DR. CHARLES W. HANSEN, PH.D.

QUALIFICATIONS

Dr. Hansen offers a diverse knowledge base due to his active involvement in multiple facets of the electric power industry. Energy markets, Operational and Planning Studies, Energy Control Centers and real-time operations, training, Operator Training Simulators and management are his most recent endeavors. Specifically, he has extensive experience in long-term planning and reliability studies, integration of renewable energy sources, energy market development, real-time operational tools and systems, software tool development, team management, and training development and delivery.

Dr. Hansen is a strong technical leader, an effective communicator at all levels, with strong writing, speaking and presentation skills. Dr. Hansen has consistently demonstrated that he can work well independently or as a member of a team.

Dr. Hansen offers extensive experience and expertise in:

- Reliability and planning studies
- Energy simulation studies
- Development and testing of simulation software
- Energy Markets, Congestion Management and Ancillary Services, FTRs
- Integration of renewable energy sources, and their impact on real-time operations and long-term economics
- Long-term valuation of generating resources, especially considering impact of future renewable energy resources
- Optimization, Day-Ahead and Real-Time clearing, SCUC, SCED
- Certified NERC Reliability Coordinator
- CIM Model
- Training, including development and delivery
- Automatic Generation Control
- Emergency Operations, Communication Protocols and Standards, ICCP
- State Estimation
- EMS Advanced Applications, including Contingency Analysis & Optimal Power Flow
- NERC IDC, NERC E-Tagging
- AREVA DTS, ABB OTS and EPRI Operator Training Simulator

EDUCATION

- Ph.D. in Electrical Engineering, Georgia Institute of Technology, Atlanta, GA, December 1993.

Thesis: Model Enhancements for State Estimation in Electric Power Systems.
- Minor in Mathematics, Georgia Institute of Technology, Atlanta, GA, December, 1993.
- Research Assistant: Dr. Atif Debs (1989-93).

Research Topics: Three-phase system models for state estimation, measurement system models, ill-conditioning considerations, and robust load flow techniques.

- Teaching Assistant for undergraduate EE power lab.

- Bachelors of Science, Electrical and Computer Engineering (ECE) and Mathematics, University of Wisconsin, Madison, WI, 1988.

EMPLOYMENT HISTORY

ECCO International, Inc.

Senior Consultant, December 2007 – Present

ISO-New England

Dr. Hansen worked in the ISO-New England Business Architecture and Technology (BAT) group on several studies to enhance the efficiency of their markets. The first effort involved the tuning and benchmarking of a Unit Commitment simulator, to replicate the behavior of their production Reliability Market software. Next, Dr. Hansen helped study the economic impacts of proposed changes to the Unit Commitment objective function, including a change from a commitment-cost objective to a production-cost one. He also assisted ISO-NE to study the impact of virtual bidding on Unit Commitment uplift charges in the ISO-NE market.

- Used energy simulation software to study multiple years of ISO New England market performance, including Day-Ahead Market, Reliability Unit Commitment (RUC), and Real-Time Economic Dispatch.

- Studied economic benefits of switching RUC Optimization Objective to include full unit production costs, including impact on LMPs and uplift payments.

- Analyzed performance of ALSTOM RUC software in real-time operations, especially regarding the commitment of varying generator technologies (oil, peakers, combined-cycle, etc.)

- Analyzed impact on uplift (make whole) payments caused by virtual bids and offers.

Southern California Edison, USA

- Assisted in the development of market simulations by deploying ECCO's ProMaxLT™ platform to predict future congestion and energy pricing.

- Developed bid stacks for numerous generators/resources that participate in the CAISO market, including combustion turbine, combined-cycle, nuclear, and hydro plants. Historical bids were correlated to spot gas prices, and related economic factors.

- Developed bid stacks for intertie points, based on historical pricing, transmission constraints, and publicly available market bids

Public Power Corporation (PPC), Greece

- Conducted studies by deploying ECCO's ProMaxLT™ platform to determine future valuations of fossil-fuel plants in Greece, subject to variations in fuel prices, emission prices, water inflows for hydro generation, demand, and renewable energy levels. Multi-year studies were executed by deploying Monte Carlo techniques to simulate forced outages.

- Performed a study entitled: "Assessment and Economic Analysis of Wind Generation on the Ancillary Services and the Unit Commitment Process for the Island of Crete." This report:

- Described existing conditions with respect to Ancillary Services for Crete and related islands;

- Determined the type of Ancillary Services that are specifically required for Crete and related islands;

- Estimated the additional Ancillary Services specified above due to high levels of RES penetration;

- Estimated the additional costs of incorporating these increased Ancillary Services into the grid;

- Examined the impact of dumping of excess Wind Generation; and

- Examined the impact of wind generation on conventional generation commitment, production costs, and un-served energy.

Polish Transmission System Operator, PSE

Dr. Hansen led a comprehensive cost benefits analysis of implementing the new LMP-based energy market in Poland by deploying the ECCO's ProMaxLT™ platform. The scope of this work was to quantify the effects and the impacts to the energy market outcome, system dispatch, and resulting production system costs for the Polish power system under two scenarios: a status quo case ("Base Case") in which scheduling and settlement are based on the current zonal market design, and a case in which LMP based market model is implemented ("Change Case"). The work also included a quantification of the effects and impacts that the market paradigm would have on the Polish market.

TERNA, A Generator

Dr. Hansen led a major project to analyze and quantify the value of Pump Storage Hydro (PSH) facilities provides to System Operations in Greece in the presence of high penetration of Renewable Energy Resources (RES) and especially wind generation by deploying the ECCO's ProMaxLT™ platform. In this study we focused on quantifying by deploying simulations the reliability benefits PSH facilities provide to the system. The simulation was based on actual data of the Greek generation and transmission data and the current rules of the wholesale Day-Ahead energy market. As part of the study we also deployed the market prices produced from the energy simulations to calculate the capacity payments to the proposed PSH facilities along with the cost savings due to pump operation where PSH facilities pay low prices at night to pump and sell energy during the day at higher prices.

Electric Reliability Council of Texas (ERCOT): Taylor, TX (December 2007-November 2010)

Nodal Business Process and Training Coordinator Lead

- Led nodal transition team efforts to revise and enhance enterprise business processes

- Reviewed and tested nodal processes, procedures and systems, to assure readiness for Nodal Market launch

- Developed departmental training plans for ERCOT personnel during transition to Nodal Market

- Tracked training progress compared to training plan

- Developed and delivered training material for multiple internal courses, include Reliability Unit Commitment and Price Validation techniques

Market Management System (MMS) Subject Matter Expert (SME)

- Developed MMS business process designs that met design objectives;

- Developed MMS user guide, which has now become a Control Room Desktop Guide

- Ensured the quality of detailed business and technical solutions

- Proactively investigated ideas and issues related to MMS that were likely to impact ERCOT

- Participated in structured and unstructured testing of MMS applications

- Provide support to other projects as related to MMS

Wal*mart (2011)

Developed and provided training to energy traders regarding Day Ahead and Real-time markets in ERCOT

Midwest ISO: Carmel, IN

Technical Trainer, April, 2005-November, 2007

Energy Market Experience

- Lead Trainer for upcoming ancillary services market for over one hundred real-time operators. Training topics span a wide range of knowledge, including economic theory, new systems/interfaces, Automatic Generator Control, optimization theory, and updated operating procedures.

- Developed training plan and learning content for upcoming Business Process Testing for new market

- Participated in redesign of EMS interfaces, to support upcoming operating reserves market. He eviewed and offered meaningful improvements to market redesign efforts at MISO of forward markets, SCUC, real-time markets and SCED and FTRs.

- Worked closely with PowerWorld developer (vendor) to implement Midwest ISO Energy and Operating Reserves Market rules into a product upgrade

Training Experience

- Developed curriculum and content for numerous classes taught to real-time operators, power system engineers, and managers within the Midwest ISO. Topics have included Ancillary Services Market, Automatic Generation Control, Market Introduction and Congestion Market, Market to Market Operation, Emergency and Abnormal Procedure Overview, Power System Restoration, NERC IDC, Primary Control Center Evacuation, and Introduction to Voltage Control and Reactive Power Management.

- Lead trainer for real-time operators simulation classes utilizing MISO-specific scenarios on the ALSTOM DTS and generic scenarios using the EPRI-OTS.

- Tutored employees through the Midwest ISO "Fundamental of Power Systems" course.

Management Experience

- Developed NEXT STEP (control room apprentice) training curriculum

- Created Job Task Analysis (JTA) for Regional Generation Dispatcher positions

- Integrated L&K training modules in Midwest ISO intranet and Learning Management System

- Lead Trainer for upcoming ancillary services market for over one hundred real-time operators

- Assisted in EPRI Advanced Alarming prototype

- Managed nine Midwest ISO personnel and numerous consultants

- Exercised the appropriate use of over a one million dollar budget

- Developed and monitor department goals

- Implement department improvement opportunities that encompass Midwest ISO, training, and personnel goals.

- Certified NERC Reliability Coordinator

- Member of NERC Personnel Subcommittee and the ISO/RTO Trainer Working Group.

Decision Systems International, INC.:   Atlanta, GA

Senior Development Engineer, 1993-2005

Heavily involved in training, consulting, and software development in the global electric power industry.

- Taught the following classes to power system engineers, managers and marketers in all parts of the world: NERC performance criteria, utilization of the EPRI Operator Trainer Simulator, Emergency Operations, Communication Protocols and Standards, State Estimation, Automatic Generation and Control, System Optimization Techniques, and Dispatcher Load Flow.

- Served as the EPRI OTS Service Center Manager for many years.   Duties included power system model maintenance, code maintenance, website development and maintenance, and OTS customer support.

- Developed, tested and implemented multiple, integrated versions of the EPRI OTS using EMS systems of Landis & Gyr, AREVA, and CEPEL.

- Upgraded the ABB OTS to the EPRI OTS at Philadelphia Electric (PECO).

- Interfaced DSI Optimal Power Flow Model with the Common Information Model (CIM) and developed a graphical user interface.

- Instructed ONS and CHESF trainers on the effective utilization of their unique model within their in-house training program.

- Integrated EPRI OTS with ComEd power system model, developed ICCP real-time interface between the EPRI OTS and ComEd EMS, and trained Com Ed personnel on how to use their unique model for in-house training.

- Developed P-I-D unit controller which allowed the EPRI OTS to simulate isochronous(zero droop) governor mode.

- Assisted in completing a feasibility study for the Lebanese National Control Center and a new national control center for Jordan.

- Provided recommendations for the combining of operational and planning network data for a Belgian utility.

- Utilized Langrangian-Relaxation methodology and created a link to the Common Information Model (CIM) database to make the EPRI Dynamics Unit Commitment program Y2K compliant.

- Developed the EPRI ANNSTLF Short-Term Load Forecaster using an Artificial Neural Network (ANN) that predicts future load curves from predicted weather patterns and a converter program to automate the data transformation and validation process. This program interfaced with the PTI database (ODBC interface).

TECHNICAL HISTORY

Power System Industry:

- **Base Power Applications**: AGC, security constrained economic dispatch

- **Deregulation:** Energy and Operating Reserve Markets, Two-part settlements, Financial Transmission Rights, ISO operations, Transmission Reservations, NERC E-Tagging, NERC Interchange Distribution Calculator, Transmission Congestion Management and Pricing.

- **Transmission Network Applications:** power flow, optimal power flow, real-time network modeling, state estimator, contingency analysis

- **Generation Scheduling Applications**: Security Constrained Unit Commitment, Short-Term and Mid-Term Load Forecasting

Technology

- **Software, Tools & Languages**: Java, C, C++, Fortran, Visual Basic, Matlab

- **Database Experience:** PowerData Common Data Sources, SQL

- **Operating Systems**: Windows, Linux/Unix, VAX/VMS.

- **System Architecture Design:** Client/Server, Network Computing

PUBLICATIONS

1. "Operational Impact and Cost Analysis of Increasing Wind Generation in the Island of Crete", C. Hansen & A. Papalexopoulos, IEEE Systems Journal. Special Issue - Integration of Intermittent Renewable Energy Resources into Power Grid, 2011.

2. Development of an Electric Energy Market Simulator, by A. Debs, C. Hansen and Y.-C. Wu, [Contribution to book entitled, "The Next Generation of Electric Power Unit Commitment Models," B. F. Hobbs, et al (Editors), Kluwer Academic Publishers, Norwell, MA (2001)]

3. Yu-Chi Wu, Atif S. Debs, and Charles Hansen, "Simulated Extensive Optimal Power System Operations via Effective Optimization Techniques," Energy Management and Power Delivery Conference 1998, March 3-5, 1998 Singapore

4. "Enhancement of the EPRI-OTS for the Restructured Electric Utility," Final Report to NSF for SBIR Phase I project by Decision Systems International (DSI), Atlanta, Georgia, September, 1997.

5. A. Debs and C. Hansen, "The Total Power System Simulator: A Comprehensive Tool for Operation, Control and Planning," Proceedings of the Arab Electricity '97 Conference & Exhibition, organized by PennWell Europe and DSI, held in Bahrain, March 3-5, 1997.

6. A. Debs and C. Hansen, "The EPRI-OTS as the Standard for Training and Studies in the New Era: Strategy for Global Application," Presentation at the First Asia Pacific Conference on Operation and Planning Issues in the Emerging Electric Utility Environment, sponsored by EPRI and organized by DSI, held in Kuala Lumpur, Malaysia, August 11-14, 1997.

7. Electricity Supply Board - Ireland", C. Hansen, H. Jones, V. Calovic, D. Van den Akker, A. Debs, M. Foley, A. Bose, Accepted by PSSC, July 1996, Dresden, Germany.

8. "The expansion of an Energy Management System to include an Advanced Dispatcher Training Simulator in the Electricity Supply Board, Ireland", H. Jones, A.Sleator, V. Calovic, D. Van den Akker, A. Debs, C. Hansen, M. Foley, A. Bose, Accepted by CIGRE, July 1996, Paris, France.

9. "Power System Model Development and Enhancement," C. Hansen & M. Foley, EPRI Workshop and Exhibition on Power System Operation and Planning Tools, Amsterdam, The Netherlands, October, 1995.

10. "Power System State Estimation Using Three-Phase Models," C. W. Hansen and A. S. Debs, IEEE/PES 1994 Summer Meeting, San Francisco.

11. "Model Enhancements for State Estimation in Electric Power Systems", Doctoral Thesis, School of Electrical and Computer Engineering, Georgia Institute of Technology, 1993.

12. "Reactive Power Under Harmonic Conditions," Technical Memorandum, Dow Chemical, August 4, 1992.

13. "Observability and Meter Placement for an Effective State Estimation", Qualifying Examination Report, Georgia Institute of Technology, August, 1990.

AWARDS, HONORS AND ACTIVITIES

- Principal Investigator, National Science Foundation SBIR Grant
- Presidential Fellow – Georgia Institute of Technology
- Dow Chemical Graduate Fellowship (Four years)
- National Science Foundation Graduate Fellowship – Honorable Mention
- ECE Departmental Scholarship, U.W.-Madison, 1987-88
- Tau Beta Pi, Eta Kappa Nu, & Phi Kappa Phi honor societies
- Wisconsin Public Service Foundation Scholarship (1983-87)
- Member of I.E.E.E. and P.E.S. since 1987
- Chair of U.W.–Madison IEEE Student Chapter (1987-88)
  - Chapter Named Region 4 Student Chapter of The Year
- Alumnus of Kappa Eta Kappa (Electrical Engineering Fraternity)