities, public power and cooperatives for mitigating resource availability, economics, or reliability issues. Historically however, electricity markets have encouraged or implemented relatively very little demand response by end users.

As a result, markets have been prone to wholesale price volatility, price spikes, system reliability issues and potential market abuses. Introducing demand response into wholesale



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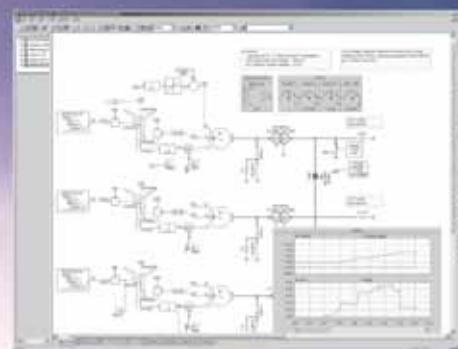
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markets would definitely enhance electricity market performance and grid reliability. Using voluntary price-based controls on consumers, congestions could be managed and ultimately demand side management programs could be employed to deal with and even avert potential grid imbalance contingencies.

**EET&D:** Are we likely to see the formation of more ISO/RTO organizations? What about ITCs?

**Hoveida:** This is a very good question! The new FERC SMD and mandatory reliability standards would have a dramatic affect on the landscape of the utilities, RTOs, ISOs and ITCs. I personally believe that there is potential for 2-3 new entities in the USA. The Southeastern, Northwestern, and Southwestern regions of the country have their unique energy and reliability demographics and may opt to develop their own focused Independent System Operators.

**EET&D:** Is it really feasible to strive for a grid that doesn't experience major outages?

**Hoveida:** Yes, but only if we as consumers would be willing to pay \$5.00 per kilowatt-hour for electric energy! Like anything else, there is a price for reliability and the real question is who will pay it. Foremost, it is a matter of adequacy of generation and transmission assets. Most major outages occur when a system is pushed to its limits. Lack of economic incentives and/or excessive regulatory challenges that discourage or prevent investing in generation and transmission expansion projects will always keep the complete achievement of reliability goals out of reach.

Nonetheless, a more pragmatic approach - let's call it reaching for the low hanging fruit - is striving for "optimal reliability." This means that taking into account the present condition of the power system along with its various constraints, still being able to achieve the highest level of reliability at any given time, or as a minimum, avert or mitigate any contingencies that could move the system away from this optimal reliability point.

**EET&D:** Are we spending too much time trying to predict/prevent major outages rather than focusing on rapid restoration as a primary means of mitigating the impact?

**Hoveida:** Our first and foremost efforts need to be focused on preventive measures. Strengthening the grid, optimally operating the grid, predicting failure modes, and devising remedial plans to deal with contingencies are the most important factors in achieving reliability. Naturally, we also have to be prepared to deal with the aftermath of an outage, and that is having robust and tested rapid restoration strategies in place.

**EET&D:** Whereas SCADA, EMS, DMS and many other parts of the utility automation/IT infrastructure were almost completely stand-alone not so very long ago, now almost everything is at least interconnected, if not interoperable and/or fully integrated. What are your thoughts about how this integration of systems, platforms and technologies should be planned and managed?

**Hoveida:** Full integration is a lofty goal for most utilities. In my opinion, this is not a technology problem anymore, as there are many standards and mechanisms to interface systems and exchange data appropriately

and efficiently. The real issue, I believe, is a lack of a true vision and finding a strategic champion who stewards the implementation and integration of these systems into the business, and determines which data or systems to integrate. Automation systems are among the most critically important IT assets a utility has, but historically, many CEOs and CIOs have been uninformed or mal-informed about the existence, importance and criticality of these systems.

As a result, important decisions have been relegated down the organizational hierarchy to people guided mainly by a narrow view of - and focus on - technology rather than on the business itself. I am hopeful that the newly mandated reliability standards and the NERC cyber-security standards will begin to shine the light on these systems and that CEOs and CIOs will start paying more attention to automation/IT solutions and embrace the growing importance these systems have for the safe, reliable and efficient conduct of their enterprise.

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I think I can state fairly unequivocally that everyone involved in the automation business is hopeful that utilities will start allocating a larger portion of the resources that are routinely spent on ERP and corporate IT initiatives, on these increasingly critical automation systems. Between the declining infrastructure, aging workforce and rising costs, automation may not be a panacea, but it certainly represents a sound and proven investment strategy that works well and has countless financial and operational benefits when properly conceived, planned and deployed.

**EET&D:** I think we can probably agree that the EMS market area has proven to be a particularly challenging and sometimes rocky road for many. Indeed, only a handful of EMS suppliers survived the project downsizing trends in the 1980s – first with the introduction of workstations and shortly thereafter, PCs. Do you think there is another round of changes on the horizon, or will we see some stability for awhile?

**Hoveida:** Yes, I think we can expect more consolidation in the future. I also believe we will see some new players in the market, mainly by the acquisition of present suppliers. There seems to be a race by larger IT software companies to carve up a chunk of the utility software and services market, and the automation software and systems sector is definitely part of their strategy.

At the low end of the market there will be some consolidation as a result of technology obsolescence, lack of market success and stranded investments in research and development. I believe the more focused companies with innovative modern products, an agile management style and both a knack for and commitment to customer service will be the ones to thrive and succeed in this traditionally difficult part of the market.

**EET&D:** The fundamental shifts that have taken place over the past two decades in system topology and architecture totally redefined previously well-established technical and financial parameters for these projects and so-called ‘forklift’ replacements’

eventually gave way to incrementally scalable architectures, which OSI was among the first to embrace. How do you see SCADA/EMS changing over say, the next 3-5 years?

**Hoveida:** As the technologies have matured, it is my view that this has steadily become more of a customer service business. Any company that can remain very responsive to the needs of its utility customers in the face of an ever-changing electric utility marketplace will flourish. Of course, an integral part of good customer service methodology is having technically innovative and modern solutions, a reliable and proven delivery track record, etc.

A large part of our success at OSI has been the promotion of this customer-focused philosophy as our number one priority and main mission. I am sad to say this focus has been substantially lost in most American businesses today as compared to say, 20 or 30 years ago. I’m sure most consumers would agree that quality of service and a total positive customer experience have become things of the past for most businesses today.

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**EET&D:** What do you think the utility market itself will look like five years from now, in terms of structure, composition and reliability?

**Hoveida:** It is hard to imagine, but given the trends in the past few years there will likely be more consolidation in the regional markets forming mega-utilities. There will be at least one or two new ISOs and several new ITCs.

A case in point might be the state of the commercial airline industry following deregulation. We have far fewer carriers, but whether the result is better, safer, more affordable or more reliable is certainly a cause for debate.

Indeed, the huge appetite among larger companies for more consolidation is frequently driven solely by their quest for market dominance. And, while there is certainly something to be said for size in certain situations, I have my doubts that sheer size, bureaucracy and the traditional conservatism of industry behemoths will allow them to embrace and take advantage of newer technologies or initiatives.

On the contrary, I believe that many will continue with business as usual and keep pushing the reliability and regulatory bounds to their limits. I am very optimistic, however, about the role of Public Power in the future. There are countless examples of innovative and forward-thinking initiatives that have and will continue to originate from this part of the industry.

**EET&D:** So, as you gaze into your crystal ball, what predictions can you offer regarding what we can expect in the future?

**Hoveida:** Well, I am not a betting man, but I'll be happy to offer a couple of general predictions for your readers to ponder. First off, I think the Smart Grid is quite achievable – in a prototype form and on a limited scale – over the next 5-7 years. However, my view is that this will most likely be achieved by a progressive power cooperative somewhere in the rural heartland rather than by a very large investor-owned utility, contrary to what many might otherwise expect.

Secondly, each operating entity has a critical mass in terms of grid or market size,

which once achieved, will be very difficult to expand without jeopardizing grid security and reliability. Therefore, it's probably not unrealistic to predict the breakup of larger RTO/ISOs into smaller entities in the next 5-10 years. The fact is, smaller entities may eventually be better equipped to deal more nimbly with the evolving complexity of the grid and related markets.

Yet another scenario could have the ISO acting as not only the market/system operator, but also having jurisdiction over a number of smaller sub-ITCs, each being responsible for regional transmission operations. Of course, as a system supplier, we are very much encouraged by the opportunities that lie ahead; especially with regard to the impending technology needs of the utilities we serve.

**EET&D:** Yes, it will indeed be interesting to see how these things evolve over the next 12-18 months, and I hope that we'll have a chance to revisit some of these issues with you again soon. Meanwhile, one thing we can both be sure of is that there will be changes, although what those changes are and how they will manifest themselves remains to be seen.

The advertisement features a woman with dark hair looking directly at the viewer through a magnifying glass held up to her eye. The background is a blue gradient. At the top left is the logo for "Electric Energy ONLINE.com", which includes a stylized red and yellow swoosh graphic. Below the logo, the text "Electric Energy" is in red and "ONLINE.com" is in white. To the right of the woman, the words "Looking For..." are written in a white, sans-serif font. At the bottom right, the website address "www.electricenergyonline.com" is displayed in white.

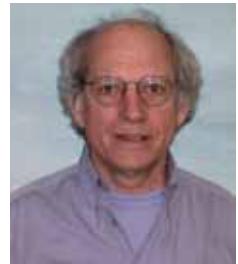
The advertisement shows a close-up of a person's hands holding a handheld electrical testing device. The device is white with a black coiled cord and a digital display screen showing the number "5". The background is a dark, industrial setting with various electrical components visible. Below the image, the text "Risk Transformed" is prominently displayed in large, bold, black letters. Underneath that, in a smaller bold font, is "with the Transformer Last Check". A bulleted list of features follows:

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# Assessing Water Content in Insulating Paper of Power Transformers



By: Brian D Sparling and Jacques Aubin, GE Energy

## ABSTRACT

**M**oisture content of solid insulation is a concern for power transformers as it causes several detrimental effects on the insulation's integrity. Moisture content assessment is often derived from an oil sample submitted to a Karl Fischer test in laboratory, although it is recognized that a single sampling cannot reveal the moisture content in paper if the oil temperature is unstable. On-line monitoring systems are available and continuous recording allows integration of temperature variations and the computation of a dependable value for moisture content in paper. Collection of data over a long period allows calculation of moisture content of various components of the solid insulation system even if they are at different temperatures and characterized by different diffusion rates.

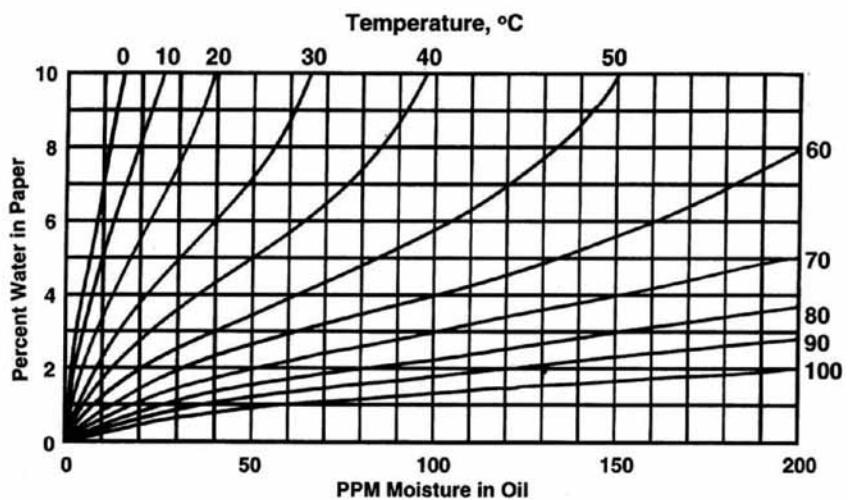
## 1. INTRODUCTION

Moisture management in power transformers is a concern. Extensive drying procedures are applied at the manufacturing stage and sustained efforts are deployed in service to maintain high dryness. At high temperatures, the residual moisture in winding insulation can trigger the release of free gas bubbles, creating an immediate threat to the dielectric integrity of the insulation structure.

In the recent IEEE Std C57.106 – 2002 (2) the permissible moisture level in paper is inferred from values of water content in oil, assuming thermal stability and moisture equilibrium between paper and oil:

The traditional method calls for oil sampling at regular intervals. It is then processed through a Karl Fischer titration method that provides the total water content in oil in parts per million (ppm). Most of the water is in the form of

Equilibrium curves have been developed to relate absolute water content in oil to water content in paper (Figure 1). Application of these curves implies that the transformer is under a thermal equilibrium.



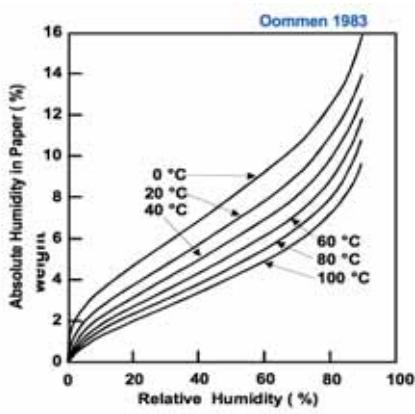
dissolved water and available to move from oil to the solid insulation as the transformer progresses toward equilibrium. Some of the measured water is chemically bound to chemical agents such as by-products of oxidation. This bound water is only partially available to migrate from the oil to the paper. Some of the water may also bind to particles in suspension in oil and this water would not be fully available to move to the solid insulation. In spite of these constraints, this method remains the most commonly used to assess the moisture content of solid insulation.

*Equilibrium Curves for Moisture Partition Between Oil and Paper (ppm vs. WCP)(3)*

Measuring relative moisture saturation (RH %) makes it unnecessary to consider the type or condition of the oil. The relative saturation is the percentage of full saturation and is the most representative figure of the water available in oil for transfer to paper. At equilibrium, relative saturations of both components of the insulation system (oil and paper) are equal. Commercial on-line moisture monitoring sensors usually provide a relative saturation measurement as well as the measurement of the oil temperature at the location of the moisture sensor. From these two measurements, the relative saturation can be converted in absolute water content in oil in ppm (WCO). At equilibrium, relative saturation of oil is the same as relative saturation of paper in contact with the oil. In this condition, the

Transformer rated voltage	Maximum water content in oil ppm			Equivalent water content in paper
	50°C	60°C	70°C	
Up to 69kV	27	35	55	3%
69 to 230kV	12	20	30	2%
230kV and above	10	12	15	125

Figure 2

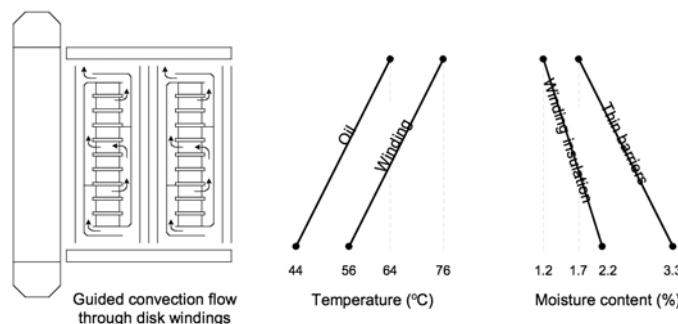


**Equilibrium Curve for Moisture Partition Between Oil and Paper (RH % vs. WCP)(4)**

## 2. WATER DISTRIBUTION UNDER STEADY THERMAL CONDITIONS

In normal operation, even though a stable thermal condition can be created, there still are temperature differences and therefore different moisture contents in the various parts of the insulation structure.

For example, we may consider a naturally cooled transformer with a temperature drop of 20 °C between top oil and bottom oil at full load. Assuming an ambient temperature of 20°C and thermal equilibrium, the temperatures shown in Figure 3 for oil and winding are typical. If a moisture sensor, installed at the bottom oil temperature, shows a relative saturation of 22%, we can deduce from the equilibrium curves in Figure 2, the moisture content indicated in Figure 3, for the different parts of insulation. These different moisture levels need to be considered in the condition assessment of transformer insulation.



**Figure 3: Moisture Content on Critical Insulation**

## 3. WATER DISTRIBUTION UNDER TRANSIENT THERMAL CONDITIONS

In practice, thermal stability conditions are never achieved. Beside load variations, the transformer is submitted to daily and seasonal temperature variations. With temperature conditions continuously varying, equilibrium curves cannot be applied directly; therefore it is not possible to assess correctly water content of insulating paper from a single sampling of insulating oil and a Karl Fischer test in laboratory, even if oil temperature is noted at time of sampling.

Temperature changes entail displacement of water from paper to oil or vice versa. The diffusion rate for this process depends on the temperature and on the thickness of solid insulation, on the area of contact between circulating oil and paper and on moisture content of paper. Diffusion time constants reported in literature for thin insulation (1 mm) are summarized in Table 2.

content in paper might not warrant deployment of expensive monitoring systems over a large population of transformers. An interesting solution is to combine real-time moisture in oil measurement with a more essential monitoring function such as real-time detection of fault gases dissolved in oil. This is the avenue selected for the HYDRAN® M2 that combines two functions. The first is detection of incipient fault in transformer insulation. On-line monitoring of hydrogen and CO has been recognized as an excellent method for detection of dielectric and thermal problems. Detection at an early stage is the best means of reducing the risk of failures and forced outages. A moisture detector is also available, which is a thin-film capacitive sensor that is sensitive to relative saturation. The RH % reading can then be converted to absolute moisture content in ppm. Configurable analog inputs are provided for recording significant parameters such as top oil temperature, bottom oil temperature and load.

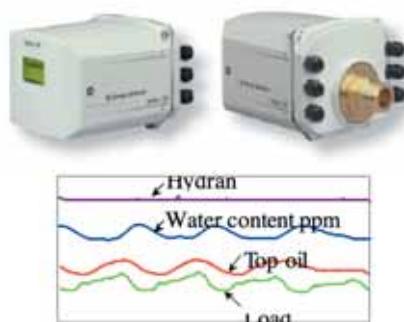
Temperature	Insulation Thickness		
	1 mm	2 mm	4 mm
80 °C	0.9	3.6	14
60 °C	4.2	17	67
40 °C	20	79	317
20 °C	93	373	1493

**Table 2: Diffusion Time Constant for Oil-Impregnated Pressboard Insulation (in Days)**

These slow diffusion rates make it necessary to average recorded data over a long period. The averaging period has to be adjusted according to oil temperature and thickness of the insulation to be assessed. This is best done with on-line monitoring providing data acquisition of moisture in oil and relevant temperatures.

## 4. ON-LINE MONITORING OF MOISTURE CONTENT IN TRANSFORMER INSULATION

Several on-line monitoring systems are available to record variations of moisture content in insulating oil. The concern over moisture



**Figure 4:**  
**HYDRAN M2 Sensor With Display of Typical Recorded Data**

With such a device, it is possible to record data over a long period. This data can be processed with a suitable algorithm that takes into account the variations of winding and oil temperature on the dynamic process of water migration.

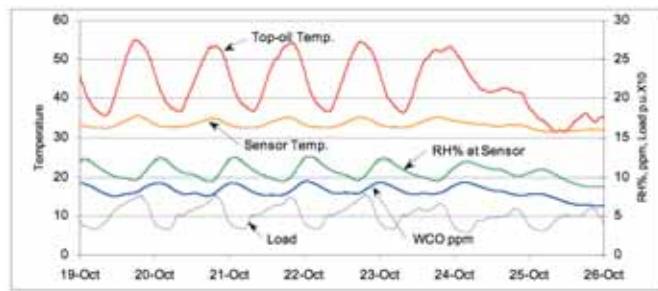
Relative saturation needs to be recorded with oil temperature at the sensor. Top and bottom oil

can be recorded along with load to determine the temperature in the insulation components. This data is averaged over time to account for slow diffusion rate involved in migration of water between paper and oil.

## 5. FIELD DATA

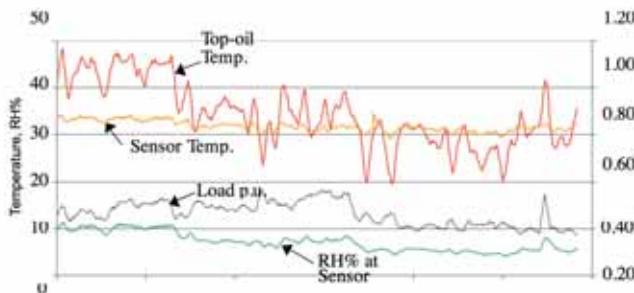
In August 2003, a 50 MVA, 230 kV transformer was equipped with a HYDRAN M2 sensor and a continuous string of data was made available from the data logging function for off-line processing. It is an old unit, core type, 55°C rise with a nitrogen blanket. The sensor is mounted on a spare cooler outlet at the bottom of the tank between two sets of coolers.

Figure 5 shows one week of data where daily variation of moisture content in oil is visible along with relative saturation and top oil temperature. Since thermal conditions are continuously changing, it is impossible from a single measurement to assess water content in insulating paper. Depending on sampling time, the computed value of water content in paper at top oil temperature could give any value from 1.3 % to 2.5 %, almost a two-to-one variation. If this data is recorded over a long period, it is possible to determine moisture content of various components of the insulating system taking into account physical characteristics of solid insulation, diffusion rate and temperature.



*Figure 5: Data Logging for One Week in October 2003*

Figure 6 shows the main data recorded from September 2003 to March 2004. Loading is fairly stable between 0.5 p.u. in fall to 0.4 p.u. in winter. The transformer is running cold with top oil temperature ranging from about 45°C in fall to 25°C in winter. Using top oil temperature, load and transformer characteristics, it is possible to calculate bottom oil temperature and hot-spot temperature. Daily variations have been filtered out from these data to better show long-term trends.

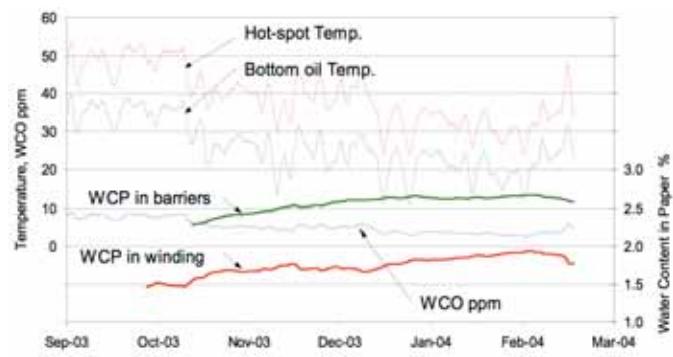


*Figure 6: Data Logging Over a Period of Three Months*

The insulation structure is made of several components that need to be evaluated separately in terms of moisture content. The first component is the winding insulation paper because moisture content has a direct influence on insulation aging and on the probability of releasing bubbles should an

overload occur. This component is fairly thin and experimental evidence has shown that in regard to diffusion rate, disk winding can be assimilated to a 1-mm paper(6). As can be seen in Figure 7, the average hot-spot temperature over the first month of data logging, is about 50°C leading to a diffusion time constant of approximately nine days. As hot-spot temperature drops, diffusion time constant rises to reach above 60 days in some cold winter periods.

The second component is the thin barriers providing main insulation between windings and between winding and tank. In the main insulation, the highest electric field is often found on the barrier closest to the winding. Moisture content in this area is critical for dielectric strength of the main insulation. It is known that an increase in moisture content from 0.5% to 3.0% may reduce by 50 % the inception voltage for partial discharges. The bottom part of the barriers is more at risk because cooler temperatures will lead to higher moisture contents. The barriers' temperature is the same as bottom oil temperature.



*Figure 7*

Figure 7 shows temperatures of interest and moisture contents calculated for winding insulation and barriers. Moisture content of the barrier can be significantly higher than moisture content of winding paper. This difference will increase with load as it is mainly sensitive to temperature difference between winding hot-spot and bottom oil.

Regarding the thick insulation, data would need to be averaged over a much longer period. Diffusion rate of these components is difficult to assess since thickness varies over a broad range, the surface in contact with oil is also very variable, as is actual oil flow on these exchange surfaces. A large segment of water in the transformer is stored in thick insulation. Thermal aging for these components is usually not a concern and the electric field sustained by thick insulation is unusually much less than the stress of thin barriers.

## 6. WHAT TO DO WITH RESULTS?

Determining water content in solid insulation has been presented, along with the negative consequences of high moisture levels inside the transformer tank.

Now that the situation is known, it is best to remove moisture from not only the oil, but also the solid insulation. The objective is to achieve a level that will not have negative influences such as excessive aging of solid insulation and oil. Several techniques have been used for this task with various degrees of success .



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#### a) Traditional Hot Oil Circulation

The traditional technique of circulating hot oil through the transformer has been used in many countries. The limiting factor in this process only removes moisture from oil and very little from the solid insulation. Once the transformer is returned to service, heat generated in the windings due to the load 'push' moisture from the paper into the 'dry oil'.

#### b) Low Frequency Heating (LFH)

This technique requires the transformer to be removed from service, with portable equipment brought to the site.

The transformer is disconnected from the grid, and a variable frequency high current power supply is connected to the transformer, together with traditional oil treatment and vacuum pumps.

The transformer is energized at a frequency of less than one Hz and high current, in order to heat the windings of the transformer to at least 80°C to 90°C. It is energized from the primary side, with the secondary side shorted out.

This technique is quite effective as it uses heat and vacuum to remove moisture from solid insulation.

#### c) Stationary Molecular Sieve Technology

Permanently installed molecular sieves have proven to be effective in drying transformers with oil capacities of up to 30,000 liters. Benefits of this technique are that the transformer is not removed from service, but depends on the transformer in service to generate heat required to move moisture from the paper into the oil. From there oil is circulated through the molecular sieve at a slow rate from which moisture is removed with the use of water absorbent beads.

This technique is long term, and to observe its effectiveness a monitor with the ability to calculate moisture content in the solid insulation provides the most effective method to stop the drying process.

#### 7. CONCLUSION

The effect of moisture on thermal aging and reduction of dielectric strength are concerns for aging transformers. If the transformer is submitted to daily temperature variations, a single sampling can lead to large errors on the assessment of water content in paper. On-line monitoring over a period of several months allows for a more dependable assessment.

Moisture content in winding insulation should be treated separately from that in the main insulation. Depending on the type of cooling, temperature at the winding hot spot can be different from temperature at the bottom of the main insulation leading to different water contents. Because of temperature and insulation thickness, moisture diffusion rates can be very different for these two components.

Combining a moisture sensor with more monitoring functionality, such as dissolved gas, makes it cost effective and allows for dependable determination of moisture content in transformer solid insulation. ■

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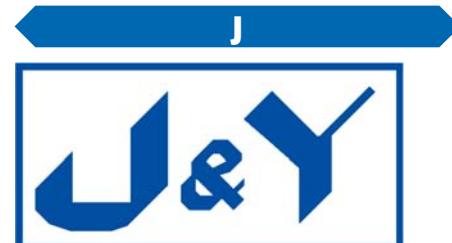
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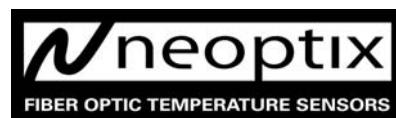
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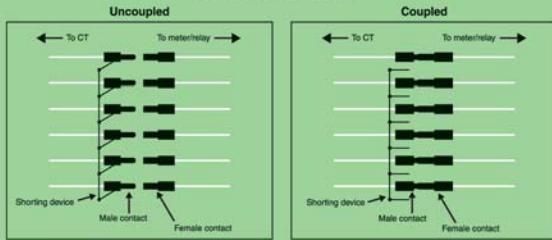
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An alternative to CT shorting blocks

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Electrical schematic



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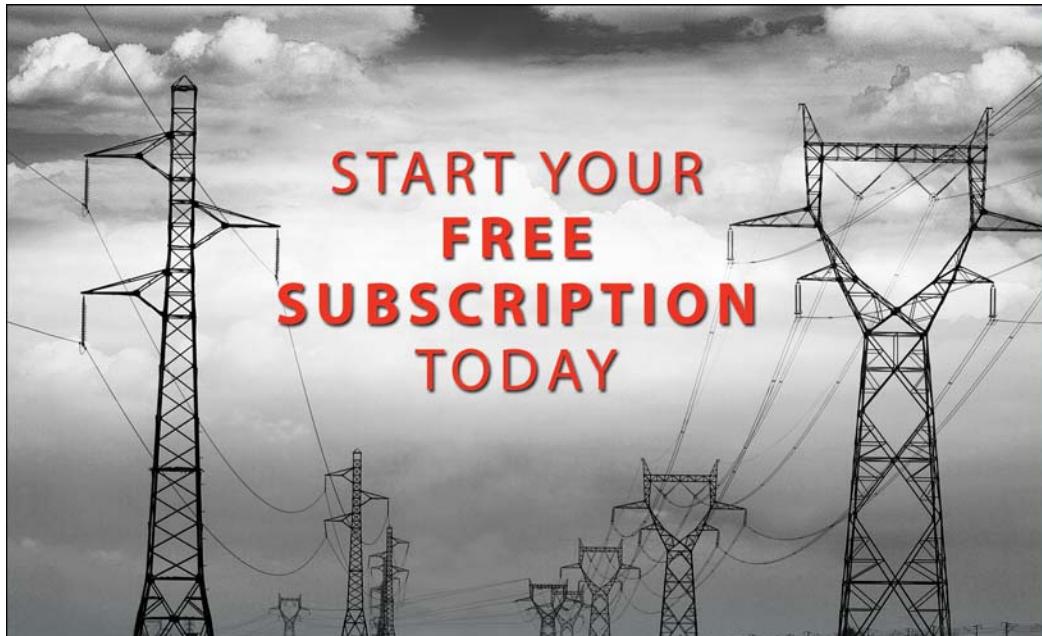
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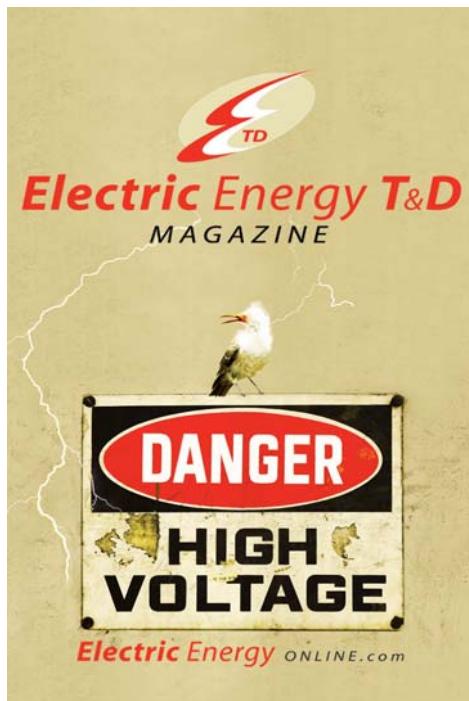
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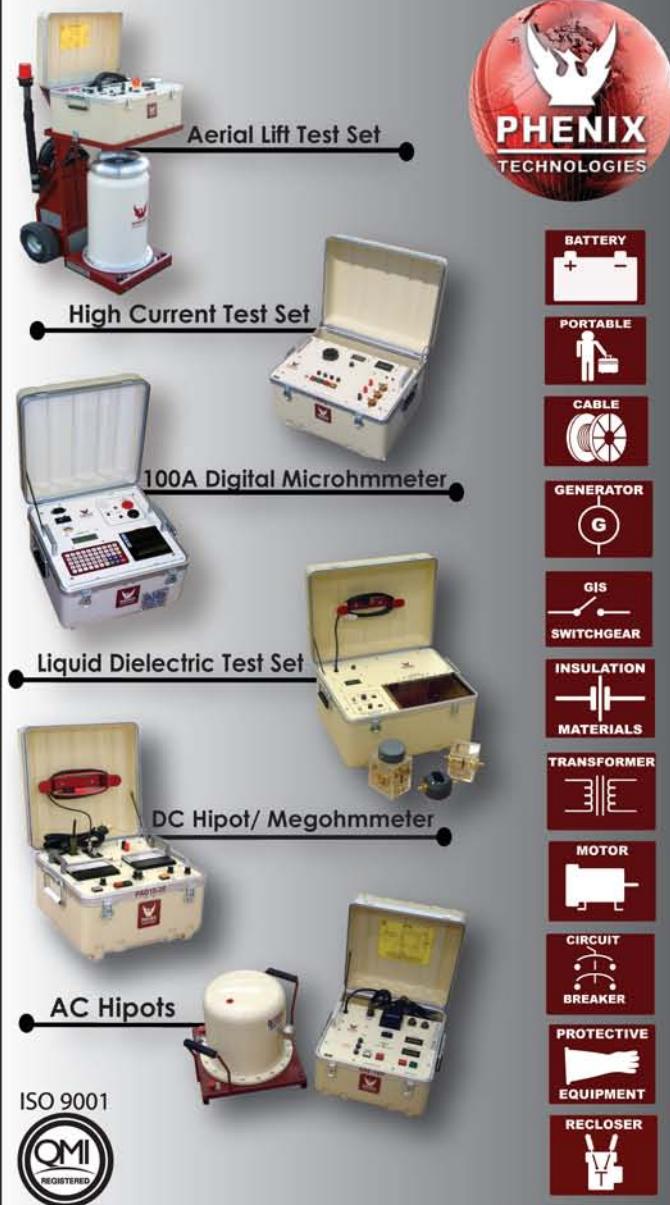
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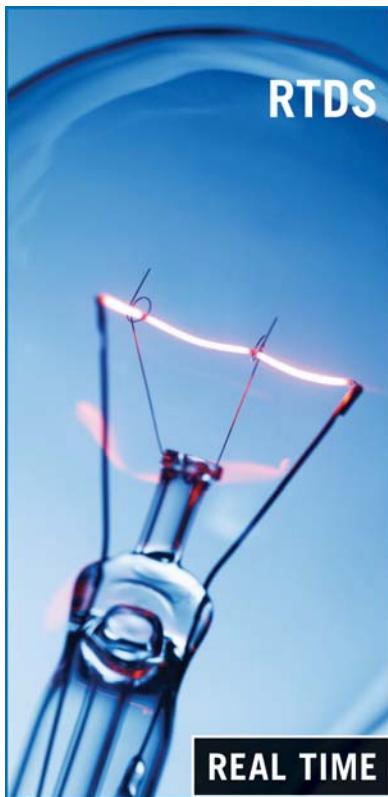
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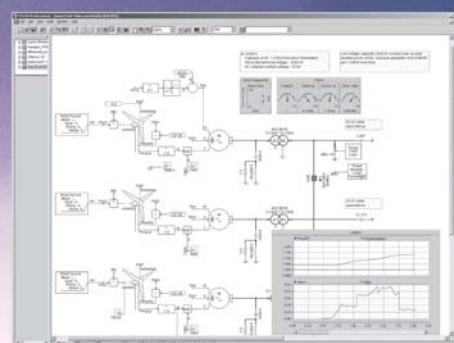
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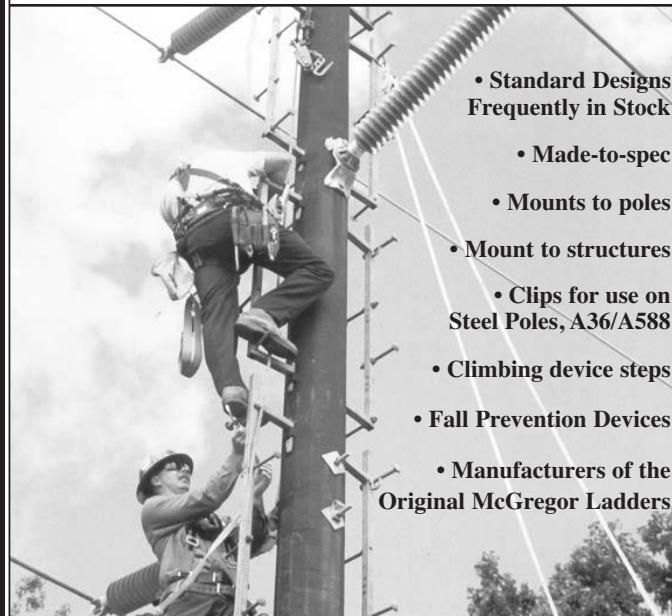
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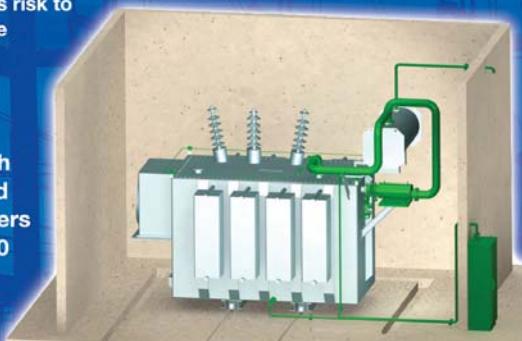
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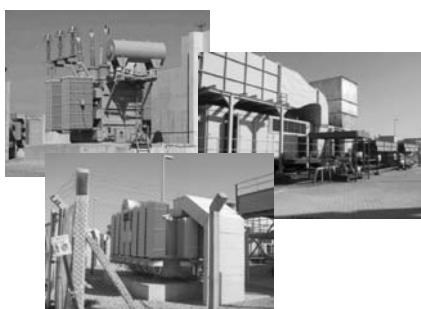
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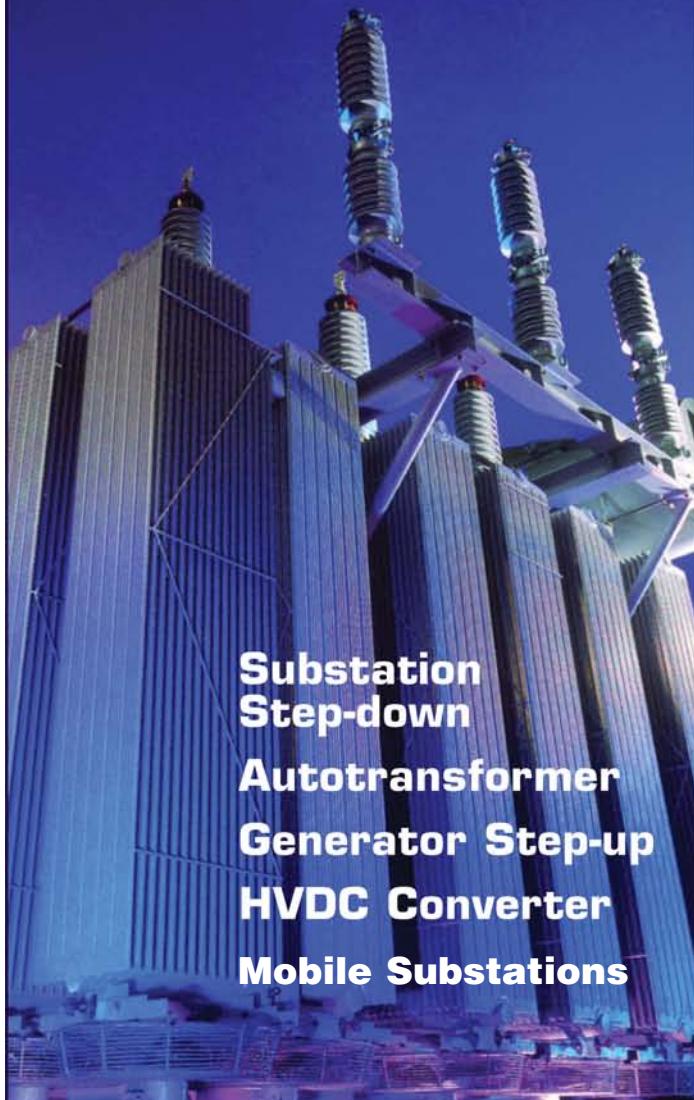
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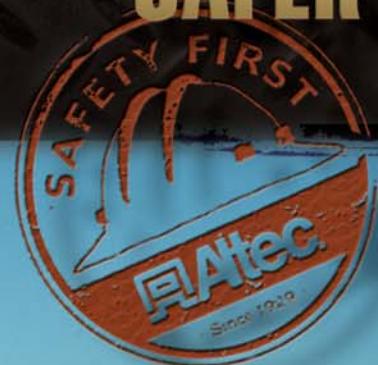
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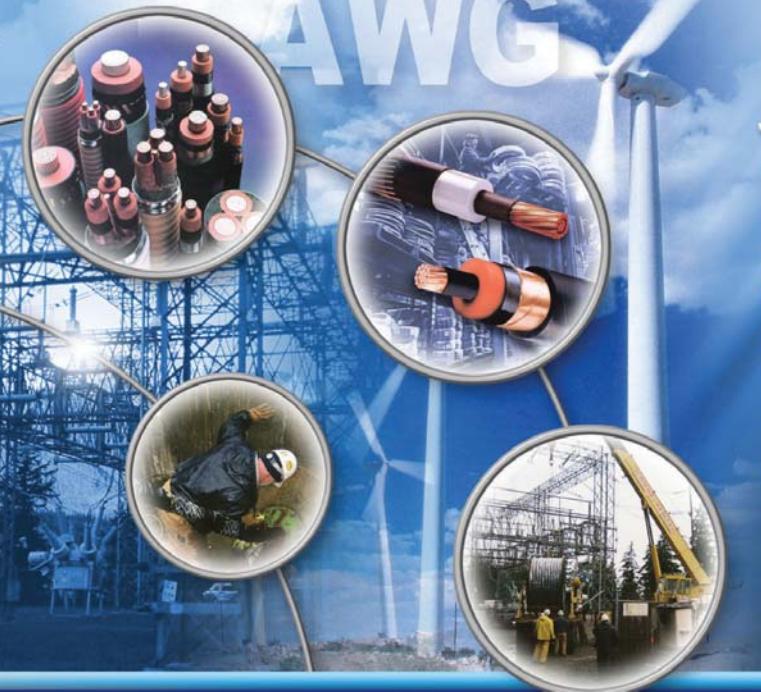
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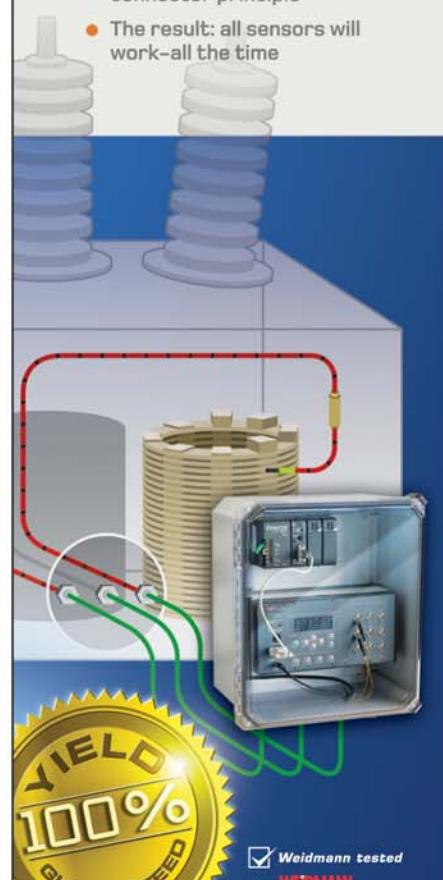
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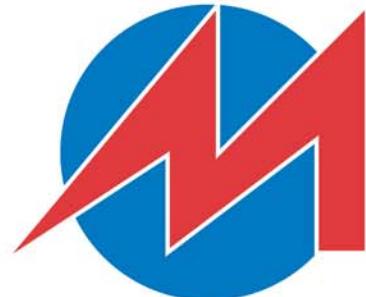
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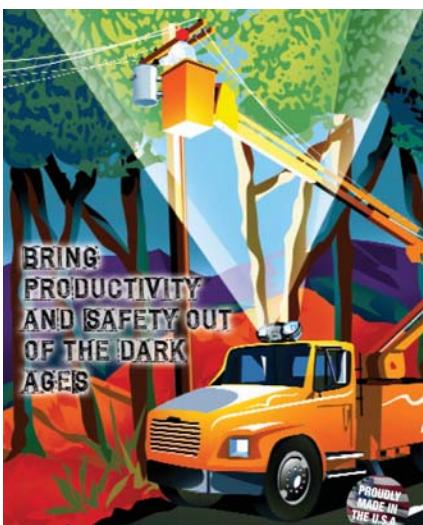
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124	Flir Systems	www.goinfrared.com	3
125	GarrettCom Inc.	www.GarrettCom.com	14
126	GE MDS LLC	www.gemds.com	74
127	Hamby Young	www.hambyyoung.com	18
128	Hastings Fiberglass Products Inc.	www.hfgp.com	25 - 27 - 29
129	HD Electric Company	www.hdelectriccompany.com	20
130	High Voltage Inc.	www.hvinc.com	28 - 123
131	Hipotronics Inc.	www.hipotronics.com	24
132	Hughes Brothers Inc.	www.hughesbros.com	34
133	ICUEE 2007	www.icuee.com	142
134	Incon Power Reliability Products	www.incon.com	11
135	Indeck Power Equipment Company	www.indeck.com	4
136	InfoNetrix	www.infoNetrix.com	68
137	Inner-Tite Corp.	www.inner-tite.com	101
138	Manitoba HVDC Research Centre Inc.	www.pscad.com	26 - 121
139	Middle East Electricity Exhibition & Conference 2007	www.middleeastelectricity.com/eetc	148
140	Neoptix Fiber Optic Sensors	www.neoptix.com	Front Cover
141	Nesco Inc.	www.nescosales.com	143
142	Nynas Canada Inc.	www.nynas.com	Inside Front Cover
143	Open Systems International, Inc.	www.osii.com	15
144	Opsens Fiber Optic Sensors	www.opsens.com	147
145	Pauwels Canada Inc.	www.pauwels.com	135
146	Phenix Technologies Inc.	www.phenixtech.com	117
147	Positronic Industries Inc	www.connectpositronic.com	85
148	Ranpro Inc.	www.ranpro.com	109
149	RTDS Technologies, Inc.	www.rtds.com	119
150	Rugged Com Inc.	www.ruggedcom.com	23
151	Sabre Communications Corp	www.sabrecom.com	Inside Back Cover
152	Satec	www.oksatec.com	Outside Back Cover
153	Schweitzer Engineering Laboratories Inc.	www.selinc.com	106
154	Sensus Metering Systems	www.sensus.com	13
155	T&R Electric Supply Company Inc.	www.t-r.com	133
156	The Von Corporation	www.voncorp.com	8
157	TPC Transformer Protector Corp.	www.transproco.com	131
158	Trench Limited	www.trenchgroup.com	83
159	Twacs by DCSI	www.twacs.com	21
160	Underground Devices Inc.	www.Udevices.com	146
161	Valmont Newmark	www.valmont-newmark.com	17
162	W.I.R.E. Services a div. Of Manitoba Hydro	www.wireservices.ca	91
163	Westex Inc.	www.westexinc.com	33
164	Winola Industrial Inc.	www.winolaindustrial.com	125

# Exceeding Expectations



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The diagram illustrates a network of interconnected software modules. At the center is a laptop connected to a website with the URL [www.expertpower.com](http://www.expertpower.com). Surrounding the central node are several software application windows:

- Metering:** Displays analog and digital meter readings.
- Power & Energy:** Shows energy consumption and production data.
- Demand & Loading:** Monitors system load and demand levels.
- Analog & Digital I/O:** Manages input/output signals.
- Logs & Profiles:** Tracks operational logs and performance profiles.
- Directional Harmonics:** Analyzes harmonic distortion in power systems.
- ITI Curves:** Plots Interharmonic Index (ITI) curves.
- Report Writer:** Generates detailed reports and documentation.
- Flicker:** Measures and analyzes power flicker levels.
- IEEE 1159 PQ Log:** Logs data according to IEEE 1159 standards.
- COMTRADE & PQDIF:** Handles data exchange formats.
- PQ Waveform & Fault Analysis:** Provides real-time waveform analysis and fault detection.
- Real-Time "Scope Mode":** Offers real-time monitoring and analysis in scope mode.