QT e-News™

Quanta Technology's Online Newsletter

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INSIDE THIS ISSUE

Massive Deployment of Renewable Energy – The Planning & Operational Challenges

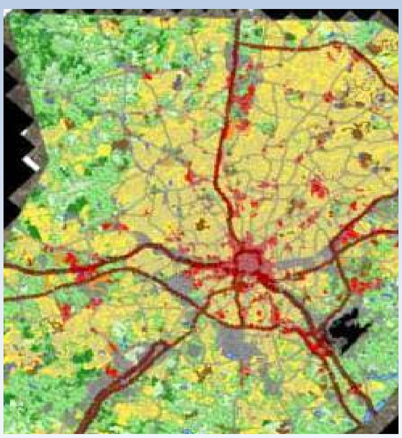
By **Don Morrow, PE**

Renewable energy has arrived – in a big way. Driven by renewable energy portfolio standards and supported by favorable tax treatment, wind and solar energy developments are reaching truly impressive levels. A recent review of selected generation queues tells the story: the combined MISO, PJM and SPP queues showed a staggering 126,300 MWs of renewable generation (mostly wind) currently seeking to connect to the grid. The West is also extremely active, with the California ISO queue alone showing 26,400 MWs of renewable energy seeking to connect. Of note in Massive deployment of renewable energy resource will introduce significant complexity in the operation of the electric system. To effectively deliver these amounts of renewable energy, electric systems must address two unique requirements: the need to keep power flows through transmission facilities at acceptable levels and the need to maintain an instantaneous balance between generation and load. To satisfy these requirements, planners and operators must understand and manage two critical attributes of renewable generation – variability of plant output due to changes of the

Continued on Page 4

Spatial Load and Resource Analysis Needed for Smart Grid Planning

By **H. Lee Willis, PE**



Many long-time electric utility planners are familiar with spatial load forecasting for distribution systems. This approach grew out of small-area load forecasting methods used in the 1960s: the utility service area was divided into many small areas and the peak demand for each area was forecasted. Often this concept was *illustrated* as dividing the territory into a grid of squares, typically a half-mile per side. However, in practice most utilities defined the small areas as feeder service areas – developing a forecast for each feeder by trending its past peak load history. Advanced methods, such as one I used at Houston Light and Power in the early 1970s, divided each feeder into three or four "collector areas" (portions between major operable switches and end points), giving additional detail for planning. A computer program would cycle through all areas one at a time: for a utility with 2500 feeders, divided on average into 4 collector areas each, it would serially perform 10,000 load history trending/forecast calculations, taking, say, the

Continued on Page 5

Best Practices for Distribution Storm Hardening

By **Dr. Richard E. Brown**, PE

Distribution systems are typically not designed to survive major weather events like hurricanes. Based on recent major storms, such as Hurricane Ike, many are beginning to wonder whether it may be beneficial for utilities to "harden" their systems so that they will incur less damage and facilitate faster restoration. To determine best practices for prudent implementation, Quanta Technology recently conducted a survey with 26 participating utilities.

Based on overall survey results, Quanta Technology has developed a list of twelve best practices to help ensure hardening is being pursued through a process that is cost effective, consistent, transparent, and data-driven.

Continued on Page 2

Letter from the President

Dear Colleague,

We are pleased to continue providing you with thoughtful and timely articles in the QT e-News newsletter developed by the Quanta Technology staff. This issue includes articles on:

- Challenges of Massive Deployment of Renewable Energy: We have witnessed renewable energy arriving in a big way. The interconnection of massive amounts of intermittent renewable energy sources will introduce significant complexity into planning and operation of the grid. While the 2010 Winter Issue of QT e-News discussed system design issues of renewables, this article provides a system operations perspective.
- Spatial Load Forecasting: Deals with more granular and localized load forecasting techniques, which were quite expensive in early days of usage. This methodology can now be implemented and operated much less costly - thanks to geographic information systems technology and enhanced forecasting tools. The need for spatial load forecasting is being driven by contemporary planning needs (eg, energy conservation, home automation, electric vehicles, distributed generation and energy storage).
- Distribution System Hardening: While North America is fortunate to recently have had mild storm seasons, the changing weather patterns could foster major storms that may severely impact power systems. This article highlights results and recommendations from a survey with 26 utilities, as well as from our own planning work with utilities, on best practices to pragmatically strengthen systems to incur less damage and facilitate faster restoration.

We are also pleased to include announcements of additional industry experts who have joined the Quanta Technology team. Of equal importance to our senior staff expansion is the on-going identification and development of junior staff who will evolve to become our future experts. We have included an overview of our power system intern program, which has exceeded our expectations for finding and developing exceptional young talent – a need voiced throughout the power industry.

We believe these articles should whet your interest to discuss the subjects further, and we would be pleased to hear from you.

Sincerely, Damir Novosel - President

Best Practices for Distribution Storm Hardening

Continued from Pg 1

those utilities wanting to consider further improvements.

The twelve best practices are organized into two stages. The first six practices are either inexpensive or good practices regardless of hardening considerations. They are also relatively simple to implement. The second six best practices are designed to be implemented in a longer term and generally require more utility effort, investment, and potentially process changes.

1. Pole test-and-treat. Wood poles are susceptible to decay, causing a reduction in strength and a corresponding increase in failure probability during a major storm. As such, utilities should establish and maintain a test-and-treat cycle for wood poles. The goal is to ensure that no pole is likely to have lost more than one third of its original strength before its next scheduled inspection.

2. Feeder inspections. Utilities should have a formal feeder inspection program that periodically examines feeders for problems that will likely lead to an outage during normal and/or storm conditions. At a minimum, all three-phase main feeder trunks should be inspected every five years.

3. Attachment audits. Third-party attachment audits should occur, at a minimum, every five years for all three-phase main feeder trunks. Processes should be in place to identify new attachments, to determine whether these new attachments have overloaded the distribution poles, and to mitigate overloaded poles.

4. Foreign-owned poles. Electric utilities should try their best to ensure that foreign-owned poles are in as good shape as their own poles in terms of remaining strength and loading. The processes addressing foreign poles can vary widely, ranging from the electric utility performing all inspections and maintenance to the electric utility ensuring that the foreign owner is doing an adequate job.

5. Setting depths. A strong pole is of no use if its foundation is insufficient. Therefore, each utility should develop standards and processes to ensure that the foundation of distribution poles will not fail before the pole.

6. Loading calculations. Utilities should have systems and processes in place to ensure that poles do not become overloaded after they are initially installed. At a minimum this should include (A) a loading assessment whenever an additional piece of equipment is placed on the pole, (B) a loading assessment whenever a new attachment is discovered on the pole, and (C) mitigation actions as appropriate.

7. Grade B construction. The use of Grade B for storm hardening is popular, effective, and easy to implement. Utilities should have an explicit process to review new construction and rebuilds to decide whether the system should be built to Grade B (or equivalent) rather than a weaker standard.

8. Non-wood poles. Utilities should, at a minimum, have standards for at least one type of non-wood distribution pole and should install some on their system to gain field experience. The intent is for utilities to have a viable alternative to wood should this be necessary in certain hardening situations.

9. Post-storm data collection. Utilities should have a data collection plan that has trained staff collect data on distribution damage sites immediately after the storm subsides. This data should be collected in a way that is statistically representative of the entire system. The intent of this recommendation is not to have a large number of data collectors that otherwise could be helping with storm restoration. Rather, a utility should train a few data collection teams (e.g., three teams of two

Continued on Page 3

Best Practices for Distribution Storm Hardening *Cont from Pg 2*

engineers) and have these teams spend the first two days of storm restoration collecting data.

10. Hardening toolkit. Utilities that intend to harden portions of their system should develop a "hardening toolkit" that consists of a set of approved approaches to hardening and an application guide for their use. The utility should ensure that all of the appropriate standards are in place for each element of the hardening toolkit, and should install pilot applications for each unfamiliar element to gain field experience. Toolkit examples include: stronger poles, strength uprating, new mid-span poles, storm guying, push braces, reinforcing pole hardware, and underground conversion.

11. Like-for-unlike replacement. Utilities are continuously inspecting, repairing, replacing, and generally working on the distribution system. When a utility identifies a cost-effective approach to storm hardening, it should enact systems and processes that allow the system to be gradually hardened through normal work processes.

12. Strengthen critical poles. A good way for a utility to gain experience in hardening is to identify and strengthen critical poles that are highly undesirable to fail during a major storm. This could be because the pole is very difficult to restore (e.g., freeway) crossing, expensive to restore (e.g., automation equipment), or critical during restoration (e.g., communications repeater).

Implementing the twelve best practices described in this article will result in a well-managed distribution system infrastructure and will establish good credibility for a utility's current and planned hardening activities. These best practices will result in modest reductions in overall storm damage, significant reductions in critical pole failures, and faster restoration times, and lower restoration costs.

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Our Successful Intern Program

Quanta Technology has established an aggressive internship program to give graduate students practical experience and enable us to find future permanent employees. We have had great success to date, with more than ten percent of our current staff having joined Quanta Technology through our intern program.

Typical interns are pursuing their masters or PhD degrees in power engineering or a related field. Some interns work for us full-time over the summer, while others work for us part-time and continue their studies. We have had successful interns from a variety of universities including North Carolina State University, Kansas State University, the University of Washington, the University of Toronto and others.

Our interns are given assignments supporting client projects and are closely monitored and mentored by our senior staff. Typical assignments include transmission planning studies, distribution reliability studies, load forecasting analyses, system protection studies, smart grid studies, and a variety of other interesting and timely work. The interns get to learn use a wide variety of industry planning and system analysis tools during the course of their projects, which prepares them well for life after graduation.

This program gives us an opportunity to assess interns' technical abilities, creativity, inter-personal skills and job dedication. The interns get to see how a professional services company functions and can obtain a sense of our company's culture and appropriateness for their career needs. As a result, more than 50% of our interns have accepted full-time positions with us upon graduation.

This program has enabled us to grow and strengthen our staff with exceptionally bright, qualified and energized talent to serve our clients' expanding needs. We view our interns as the future thought leaders in the industry.

Projects for CEATI International, Inc.

Quanta Technology is completing studies regarding energized transmission technology and work applications for *the* Centre for Energy Advancement through Technological Innovation (CEATI), which is headquartered in Montreal and serves more than 100 worldwide organizations including electric and gas utilities, governmental agencies and research bodies.

The Quanta Technology major study provides an overview of worldwide robotic applications for energized transmission line work, from technologies and design principles to field projects and future developments. The need for this study is driven by the expected increase in live-line transmission work and the continual industry effort to minimize risk to field personnel safety and ensure power system reliability. The applications reported include facility upgrades, condition assessment and monitoring, maintenance and repairs. The study found robots in usage that included ground-based units (for heavy lifting) and line-suspended and aerial units (predominately for inspection). An example of a ground-based unit, shown in the attached photograph, is utilizing robotic arms to replace deadend structures. A paper outlining the major findings will be presented by David Elizondo and Hans Candia of Quanta Technology at the robotics conference CARPI2010, September 2010.

Quanta Technology has commenced the updating of the CEATI Distribution Planner's Manual, a comprehensive planning manual that has been used by many utilities. Many contemporary issues will be covered such as smart grid design and applications, integration of distributed generation including renewables, energy storage, and considerations for electric plug-in vehicles. A progress report will be shared at the CEATI Distribution Planning Workshop in June (see page _ of this newsletter).

For further information regarding these CEATI projects or workshop, please see www.ceati.com.

Massive Deployment of Renewable Energy - The Planning & Operational Challenges

primary fuel (wind or sunlight in the case of renewable energy) and uncertainty of plant output (magnitude and time) due to inability to provide a perfect forecast of weather conditions.

As an example of the impacts of variability and uncertainty of renewable energy on transmission, consider the incident that occurred in Europe on November 4, 2006. On that evening, the European grid was affected by a serious incident originating from northern Germany that led to power supply disruption for more than 15 million households. Strong, unpredicted winds developed which stressed the transmission system that had a major 380kV double circuit out for maintenance. The unplanned-for high wind generation overloaded the remaining facilities. Protection relays then split the network into three islands. Two of three resulting islands had a significant amount of wind generation resources.

Of particular concern is that one of these islands experienced an over-frequency state. Significant imbalance in this island caused rapid frequency increase and triggered the automatic tripping of wind generation units. Approximately 6,200 MW of wind generation was shed. After a few minutes, wind generation units began to automatically reconnect. This reconnection, however, was contrary to the action needed to reduce frequency, thus contributing to further deterioration of system conditions in the island. Only after resynchronization (which required several attempts) were the operators able to stabilize the system.

The ability to balance generation and load instantaneously and continuously will be a challenge due to large amounts of renewable energy. Wind and solar energy are intermittent, which may diminish rapidly even while system load is increasing – or vice versa. These types of operating conditions place additional burdens on the conventional on-line resources used for load following and frequency regulation. As renewable energy generation is increased, planners and operators will need to provide supplemental resources, which include additional generation, energy storage, transmission transfer capability, and demand response, that will need to respond faster and in greater amounts than those resources traditionally used by balancing authorities.

To meet these challenges planners and operators will need to improve and enhance their standard "toolkits" for analyzing system performance. Traditional generator interconnection studies have focused on power flow, contingency analysis, generator stability and transient analysis. With the variability of large wind farm output, it is necessary for system planners to supplement their traditional analysis to study rapid hourly and daily variations in output. Planners will also need to consider sudden shutdowns of large, geographically concentrated wind farms due to excessive wind speeds. These studies will of necessity be more "operational" in nature than traditional analyses, but the additional analyses will be necessary to fully understand the impacts of renewable energy and to develop the mitigation strategies to maintain reliability.

One intriguing approach is to conduct this additional analysis within a simulated electric system environment similar to a dispatcher training simulator (DTS) typically used at many control centers. These environments enable time domain changes to be studied and to capture the effects of regulating unit ramp rates and transmission constraints that come into play when renewable resources rapidly vary. While the needed modeling would be more detailed and involve significantly larger networks than that currently utilized in DTSs, the approach appears feasible and may present the only effective way to fully understand the dynamic system impacts of massive amounts of renewable resources. Contingencies and the resulting system dynamics will also need to be enhanced by incorporating probabilistic planning techniques. For example, Monte Carlo analysis could be utilized to detect unusual combinations of events that may negatively impact regional reliability effects. This type of analysis would be deployed over large, wind-saturated areas of the grid to determine combinations of wind variation and other events that have detrimental effects. This approach shows promise as a rigorous method for identifying extreme disturbance events as required by NERC.

An additional challenge for planners is the need to identify feasible alternatives for transmission projects. Because renewable resources are often located in concentrated - but large - portions of the electric system, the transmission reinforcement options may be extensive and can be difficult to fully assess. Complicating this is the advent of inter-regional planning, which requires much larger databases, greater coordination between control areas, and more interactions with many interested parties.

Evaluating the impacts of the options requires screening tools to determine which alternatives provide the highest benefit-cost ratio. Ann effective tool developed by Quanta Technology and PowerWorld Corporation to evaluate alternatives uses weighted-transmission loading relief (TLR) analysis and other linear techniques to quickly estimate the impacts of a large number of potential transmission lines on transmission system security. This tool is capable of screening thousands of options in a matter of hours for a given set of system conditions.

Quanta Technology has helped many clients deal with the challenges identified in this article. ■

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Continued from Page 1

Spatial Load and Resource Analysis Needed for Smart Grid Planning

past ten years of customer and peak load data on each area, and extrapolating that ten years into the future.

During the 1970s and 1980s, a period when load growth and capital budgets were large by today's standards, most electric utilities did much longer range and more strategic delivery system planning than they do today, looking out up to 30 years and producing "big picture" plans that identified where and what substations and lines they would build, and even anticipated major feeder level problems (how they would get around major geographic barriers, etc.). Trending methods as described above proved unsatisfactory: forecasting load growth on the basis of past load history, when "a feeder a time" as described above, is inaccurate beyond about three to four years ahead.

Spatial load forecast methods were developed to support those longer range and "bigger picture" planning needs. Spatial forecast methods produce the trends for all small areas simultaneously while using the data for all small areas to forecast every small area. The forecast methods themselves are more involved numerically. Instead of cycling through each small area one at a time and trending its load history, they usually use additional data beyond just load histories, and analyze patterns of growth among groups of neighboring areas, etc., and only then trend groups and sets of areas. They used land use, zoning, and econometric data, too, so that they could anticipate long-term trends in regional growth and change.

Spatial forecast programs stretched data collection, engineering skills, and particularly computer processing technology of the time to the breaking point. As a result they were expensive and difficult to use. But they were widely used nonetheless, because the results were much better from a strategic planning standpoint. Forecasts could identify future growth hot-spots, show areas of declining load, and forecast changing patterns of customer location and density – all usefully up to 15 years into the future. Meaningful what-if scenarios could be generated to guide utilities for studying the risk of over-building, not building, or simply building in the wrong place. By the mid 1980s, a majority of the 200 largest US utilities used some form of the spatial forecasting/planning approach, including 71 that relied on a particular forecast tool Hahn Tram (now with Quanta Technology) and I wrote. In the 1990s, as growth slowed, as budgets became meager, and as deregulation "distracted" the industry, many utilities returned to easier to use feeder-by-feeder trending methods. By 2005, fewer than ten North American utilities continued to use spatial forecasting.

But in the past five years, we've seen a considerable resurgence of interest and use of spatial load forecasting methods in North America. Several utilities have already adopted newer methods, and many others are using studies that incorporate them. This trend is being driven by both improved technology and more evolving complex planning needs. The major reason for this resurgence is basically because utilities once again find themselves needing longer range, strategic plans.

Improved Technology: But an important factor in this resurgence is that all those once very expensive data sources and methods are for the most part straightforward given today's Geographic Information Systems (GIS). And, computing power has increased by orders of magnitude, so that even the most numerically intense, comprehensive spatial customer-based econometric-demographic forecast models can be run on standard PCs with no difficulty. And, Jim Burk, Executive Advisor at Quanta Technology has famously observed, "If it's possible to do something, people will expect you to do it." Since modern GIS and computing technology make spatial forecast methods easier to apply, and the methods are used in government and other industries, there is more of an expectation that utilities will use spatial load forecasting too.

Evolving Complex Planning Needs: But as stated above, today's "non-traditional" planning needs are the big driver behind this trend. Energy conservation, customer control of energy usage via home and business automation, support of electric vehicles, interconnection of customer PV generation, integration of energy storage, and targeted distributed generation are all factors that do start at and impact individual feeders, but can't be planned at the individual feeder level. They have *system-wide* impacts and long-range *strategic* implications for a utility's customer and stockholder performance. Studies to determine the consequences of policy changes and investment commitments require a merger of customer data, public data, customer energy marketing initiatives, and system data, and coordination of all information over a wider set of considerations and factors than in traditional T&D planning. The figure on page 1 shows the results of one such study: a utility looked at a combination of rate changes and Smart-Grid demand response programs that would make it more competitive for commercial loads: the diagram shows a 10-year ahead map of customer class load density in which its share of regional commercial growth doubles over its base case. This forecast supported studies of the cost of serving this additional revenue (and led to a decision to modify the program slightly, but go ahead).

This is where, and why, modern spatial electric load analysis and forecasting methods shine. They provide the unified-data, multi-dimensional analysis and planning foundation needed to look at these factors from all sides and truly integrate all these factors into "integrated resource planning" appropriate for the smart grid world. Utilities such as Duke and Northern Virginia Electric are using spatial forecasting systems to produce coordinated pictures from which they can plan and coordinate their T&D, DSM, marketing and Smart Grid planning. As the industry moves further into a future dominated by Smart Grid, distributed resources, and customer-choice and control, GIS-based spatial planning tools will probably become common, if not the standard best-practice. We see nothing else on the horizon that can address better the "bigger picture" T&D system strategy and investment planning issues, fit within a utility's IT and human resource limits, and have the required credibility for management and the regulatory community.

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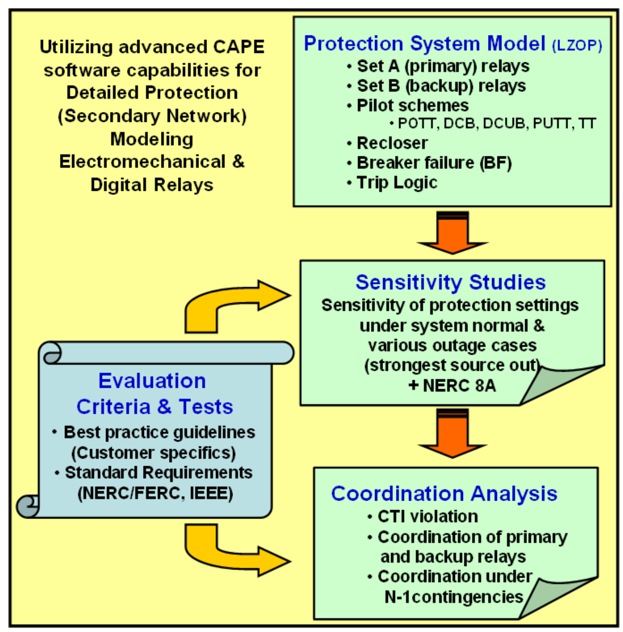
Wide Area Protection and Coordination Studies National Grid – USA

By Farid Katiraei, Quanta Technology and Mark Stanbro, National Grid - USA

In December 2008, National Grid – USA awarded Quanta Technology a contract to perform a 'Wide Area Protection and Coordination (WAPC) Study' of all bulk power and specific critical transmission facilities across National Grid's New England and Upstate New York service territories. Based on early project results and recognizing the benefits that overall project findings would likely have on system performance and reliability, the contract was extended in December 2009 to include all transmission facilities. This covered all 69kV and above in New England and 115kV and above in Upstate New York by the study.

The project objective is to review and model relay settings, verify and rebuild network models as needed, and then utilize the models to study sensitivity of settings and analyze protection coordination on a system wide basis. In total, approximately 550 transmission lines and 1,300 transformers are being studied along with their pertinent relay systems.

The 'PRIMARY' network parameters and models (lines, generation units and transformers) were validated to ensure the accuracy of the short circuit database for fault analysis. This included review of transformer name plates and test reports as well as physical characteristics and structural configuration of transmission lines (right of way information, tower design, conductor type, etc.). The information was used to re-calculate and confirm transformer and line impedance parameters including mutual coupling effects for input to the short circuit model The 'SECONDARY', or relay, modeling was also performed. This consisted of gathering as-found relay setting data and reviewing applicable drawings to determine the applied protection schemes. Line protection (both communication and non-communication based), breaker failure protection and, to a degree, relaying on power transformers was modeled. The modeled data included vendor-specific relay types, ranges and settings as well as the interrelationship of equipment in various protection schemes.



To overcome the challenges of the project complexity and the broad regional extent of the study area, Quanta Technology, in collaboration with the modeling software vendor, demonstrated feasibility of applying an automated and unified analysis approach using the advanced protection modeling and coordination analysis capabilities of the modeling software package. As shown in the following study diagram, the approach included design and implementation of customized sensitivity and coordination macros, which could be applied to each line (or sets of lines) to investigate protection system performance. The performance evaluation was according to pre-determined evaluation criteria and coordination requirements, which were derived from the utility's best practices and applicable protection design standards (ie, NERC/FERC, IEEE). With the system model completed and the sensitivity and coordination macros developed, a two-step approach was utilized to check and improve relay settings. First, the sensitivity macro was applied to investigate sensitivity of as-found protective relay settings. This sensitivity study included step distance, time overcurrent and various fault detectors for direct tripping, supervision and breaker failure for various fault conditions normal and N-1 or N-2 scenarios. For the second step, the coordination macro was applied using as-found settings enhanced with revised settings from Step 1, to analyze coordination between relay systems on adjacent parts of the transmission system. This step uses sequence-of-event analysis by applying multiple faults to a study line and all adjacent lines that terminate at local or remote terminals and with lines mutually coupled to the main line under normal and N-1 or N-2 conditions. Protective relay actions and coordination time intervals are determined by comparing the fault clearing time of primary protection versus predicated operating time of the backup and breaker failure protection. Step distance and time overcurrent devices were considered and setting adjustments were fed into the model to resolve critical protection coordination deficiencies.

This project has provided National Grid with highly valuable protection system evaluation results and led to uncovering of problematic situations needing immediate corrective actions, which if not identified could have caused over-tripping and potential miss-operation. The ability to accurately model complex vendor-specific protective relays (rather than conventional generic protection schemes), incorporating detailed trip logic and numerous protection settings, as well as automatic reclosing and breaker failure schemes introduced a superior analysis approach that can provide additional levels of sensitivity checks and coordination tests.

For further information about this project, the tools used, and Quanta Technology's protection/coordination capabilities, please contact Dr. Farid Katiraei (fkatiraei@quanta-technology.com

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

Lisa M. Beard

Lisa Beard has recently joined Quanta Technology and is serving as a Program Manager for synchrophasor-related Smart Grid Investment Grant projects. She has more than 30 years of utility industry experience. Lisa is recognized throughout the world as leader in synchrophasor related research and applications. She currently serves on the Leadership Team of the North American SynchroPhasor Initiative (NASPI) and is the Co-Chair of Research Initiative Task Team.

Ms. Beard previously worked for the Tennessee Valley Authority. She was a Program Manager for Transmission Technologies projects including:

- Phasor measurement unit (PMU), enhanced , state estimator
- Oscillation monitoring system using PMUs
- Frequency network (FNET) monitoring to detect and locate system disturbances
- Reactive reserves modeling
- Wide area, situational awareness monitoring

Hans J. Candia

Quanta Technology announces the recent addition of Hans Candia, Sr. Director Energize Service Practice/ Operation Design. Hans has over 28 years of experience in the Transmission Power Industry and has held technical and management positions in utilities and major worldwide leading technology vendors. He has successfully led and managed engineering and commissioning teams for the execution of national and international multimillion transmission substation turnkey projects. He is result-driven and is recognized for his abilities to meet challenges in the planning and execution of large local and international transmission/substation turn-key projects. He is an experienced hands-on manager, managing multidiscipline technical teams, project execution teams, transmission operations teams, systems after-sales teams and contractors. He has been a member of large international firm's leadersh execution strategy team He has been a member of university advisory boards.

Dr. Swakshar Ray

Dr. Swakshar Ray rejoins the Quanta Technology staff with over 4 years of industrial experience. In 2008, Dr. Ray worked on system study at Quanta Technology as a Senior Engineer. He left for one year to research wide area control for FACTS devices using remote PMU measurements at ABB Corporate research, Sweden. His expertise in FACTS devices, wide area measurement and control using PMUs, power oscillation damping controller design and system stability analysis will be a true asset to Quanta Technology.

Waylon Parham and Mary Cornwall

Quanta Technology also welcomes **Waylon Parham**, Controller and **Mary Cornwall**, Sales and Marketing Analyst.

Both Waylon and Mary are exceptional additions to this elite team and we are happy to have them onboard.

Dr. Vasudev S. Gharpure

Dr. Vasudev Gharpure joins Quanta Technology with over 27 years of industrial and academic experience in three countries. He has designed the hardware and firmware for digital and analog protection relays, phasor measurement unist, power system stabilizers and other real time embedded systems based industrial products. His areas of interest and expertise are in protection and control of power systems, power electronic based utility applications such as static VAR and other FACTS-based systems, embedded control applications, motor controls, numerical algorithms, automation and automated test equipment.

Dr. Reza Rastegar

Quanta Technology announces the recent addition of Dr. Reza Rastegar. Reza has more than 10 years of experience in the field of power system transmission and distribution. His experience includes studies and research in power quality, power system analysis and optimization, grounding systems, pipeline grounding and electrical interference mitigation, and arc flash analysis.

Dr. Anatoliy Meklin

Dr. Anatoliy Meklin joins Quanta Technology with more than 39 years of experience in the fields of electric power system analysis, transmission planning, operation and emergency control technique for providing reliability and stability. He worked for more than 20 years at the Engineering and Research Institute of Electric Power Systems St. Petersburg, Russia. Starting from relay projects, Anatoliy became an expert in emergency control systems for preserving system integrity and stability, controlled islanding, as well as electric power system analysis, justifying the control solutions.

Dr. Panitarn Chongfuangprinya

Panitarn has expertise in the field of data mining and nonparametric statistical process control under nonnormality scenarios. He also has a broad background in enterprise analysis, financial analysis and asset management. Prior to joining Quanta Technology in 2010, he worked at The University of Texas at Arlington as a graduate teaching/research assistant.

Recent QT Publications

"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

"Capacity Credit Value of Wind in a Balanced Portfolio"
by Johan Enslin, Bhavya Gudimetla, & Ramakumar, RG

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

Please Join Us

- **Power Systems Research Center (PSERC)**
  May 25 – 26 Pullman, WA
- **NASPI Work Group Meeting - International Deployments of Synchrophasor Technology**
  June 8-9 Vancouver, British Columbia
- **CEATI Distribution Planning Workshop 2010**
  June 9-10 Toronto, Ontario Speakers: Luther Dow and Julio Romero Aguero
- **IEEE PES General Meeting**
  July 25-29 Minneapolis, MN
- **Engineers and Engineering Managers Conference**
  July 26-28 St. Maarten, N.A.
- **CEATI Grounding & Lightening Workshop, 2010**
  Sept. 12-14 Montreal, Quebec Speakers: Jim Burke, Tao Hong
- **Autovation, 2010**
  Sept. 12-15 Austin, TX Speaker: Hahn Tram

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

Upcoming QT e-News Feature Articles

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

Summer 2010

- Maintenance/Testing Strategy for Smart Grid Devices
- Benchmarking System Protection for ERO Compliance
- Optimization Strategy for Home Automation and Demand Response

Autumn 2010

- Grid Energy Storage Approaches for Renewable Generation
- Energized Transmission Maintenance and Construction with Robotics

About Quanta Technology

Quanta Technology, LLC, headquartered in Raleigh, NC, is the high-growth, 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 approaching $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.

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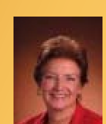

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