

First Texas Electric Energy Forum: Partnership for Electricity Research

Key players involved with the electric power industry in Texas and the nation met for the first Texas Electric Energy Forum: Partnership for Electricity Research



at the Annenberg Presidential Conference Center, Texas A&M University in November, 2004.

Hosted by Texas A&M's Department of Electrical Engineering and EPPEI, the forum's discussion dealt with research needs and partnership opportunities to assure efficient, reliable power for the state and nation for the next 20 years.

Organized through a collaboration of seven Texas universities, the forum's major aims were to identify research needs, showcase faculty research programs in participating universities and foster communication leading to partnerships between industry, universities and government. The participating universities all have electric power and power electronics programs, and along with Texas A&M include the University of Texas at Austin, the University of Houston, Texas Tech University, the University of Texas at Arlington, the University of Texas at El Paso and Texas A&M University-Kingsville.

Speakers at the plenary session which kicked

off the event included Patrick Wood III, chairman of the Federal Energy Regulatory Commission; Michehl Gent, president and CEO, North American Electric Reliability Council;

T.J. Glauthier, president and CEO, Electricity Innovation Institute; and William Parks, acting director, Office of Electric Transmission and Distribution in the U.S. Department of Energy.

The next session focused on the immediate development opportunities and research needs for the next five years. Featured speakers were (pictured from left): Brett Perlman, moderator; Sam R. Jones, Executive VP and Chief Operating Officer, ERCOT; Douglas J. Mader, Director, Technology Delivery, Entergy Services, Inc.; Don Cortez, VP of Distribution Support, CenterPoint Energy; Donna N. Geiger, Governor's Advisor, Budget, Planning & Policy Office of the Governor of Texas; and Julie Parsley, Commissioner, PUC of Texas.

Jimmy Glotfelty of ICF Consulting discussed the Texas Opportunity for Federal R&D during lunch.

The third session focused on the long-term future opportunities and research needs from the next

contd. page 3

Texas Consortium for Electric Energy (TxCEE) Research

From the Texas Electric Energy Forum, a new consortium was formed, the Texas Consortium for Electric Energy (TxCEE) Research.

The objective of this consortium is to explore the opportunities in Texas for its unique focus in electricity research and utilize Texas universities' expertise.

Some of the opportunities in Texas include: ERCOT's independent electricity grid, which is unique in its size and mode of operation. Therefore it is hoped that through field demonstrations and system studies, the ERCOT grid research can be applicable for future grid developments throughout the nation.

Versatile renewable resources also are available throughout Texas, which include wind, solar, biomass and geothermal energy resource potential. This creates an opportunity for demonstration of these resources and transportation of the power, from remote locations to rural centers.

Experiences with On-site Generation from Texas' petrochemical base creates a unique test bed environment for demonstrating and evaluating new technologies and system studies for distributed generation and microgrid designs, stand alone operation and grid interfacing.

A High-Tech Industrial Base requires reliable power supply and it is essential for developing 21st century power generation. Therefore Texas offers distinctive opportunities for demonstrating the relationship between electricity research and high-tech technology development.

In addition, major Texas universities have nurtured their power programs starting in the 60s, and this strategy has paid off, since the collective expertise of Texas universities in power systems is ranked among the best in the nation. The research topics these universities offer include: advanced power grid operation for enhanced reliability, intelligent demand-side load management for improved efficiency, renewable energy resources for sustainable electricity generation and distributed electricity generation for increased security.

EPPEI Recognizes...

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For more details, visit us at
<http://eppe.tamu.edu/>.

EPPEI Faculty

Dr. Ali Abur	Dr. Garng Huang
Dr. Karen Butler-Purry	Dr. Mladen Kezunovic
Dr. Mehrdad Ehsani	Dr. B. Don Russell
Dr. Prasad Enjeti	Dr. Chanan Singh

Dr. Hamid Toliyat

Awards and Honors

- Karen Butler-Purry was a keynote speaker at the 76th National Technical Association (NTA) Conference student luncheon. She also presented the third lecture in the "First Friday Lecture Series", which is a program of the African American Professional Organization sponsored by the Office of the Vice President for Research. Butler-Purry, also received the Shell Oil Company Faculty Fellow from the Dwight Look College of Engineering.

- Mark Ehsani was named inaugural holder of one of two Robert M. Kennedy '26 Professorships in Electrical Engineering.

- Prasad Enjeti was named the inaugural holder of the TI Professorship in Engineering.

- Hamid Toliyat was named a Texas Engineering Experiment Station (TEES) Fellow by the Dwight Look College Of Engineering.

- A Former Texas A&M Electrical Engineering Ph.D. student from the Power group, Dr. Annette von Jouanne, was honored as the recipient of the Outstanding Teacher Award for 2005 at the Eta Kappa Nu annual awards dinner in March.

Lab Improvements

Power Engineering Lab

Hardware

2 GPIB cards from NI
8 new workstations DELL
OPTIPLEX GX260
(Pentium 4 2.4G/512M/
80G)

Software

ATP Draw 3.7 (free
software)
CAPE 2005
Matlab 6.5
MS Office XP
Netomac 2003
GE PSLF 14.0
Symantec Ghost 7.5

EPPEI Graduate Student Travel Grants

EPPEI provides matching support travel grants up to \$500 for undergraduate and graduate students for attendance of professional meetings. The following students are the recipients so far this year:

Salih Baris Ozturk, Bilal Akin and **Salman Talebi** received travel grants for the 2005 International Electric Machines and Drives Conference.

Hongbiao Song, Xu Luo, Nan Zhang, Fabian Uriarte, Matthew Marroti and **Mirrasoul Mousavi** received travel grants for the IEEE PES General meeting.

Jeffrey Wischkaemper and **Karthick Manivannan** received travel grants for the IEEE T&D Conference and Expo.

From the Editor...

Our Electric Power and Power Electronics (EPPE) group has achieved many important objectives since the last newsletter was issued. At more than 250 enrollments in the four undergraduate courses, our undergraduate enrollment is growing. The number of graduate students is steady at more than 60 students.

The research activity is strong, in particular through PSerc, which has awarded to EPPE



researchers three projects that started in June 2004 and three more that will start in June 2005.

And as a result of all the activities, our faculty and students received several distinguished recognitions over the last year. In summary, the past year was another one to be proud of.

Mladen Kezunovic

EPPE Group Publications based on PSerc Activities

This past year EPPE faculty members have generated a list of publications as a result of PSerc research. These publications are listed below and can be downloaded from the PSerc website at www.pserc.org.

A Study of Synchronized Sampling Based Fault Location Algorithm Performance under Power Swing and Out-of-step Conditions, Nan Zhang and Mladen Kezunovic; *Coordinating Fuzzy ART Neural Networks to Improve Transmission Line Fault Detection and Classification*, Nan Zhang and Mladen Kezunovic; *Static Analysis of Vulnerability and Security Margin of the Power System*, Hongbiao Song and Mladen Kezunovic; *Improving Real-time Fault Analysis and Validating Relay Operations to Prevent or Mitigate Cascading Blackouts*, Nan Zhang and Mladen Kezunovic; *Optimal Placement and Utilization of Phasor Measurements for State Estimation*, Xu Bei, Yeo Jun Yoon and Ali Abur; *Automatic Simulation Of IED Measurements For Substation Data Integration Studies*, Yang Wu and Mladen Kezunovic; *Requirements Specification for and Evaluation of an Automated Substation Monitoring System*, Mladen Kezunovic and G. Latisko; *Automated Analysis of Digital Relay Data Based on Expert System*, Xu Luo and Mladen Kezunovic; *Automated Analysis of Protective Relay Data*, Mladen Kezunovic and Xu Luo; *Fault Analysis Based on Integration of Digital Relay and DFR Data*, Xu Luo and Mladen Kezunovic; *Interactive Protection System Simulation Using ATP MODELS and C++*, Xu Luo and Mladen Kezunovic; *Static Security Analysis based on Vulnerability Index (VI) and Network Contribution Factor (NCF) Method*, Hongbiao Song and Mladen Kezunovic; *A Novel Digital Relay Model Based on SIMULINK and Its Validation Based on Expert System*, Xu Luo and Mladen Kezunovic; and *Implementing an Advanced Simulation Tool for Comprehensive Fault Analysis*, Nan Zhang and Mladen Kezunovic.

Students visit ERCOT/CenterPoint Energy

Undergraduate and graduate students had a very informative experience during two field trips to the Operations Center of Electric Reliability Council of Texas (ERCOT) in Taylor. The goal of the field trips was to give the students a better understanding of the operations of the power grid of Texas, and its central monitoring and control facilities.

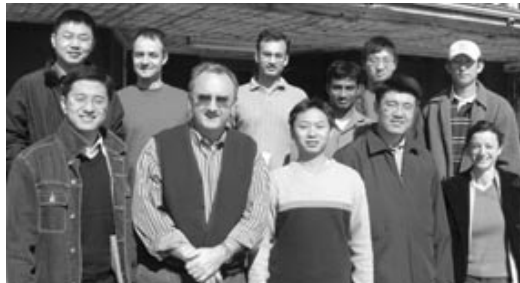
The first tour was guided by Sam R. Jones, Executive VP and Chief Operating Officer of ERCOT, who showed a 679 "Computer Relays" class around the facility. John Adams, Senior Engineer of ERCOT, described the facilities to students from a 460 "Power System Operation and Control" class during the second tour.

During the tours the students saw the central control room and learned about the operations of Texas' main power grid. Technical information was given regarding the interconnected systems, power system operation and control, concepts of power flow and state estimation.

Students also saw the maintenance facilities and the computer room and learned the significance of each piece of equipment.

As one of 10 regional reliability councils in North America, ERCOT is entrusted to keep electric power flowing to approximately 20 million Texans, representing 85 percent of the state's electric load and about 75 percent of the Texas land area. As the Independent System Operator for its region, ERCOT manages the scheduling of power on an electric grid consisting of 78,000 megawatts of generation capacity and 38,000 miles of transmission lines.

During a third field trip, students understood the abstract concepts of the ELEN 459 Power System Fault Analysis and



Protection class better after a very informative visit to the CenterPoint Energy Tomball Substation. The goal of the field trip was to give students an understanding of the utility substation apparatus and physical layout, as well as learning to

protect, monitor and control the equipment.

The first part of the tour was in the CenterPoint Energy Service Center in Cypress, Texas, where Sandra Vasquez briefly introduced the company and the company structure, followed by Don Sevcik's presentation about the technical services of the company and safety reviews by two senior engineers. Next the students were given a tour of Tomball substation. Here, the students had a chance to view the switchyards (12 kV, 35 kV, 138 kV & 345 kV) and the control houses. The technicians and senior engineers provided a very detailed description of the substation apparatus.

CenterPoint Energy is one of the largest combined electricity and natural gas delivery companies with almost five million metered customers. With more than 11,000 employees, CenterPoint Energy and its predecessor companies have been in business for more than 130 years. CenterPoint Energy is the third largest energy company employer in the greater Houston metropolitan area. CenterPoint Energy's electric operations unit serves 1.82 million customers in a 5,000-square-mile area that includes Houston, the nation's fourth largest city.

Contd. from page 1

five to 20 years. Featured speakers included Charles Jenkins, VP for Grid Management for TXU Electric Delivery, Cliff Braddock, Director, Energy Business Development, Austin Energy, Trudy Harper, President and General Manager of Tenaska Power Service Co. and Walter Hornaday, President, CIELO Wind Power. Alison Silverstein was the moderator.

The fourth session was moderated by Dr. B. Don Russell. During this session Research and Education issues in the power programs was discussed. Featured speakers included Ross Baldick, The University of Texas Austin, Paul Chu, University of Houston, Michael Gisselmann, Texas Tech, Mladen Kezunovic, Texas A&M University and Wei-Jen Lee, The University of Texas Arlington.

The next day an introduction of the Electric Power and Power Electronics Programs at Texas Universities was given along with presentations of research programs by individual faculty members, and there was a round table discussion about the opportunities for future research cooperation. For more on the forum, visit <http://eent1.tamu.edu/txeef/>.

Faculty Research Feature-This and future issues will highlight joint research projects of EPPEI faculty aimed at solving multidisciplinary problems

PSerc project : Enhanced Reliability of Power Systems Operation Using Advanced Algorithms and IEDs for On-Line Monitoring

This project, led by Drs. Mladen Kezunovic and Ali Abur, is a PSerc project that was taking place during June 2002-May 2005. The project goal was to demonstrate the multiplicity of benefits that can potentially be achieved by both the substation and control center applications, as a result of utilizing data from Intelligent Electronic Devices (IEDs).

DATA INTEGRATION AND INFORMATION EXCHANGE

A new approach of substation data integration and information exchange (DIIE) is introduced to enhance the existing substation automation practices and enable introduction of new applications. The list of new applications made possible by utilizing the DIIE concept is given as follows:

- Automated digital fault recorder data analysis (DFRA)
- Automated circuit breaker monitor data analysis (CBMA)
- Automated power quality meter data analysis (PQMA)
- Automated digital protective relay data analysis (DPRA)
- Verification of IED data stored in substation database (VSDB)
- Two-stage state estimation (TSSE)
- Substation Switching Sequences Verification (SSSV)
- System-wide fault analysis including fault location (FAFL)

PARAMETER ERROR DETECTION AND IDENTIFICATION

State estimation plays a key role in today's Energy Management Systems by providing the reliable network data and operating point

information to all the application functions used in the control center.

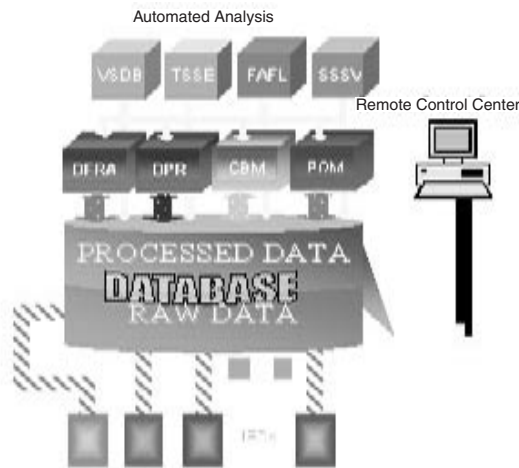
The performance of the state estimation depends on the accuracy of the measurements as well as the network parameters. State estimators are usually equipped with appropriate bad data identification functions which analyze state estimation results in order to detect and identify gross errors in the measurements. This function assumes that the network parameters are perfectly known.

However, it is well known that any errors in the line impedance or transformer tap values will lead to biases in the estimated state. Such errors are inevitable and may be due to inaccurate data input, changes in environmental conditions, etc.

In this project, a new parameter error detection and identification procedure is developed. This method is based on the Lagrange multipliers of the parameter constraints.

The main advantage of this method is that the normalized residuals for bad data analysis and the Lagrange multipliers for parameter errors can be computed simultaneously, hence making it possible to distinguish between measurement and parameter errors.

Simulations of the proposed method are carried out on various test systems and results confirmed the effectiveness of the method in identifying parameter errors in power systems. The method can be easily incorporated into the existing state estimators since it does not modify the formulation of the main state estimation problem.



The architecture of the new system is shown in the figure.

Theses

Zhu, Jun, 08/04, "Analysis of transmission system faults in the phase domain," Chair: A. Abur.

Harfman-Todorovic, Maj, 12/04, Chair: P. Enjeti

Bogdan, Naodovic, 05/05, Chair: M. Kezunovic.

Dissertations

Abolhassani, Mehdi, 05/04, "Integrated electric alternators/active filters," Chair: H. Toliyat.

Cha, Han Ju, 08/04, "Analysis and design of matrix converters for adjustable speed drives and distributed power sources," Chair: H. Toliyat.

Choi, Woojin, 08/04, "New Approaches to Improve the Performance of the PEM Based Fuel Cell Power Systems," Chair: P. Enjeti.

Ding, Qifeng, 12/04, "Optimal meter placement and transaction-based loss allocation in deregulated power system operation," Chair: A. Abur.

Gay, Sebastien, 05/05, "Contactless Magnetic Brake for Automotive Applications," Chair: M. Ehsani.

Jeraputra, Chutthaval, 12/04, "Investigation of Anti-Islanding Schemes for Utility Interconnection of Distributed Fuel Cell Powered Generations" Chair: P. Enjeti.

Kwak, Sangshin, 05/05, "Design and Analysis of Modern Three-Phase AC/AC Power Converters for AC Drives and Utility Interface," Chair: H. Toliyat.

Qi, Li, 12/04, "AC System Stability Analysis and Assessment for Shipboard Power Systems," Chair: K. Butler-Purry.

Nader, Amin Aziz Samaan, 08/04, "Reliability assessment of electric power systems using genetic algorithms," Chair: C. Singh.

Nair, Nirmal-Kumar C., 08/04, "Incorporating Voltage Security into the Planning, Operation and Monitoring of Restructured Electric Energy Markets," Chair: G Huang.

Parsa, Leila, 05/05, "Performance Improvement of Permanent Magnet AC Motors," Chair: H. Toliyat.

Ratanapanachote, Somnida, 08/04, "Applications of Electronic Transformers in Electrical Power Systems," Chair: P. Enjeti.

Song, Yu Jin, 08/04, "Analysis and Design of High Frequency Link Power Conversion Systems for Fuel Cell Power Conditioning," Chair: P. Enjeti.

Zhao, Liang, 12/04, "Multi-area network analysis," Chair: A. Abur.

In Other News...EPPEI faculty new and ongoing contracts & grants

- NSF/PSerc Grant, "Reliability Based Vegetation Management Through Intelligent System Monitoring," June 2005-June 2007, PI: D. Russell, Co-PIs: C. Benner, J. McCalley and W. Jewell.
- NSF/PSerc Grant, "Digital Protection System Using Optical Instrument Transformers And Digital Relays Interconnected By An IEC 61850-9.2 Digital Process Bus," June 2005-June 2007, PI: M. Kezunovic, Co-PI: G. Karady.
- NSF/PSerc Grant, "Transient Testing of Protective Relays: Study of Benefits and Methodology," June 2005-June 2007, PI: Dr. M. Kezunovic, Co-PIs: S. Meliopoulos and W. Jewell.
- NSF/PSerc Grant, "Automated Integration of Condition Monitoring and Maintenance Scheduling for Circuit Breakers and Power Transformers," PI: J. McCalley, Co-PIs: M. Kezunovic, C. Singh and V. Honavar.
- NSF/PSerc Grant, "Enhanced Reliability of Power System Operation Using Advanced Algorithms and IEDs for On-line Monitoring," June 2002-June 2005, PI: M. Kezunovic, Co-PIs: A. Abur, S. Meliopoulos and R. Shoureshi.
- NSF/PSerc Grant, "Detection, Prevention and Mitigation of Cascading Events," June 2002-June 2005, PI: V. Vittal, Co-PIs: M. Kezunovic and M. Venkatasubramanian.
- NSF/PSerc Grant, "MicroGrid Protection and Control," June 2002-June 2005, PI: R. Lasseter, Co-PI: M. Kezunovic.
- NSF/PSerc Grant, "Smart Sensor Development for Power Transmission and Distribution," June 2002-June 2005, PI: M. Simoes, Co-PIs: M. Kezunovic and R. Shoureshi.
- NSF/PSerc Grant, "Extended State Estimation for Synchronous Generator Parameters," June 2002-June 2005, PI: G. Karady, Co-PIs: G.T. Heydt, K. Holbert, V. Vittal, C. Singh and G. Huang.
- NSF/PSerc Grant, "Reliability Assessment Incorporating Operational Considerations and Economic Aspects for Large Interconnected Grids," 2004-2006, PI: G. Gross, Co-PIs: C. Singh, S. Meliopoulos and R. Schuler.
- Honeywell, "Vehicle Power and Energy Research," 2001-2008, PI: M. Ehsani.
- NSF, "Importance based visualization of energy networks," June 2003-May 2005, PIs: A. Abur and E. Akleman.
- "Hybrid drive train based on StarRotor engine research," PI: M. Ehsani.
- "Hybrid and advanced vehicle survivability research," PI: M. Ehsani.
- "Development of sensorless control techniques for brushless DC motor drive," PI: M. Ehsani.
- "Maximization of brushless DC generator power throughput," PI: M. Ehsani.
- "Load vibration damping using motor drive control," PI: M. Ehsani.
- "Oscillatory motor research," PI: M. Ehsani.
- NSF, "Impact Analysis and Development of New Protection Schemes for Distributed Generators in Distribution Systems," 2002-2005, PI: K. Butler-Purpy.
- Texas Higher Education Coordinating Board, "Improving the Quality, Quantity and Diversity of Electrical and Computer Engineering Graduates," 2004-2006, PI: C. Singh.

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