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Aging Infrastructure and Smart Grid – Problem or Opportunity?

By William Snyder

Just a few short years ago a leading topic of discussion in the US electric utility industry was concern over aging assets, both human and infrastructure. As time passes, the assets continue to age but the conversation in the industry today has shifted to smart grid related topics: design, specification, interoperability, grid coordination, system impacts, etc. Add a fair amount of discussion on integration of renewables and PHEVs and aging assets seem to be off the front page. Is this an indication that aging assets are no longer a concern, or simply that the topic is displaced from top of mind and top of checkbook by the ARRA driven focus on smart grid development?

Ask any utility asset manager today if they are kept awake at night with concern over aging infrastructure and the potential impacts of catastrophic failures of transmission towers, substation transformers, or other key assets and you will find that their

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Evolution of Control Center Systems

By Dr. Gerald Sheblé

The advent of GPS time stamping of sensor measurements was heralded to be a major change for the utility industry prior to 1970 by Dr. Arun Phadke. Phasor measurement devices are being deployed extensively, partly due to support by federal funds, and partly due to the value of information for operational efficiency, situational awareness, and commodity market economic impact. The major justification is awareness of the system situation. Dr. Tom Dy Liacco advanced the system state concept in 1967 identifying four states for power system analysis; normal, secure, alert, emergency. This industry research is finally resulting in a major advance for energy management systems (EMS), a key component in control center systems. The cost of communication and computers has finally achieved the hurdle of sending gigabits of data sufficiently fast to enable operators to see real time snapshots of the power system

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INSIDE THIS ISSUE

Letter from the President

Dear Colleague,

In this and upcoming issues of QT e-News we will be taking a closer look at the DOE Smart Grid Investment Grant (SGIG) and other smart grid projects that are underway across the industry. The DOE SGIG projects will result in large scale deployment of synchrophasor technology in the United States. In this issue, Dr. Gerry Sheblé discusses major changes to Energy Management System architecture that will be initiated by this deployment. We also highlight the New York ISO SGIG synchrophasor project that will utilize some of the advanced concepts discussed by Dr. Sheblé.

While smart grid technology offers improved operational schemes to manage grid loading and ease stress on power system components, the smart grid does not directly address aging infrastructure nor improve the health of system components. The article by Bill Snyder, *Aging Infrastructure and the Smart Grid*, reminds us of the important issues facing the industry regarding effective asset management and suggests the need for instilling "smarter" processes.

Because of changes introduced by distributed generation sources, new load types and smart grid controls, CEATI is updating its Distribution Planner's Manual, as described in the article by Dr. Julio Romero Aguero. When completed, this manual can be used as an industry reference by experienced planners and as a training tool by a new generation of power distribution engineers.

The article by Dr. Johan Enslin, *Quanta Technology Spreads Its International Wings*, describes some of our growing international involvement and capabilities that support Quanta Services' international business expansion. Dr. Enslin describes how we have helped South Africa fast-track the upgrade of its electric delivery system in time for the Soccer 2010 World Cup. A key element was the use of Quanta's proprietary LineMaster™ robotic arm technology to enable working on the high voltage system while energized.

As always, we would be pleased to hear from you. Sincerely, Damir Novosel - President

Aging Infrastructure and Smart Grid

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concerns are real and present every day. As has been the case for several years, the infrastructure repair, replace and upgrade needs continue to exceed available funds so each asset owner is challenged with allocation of resources and, in many cases, a lack of information and methods to optimize that allocation for greatest assurance of system reliability.

At Quanta Technology we have observed a renewed interest by utility companies in addressing their infrastructure issues. Many inquiries we receive are on the topic of condition assessment methods and technologies, data management, and project prioritization once a baseline of asset condition is established and failure risks are quantified. This industry issue has prompted my Quanta colleague, Lee Willis, to undertake a second edition of his book "Aging Power Delivery Infrastructures" which will be in print in early 2011.

But in the current environment of implementation of smart grid technology, how can infrastructure management be addressed and incorporated into smart grid functionality? Is there a natural synergy or are we considering a new, smart grid for operations management while continuing to depend on old and dumb grid assets for delivery?

Smart grid technology is primarily about information and efficient grid operations and while that brings great benefits, the technology does not directly address aging assets or infrastructure issues. Certainly improved operational schemes facilitated by smart grid can better manage grid loading and thereby ease the stress on some old or deteriorated system components. But this does not improve the health of those components. In an extreme scenario, confidence in smart grid technologies to work around infrastructure limitations could lead to further reduced priority for projects to address aged or deteriorated assets.

Smart grid devices do offer the capability to monitor condition of key

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Quanta Technology is Spreading its Wings!

By Dr. Johan Enslin

We are truly <u>international</u> both in our office locations and our project sites! See the map!

Recently Quanta Technology made some excellent inroads in establishing international activities for Quanta Technology and Quanta Services as a whole. Quanta Technology is blessed with an internationallv renowned group of people, who have worked in several countries and speak more than 24 languages. This forms an excellent team to develop and sustain international activities for Quanta Services. Although our focus is still on North America with offices in the USA and Canada, Quanta Technology is establishing activities in other main economic centers of the world.

Starting with international consulting and planning services, Quanta has several international successes evident with planning, engineering, procurement and construction projects in several corners of the world. Over the last 3 years Quanta Technology took the lead and has had several projects in South Africa, South America, Europe, India and China. These international activities and projects are in Quanta Technology's core business areas like energized services; transmission and distribution planning; Wide Area Measurement and Control; Renewable Energy Integration; SmartGrid; and protection and condition assessment of equipment.

Quanta Services now also has an international holding company in The Netherlands. Quanta Technology is operating with a presence in South Africa, The Netherlands and Brazil. Physical offices are now being established in The Netherlands and Brazil. In South Africa, Quanta Technology operates through one of the Quanta Services' sister companies, Alltech, on Energized Services uprate projects for Johannesburg.

<u>Uprating the 88 kV system in South Africa through Energized Services</u>

South Africa is in desperate need of upgrading the electricity transmission and distribution infrastructure after recent economic growth in the region. These requirements for infrastructure upgrades around Johannesburg were put on a fast-track with the Soccer 2010 World Cup in South Africa. In most of the regions, the existing electrical transmission and distribution infrastructure do not support an outage and no alternative transmission route is available. City Power in Johannesburg,

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Quanta Technology is Spreading its Wings!

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contracted Quanta through a local South African partner, Edison Jehamo Power (EJP) to uprate the existing 88 kV network around Johannesburg, using Quanta propriety LineMaster™ energized robotic arm technology. The requirements were to upgrade the existing 88 kV network from power flow of 60 – 100 MW per circuit, to around 200 MW per circuit. The Quanta Team selected high-temperature composite core conductors for the replacement wire that can operate at 200 degrees C under peak loading conditions. Although sophisticated and patented equipment with unique live-line skills are required by Quanta to perform this work, the uprating cost to our customer, City Power, is less expensive than other non-energized options available. This project is executed by a combination crew from Allteck and EJP in a highly populated urban setting in far less time and at a reduced budget than otherwise would be possible using conventional upgrading techniques and taking system outages. It was more economical for City Power to upgrade these circuits under these challenging conditions using the advanced robotic-arm technology supplied by Quanta.

In this first phase of the project, 17 km of four double circuit 88 kV lines have to be uprated through a congested Right-of-Way (ROW) with limited access in the urban areas of Johannesburg. The project started with a complete condition assessment of the lines, towers, insulators, tower footing access roads and facilities. This was followed by the line design, conductor selection and general engineering studies. Most of the tower and footing re- conditioning was done first, before the energized work started. The energized work started by installing a new additional conductor on delta strings the energized work started. The energized work started by installing a new additional conductors on the delta strings on the same tower using the robotic arms. (See picture). Then by switching the individual phase conductors to the extra phase conductor, all the conductors and insulators could be upgraded with high temperature conductors under completely safe energized conditions.

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Evolution of Control Center Systems

By Dr. Gerald Sheblé

state. Only now can the goal of state estimation to replace raw real time data with estimated data be achieved as advanced by Dr. Fred Schweppe in 1970. Other advances in state estimation, such as parameter estimation, to find the circuit parameters of transmission lines can also be achieved on a continuing basis. Projects in this area include a large range of functional thrusts to determine voltage stability limit, the presence of small oscillations, the presence of long term dynamic interactions, the events leading to and after faults, the calibration of sensor devices, and the dynamic models of demand and of generation. Estimation theory is at the heart of the majority of applications being implemented.

Now that the state of the power system is observable, the control of the power system will evolve to a larger range of

distributed resources. Battery and flywheel resources can be added for fast frequency control to enable renewable generation.

The power systems management was manual until the early 1960s. Only technically adventurous power companies installed analog computers for automatic generation control. The advent of power plant computer control in the early 1960s enabled the replacement of substation personnel using telephone equipment with remote terminal units and centralized computers. The first computer control systems for automatic generation control had 16 bit words, almost 32 kilo-words of memory, operated at a raging speed of 1.1 micro-seconds, and hard disk space of almost 600 MB on a 14 inch platter! The major advance was the availability of Extended FORTRAN for process control. That amount of computer capability can now be carried in one's hand! The computer protocol advances due to the advent of the microprocessor and memory on a single chip is a prime enabler of this technology. The advances in digital relay computers are also a prime enabler.

The latest projects include processing of data along each segment of the information supply chain. Data is can now acquired at 60 samples per cycle, calibrated continuously, models updated continuously, measurement errors identified and corrected, power flows estimated each cycle from estimated data, oscillations identified each interval of interest, and voltage stability margin calculated continuously and trended. The models of demand, equipment, and of generation can now be updated continuously. The view of the power system has now moved from the static solution of the power flow equations on a five minute basis, to a dynamic view on a per second basis. This is a major achievement in process control. It is now possible for research in all of these areas to provide more reliable, more efficient, and more economic service than ever before. We do live in interesting times with fantastic opportunities.

For further information, please contact:
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Quanta Technology- FREEDM Center joined RTDS Laboratory

Quanta Technology, as associate member of the Future Renewable Electric Energy Delivery and Management (FREEDM) System center, has engaged into collaboration with the North Carolina State University (NCSU) to develop and utilize an advanced Real-Time Digital Simulator (RTDS) testing laboratory located at NCSU. FREEDM Systems Center is an Engineering Research Center (ERC) established in 2008 by National Science Foundation (NSF) to promote industrial collaboration on renewable energy technologies.

As part of this collaboration, Quanta Technology will manage and operate the RTDS laboratory for commercial applications to provide professional services in the areas of:

- Hardware-in-the-loop functionality testing of digital and electronic devices including protective relays, distribution automation equipment, phasor measurement and synchrophasor units, etc.
- System integration and application testing such as end-to-end protective relay application evaluations, interoperability and standard compliance testing, and realization of IEC 61850 communication protocols,
- Power system transient studies for renewable energy resource integration and advanced simulation of power electronic apparatus (FACTS and Custom Power Devices).

Quanta Technology will also collaborate with NCSU on R&D projects in the similar areas and help train NSCU students.

The Quanta Technology - FREEDM center joined RTDS laboratory is expected to be operational in May 2010.

For further information, please contact Dr. Farid Katiraei (fkatiraei@quanta-technology.com). Also, please visit company website (www.quanta-technology.com) for information on Quanta Technology service offering and capabilities.

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Aging Infrastructure and Smart Grid

substation assets in real time, providing valuable data on the health of transformers and circuit breakers, for example. Data supplied and captured from substations, properly managed, can facilitate condition based maintenance programs thereby reducing maintenance costs without sacrificing reliability. The challenge however, is that the sensor technologies that can be used for such purposes are largely confined to substation applications. There do not appear to be any immediate sensor solutions to detect broken conductor strands, below grade corrosion of lattice tower legs or grillages, or broken insulators.

Smart grid devices do offer the capability to monitor the condition of key substation assets in real time.

In general, line components do not lend themselves to condition monitoring or condition based maintenance but this does not mean that diagnostic techniques are not available or should not be used. A default "run to failure" philosophy is commonly observed, not because it is a preferred approach, but because funding priorities and constraints make it a practical approach. For line components, many companies would be more comfortable with a "run to condition" approach, if they were able to determine component condition and if they are comfortable with a defined level of condition that triggers maintenance or replacement. The need to perform meaningful condition assessment of line components is increased with each year of service, especially for those aged components that have probably never had any type of diagnostic inspection.

Consider the population of steel lattice towers currently in service. The industry has many eighty year old (or older) transmission towers that have most likely been well maintained in regard to painting, replacement of missing bolts and damaged members, and other obvious needs. Assessment of the existing condition of direct buried tower legs, tower foundations, grillages and other below grade members can be assumed to have had less maintenance attention. Similarly, aged ACSR conductor remains in service in many cases with little or no knowledge of the condition of the steel core, or of the operating temperature history of the conductor and more importantly, the connectors. An area of growing concern is underground cables are providing operating history information to be used in developing cable condition profiles.

A default "run to failure" philosophy is commonly observed, not because it is a preferred approach, but because funding priorities and constraints make it a practical approach.

Smart grid operational schemes will continue to rely on the existing infrastructure for efficient power transfer and delivery. Knowledge of the health of the infrastructure and the risks associated with infrastructure condition continues to be crucial information for asset owners and managers. Smart grid technology offers capability to monitor substation asset condition but for the more voluminous line components, a smart approach to inspection, condition assessment and maintenance will also be required to ensure availability of the infrastructure.

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NYISO engages Quanta Technology as its SGIG Program Manager

As announced on May 10, 2010, the New York Independent System Operator (NYISO) will receive $37.8 million from the Smart Grid Investment Grant (SGIG) program of the US Department of Energy (DOE), funded by the American Reinvestment and Recovery Act (ARRA), for the implementation of a smart grid deployment project. The project is budgeted at $75.7 million.

NYISO has engaged the assistance of Quanta Technology, LLC, a wholly-owned subsidiary of Quanta Services, Inc., as its program manager. The responsibilities include setup of a project management office and performing selected technical and procurement services, SGIG grant administration, project scheduling, and coordination with transmission owners for system implementation, testing and commissioning. Quanta Technology has engaged Crowe Horwath, LLC as a subcontractor to setup and maintain a SGIG grant accounting system, processes and the reporting necessary for SGIG funding requirements compliance. Quanta Technology has also engaged PMOLink to deploy and maintain a Primavera project management system for use by all project participants.

This project will enhance the reliability and efficiency of the New York State power grid by the deployment of a Phasor Measurement Unit (PMU) network and capacitor banks that will be used to expand wide-area situational awareness and coordination of voltage across the New York State transmission grid. This investment will provide the foundation for further development of smart grid infrastructure in New York State.

NYISO, the primary SGIG Awardee, and all eight New York transmission owners, SGIG Sub-awardees, will work together to implement the system. The transmission owners are Central Hudson Gas & Electric Corporation, Consolidated Edison of New York, Orange and Rockland, the Long Island Power Authority, National Grid, New York State Electric & Gas, Rochester Gas and Electric, and the New York Power Authority.

The project is scheduled to be completed over a 3-year period starting July 1, 2010. NYISO will continue to report to DOE on the results of the project for an additional two years.

"We look forward to working with Quanta Technology on this important effort to make New York's electricity grid smarter and more efficient. It is the result of excellent cooperation and collaboration among federal and state officials and the owners and operator of New York's high-voltage transmission system," said Stephen G. Whitley, president and CEO of the NYISO. "Working with our team, Quanta will help to ensure these investments provide New Yorkers with a more robust and reliable power system, ultimately helping to make power more affordable and more reliable while paving the way for other advanced technologies to be deployed."

For more information please contact Jim Blackman, Director, Business Development jblackman@quanta-technology.com

WINGS....

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In some areas along this ROW, informal dwellings and settlements obstruct access to the lines and towers. This was one of the main concerns of City Power and one of the reasons selecting Quanta. Using our compact construction equipment and remote control of the robotic-arm operations, these challenges could safely be met without taking line outages.

88 kV Energized Uprating using LineMaster™ with an additional delta circuit.

Quanta and EJP is currently finalizing the planning for the additional phases of this project to be executed over the next 2 years.

Quanta Technology and Quanta Energized Services played a vital role in establishing this uprating activity in South Africa, including taking the lead in developing the EPC proposal, performing the line design, performing the conductor calculations and selecting the high temperature conductors. Quanta Technology also provided engineering services, system analysis, as well as project management and condition assessment support to the project team in South Africa.

Currently we are working on other initiatives in Europe, Brazil and India that include Energized Service, Control Centre Design, Phasor Measurement Units, Renewable Impact analysis and system planning.

For further information contact: Dr. Johan Enslin, VP, International and Sustainable Energy, jenslin@quanta-technoloy.com

CEATI's Distribution Planner's Manual

Preparing a new reference for the industry

By Dr. Julio Romero Aguero

The Centre for Advancement through Technological Innovation (CEATI) has selected Quanta Technology to conduct a review and update of the Canadian Electric Association (CEA) Distribution Planner's Manual.

The existing Distribution Planner's Manual was published in 1982 by the CEA. The document has 14 supplementary guides mainly written by utility planners that were participating in CEA's distribution program at that time, and covered a number of aspects ranging from load forecasting, reliability evaluation and loss mitigation among others. The members of CEATI's Distribution Assets Life Cycle Management Interest Group (DALCM) identified the need for a complete review and update of the existing manual to include present planning practices and challenges, including the considerations of smart-grid equipment, the integration of renewables into the distribution system and the evolution of new loads such as electric vehicles.

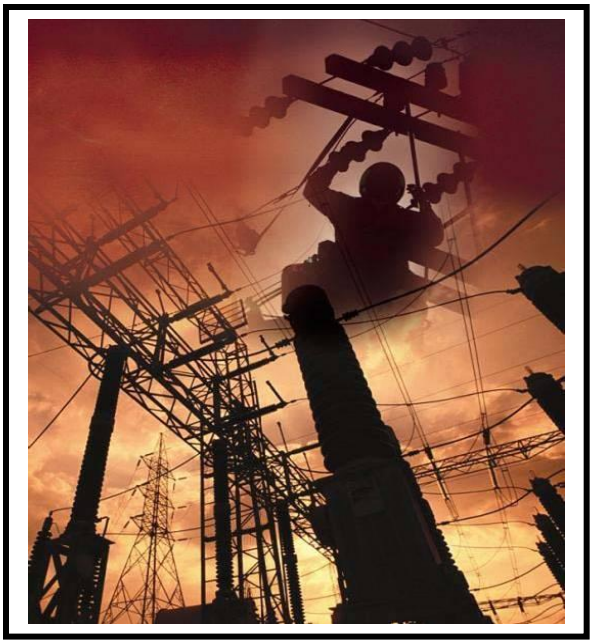
- Load Forecasting: the manual will discuss concepts such as spatial load forecasting, small area, S-curves, and stress the importance of weather normalization, land use analysis, and modern modeling techniques such as simulation methods and hybrid methods.

- Distribution Reliability: the manual will address topics that have grown in importance during the last two decades such as the IEEE 1366-2003 Standard, major event exclusion, momentary interruptions, predictive reliability modeling, regulatory reporting, and the relationship between reliability and power quality.

- Distributed Resources: Quanta Technology will include new original material on the impact of conventional and renewable distributed generation and energy storage technologies on distribution system planning.

- Smart Distribution: the manual will discuss the advances in supervision, control, automation and smart grid technologies. Some of the topics that will be discussed are substation and feeder automation, automatic Fault Location, Isolation and Service Restoration (FLISR) schemes, Distribution Management Systems (DMS), Outage Management Systems (OMS), Integrated Volt -VAR Control (IVVC), distribution state estimation, and Advanced Metering Infrastructures (AMI).

- Distribution Power Quality: Quanta Technology will discuss the practical applications and experiences, new regulations, and advances in monitoring technologies and equipment that has occurred in this area during the last two decades. This section will address and topics such as harmonics and inter-harmonics, voltage sags and swells, flicker, etc.



Quanta Technology relies on a selected team of technical experts to execute this work in an efficient, thorough and practical manner. Quanta Technology's team of experts has helped a broad spectrum of utilities in North America, including the largest IOUs in charge of the main metropolitan areas and Electric Cooperatives and Municipal Utilities responsible for rural and suburban regions. Quanta Technology is proud of working with CEATI in this project. The final aim of this important contribution to the industry is preparing a new reference document that will be used by distribution planners throughout North America.

For further information, please contact:
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julio@quanta-technology.com

Quanta Technology joins Realtime Utility Engineer's Office

in Wisconsin

January 2010 marked the one year anniversary of Quanta Technology's "office" in Madison, Wisconsin. The Madison office is provided courtesy of fellow Quanta Services company, Realtime Utility Engineers, Inc. (RUE). RUE is a progressive and growing consulting engineering firm providing Substation and Transmission Line Engineering to electric utilities nationwide. Scott Greene and Joel Berry reside within the RUE office and are visited occasionally by John Appleyard – a former RUE employee now working for Quanta Technology. The close relations between Quanta Technology and RUE have led to several opportunities for collaboration between the companies. RUE is very active in wind farm development and now Quanta Technology provides additional transmission and generator interconnection analysis to several of RUE's wind generation clients from our Madison office. At the same time, several RUE experts have participated in Quanta Technology projects.

The address for our Madison office is
Quanta Technology
c/o Realtime Utility Engineers
8417 Excelsior Drive
Madison, Wisconsin 53717

800-297-1478 (Scott x202 ; Joel x211)

We're Still Growing Bigger & Better
Announcing Our New Staff

Quanta Technology would like to welcome Hamid Maghdan as its newest transmission expert.

Hamid Maghdan, PhD, has twenty years of experience in the electric power industry including development and support of commercial production cost models for energy trading and marketing entities and electric utilities. At EDS Utilities Division, he was involved in development of an integrated fuel planning and emissions management commercial software using Linear Programming. At Mirant, as the OASIS and operations manger he worked closely with energy traders and marketers responsible for bidding generation assets in New York and New England electricity markets to maximize generation asset profitability.

Prior to joining Quanta Technology, at Ventyx, he supported PROMOD and PowerBase clients, assisting them in setting up case studies for market price forecasting, generation plant sitting, and transmission expansion planning studies. Also, as the business lead, he authored designed documents for and was involved in the development of the Transmission Security Constrained Unit Commitment and Dispatch model used in the Entergy's WPP process to grant weekly transmission reservations to IPPs on Entergy's transmission system. At DeKalb Technical Institute, as an adjoin faculty, he taught C++ and C programming languages.

Quanta Technology has a new addition in the accounting department. We extend a warm welcome to **Valerie Harris**, Senior Accounts Receivable Analyst.

Quanta Technology announces three new interns for the summer

Kyle Lewis
Graduated from Montana Tech in Butte, MT
He joins the Transmission Team

James Willis
Pursuing a Law Degree from Baylor Law School in Waco, TX
James is working on the Expert Witness Program

Hsiao-Hui Chang
Hsiao is studying abroad from Taiwan at NC State University
She is pursuing a degree in Business Management

Recent QT Publications

"Storm Hardening the Distribution System"
By Richard Brown

"Electric Power Distribution Reliability"
by Richard Brown

"The Impact of Plug-In Electric Hybrid Vehicles (PHEV) on Electric Utilities."
by Edmund Phillips et al.

"Managing Enterprise Information for Smart Meters and Smart Grid"
by Hahn Tram

"Grid Impacts and Solutions of Renewables at High Penetration Levels"
by Johan Enslin

For a complete copy of these publications, please visit us at:
www.quanta-technology.com

Please Join Us

IEEE PES General Meeting
July 25-29 Minneapolis, MN
Engineers and Engineering Managers Conference
July 26-28 St. Maarten, N.A.
IREP Conference
August 1-6 Rio de Janero, Brazil Paper: Srijib Mukherjee, Sercan Teleke, Veera Bandaru
CICED 2010
Sept. 12-18 Nanjing, China Speaker: Richard Brown
CEATI Grounding & Lightning Workshop, 2010
Sept. 12-14 Montreal, Quebec Speakers: Jim Burke, Tao Hong
Autovation, 2010
Sept. 12-15 Austin, TX Speaker: Hahn Tram
Platts 2010 Transmission Planning & Development Forum
Sept. 15-16 Washington, DC Speaker: Don Morrow
2010 First International Conference on Applied Robotics for the Power Industry
Oct. 5-7 Montreal, Canada - Paper: David Elizondo

Details to be posted at **www.quanta-technology.com**

Upcoming QT e-News Feature Articles

The feature articles for upcoming QT e-News issues will be developed by the Quanta Technology staff on the following topics. We reserve the right to make changes as the result of client feedback and industry interests.

Autumn 2010
- Topic for the issue – Optimizing the Grid
- WAMPAC

Winter 2011
- Topic for the issue – Aging Infrastructure – Resurgence of Concerns

About Quanta Technology

Quanta Technology, LLC, headquartered in Raleigh, NC, is the expertise-based, independent consulting arm of Quanta Services. We provide business and technical expertise to energy utilities and industry for deploying holistic and practical solutions that result in improved performance. We have grown to a client base of nearly 100 companies and to an exceptional staff – now over 70 persons – many of whom are foremost industry experts for serving client needs. **Quanta Services, Inc**., headquartered in Houston, TX (NYSE:PWR), member of the S&P 500, with 2009 revenue of $3.3 Billion, is the largest specialty engineering constructor in North America serving energy companies and communication utilities, according to McGraw Hill's ECN. More information is available at www.quantaservices.com.

QUANTA TECHNOLOGY

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