EnerNex

Robert M. Zavadil, P.E.

Executive Vice President of Power Systems Consulting, Co-Founder

Education
B.S. Electrical Engineering, South Dakota State University

Registrations
Registered Professional Electrical Engineer, Nebraska

Affiliations
Member, IEEE Power Engineering Society

Member, IEEE Power Electronics Society

Member, IEEE Industrial Applications Society

Secretary, IEEE PES Wind and Solar Power Coordinating Committee

Experience
36 years

Biography

Bob Zavadil is responsible for developing and overseeing EnerNex's power system engineering and consulting business. Bob is a nationally recognized expert in electric power system issues for wind generation. His clients in the wind generation industry range from turbine designers and manufacturers to project developers and operators, along with transmission service providers and independent transmission system operators. He has extensive experience with new and emerging technologies for electric power generation, delivery and utilization including distributed generation and power electronics-based equipment. Bob has over twenty-five years of experience with advanced modeling and simulation tools for electric power systems, which he routinely uses in his consulting engagements to provide a comprehensive technical and analytical foundation for advice and recommendations to clients.

EnerNex Project Experience

Eastern Wind Integration and Transmission Study (EWITS) – Led the culmination of an effort that spanned two and one-half years. The study team began by modeling wind resources in a large part of the Eastern Interconnection and finished by conducting a detailed wind integration study and top-down transmission analysis. The study resulted in information that can be used to guide future work. A number of other studies have already examined similar wind integration issues, but the breadth and depth of the analysis in EWITS is unique. EWITS builds on the work of previous integration studies, which looked at considerably smaller geographic footprints, focused almost exclusively on wind integration, and did not include transmission. EWITS took the next step by expanding the study area and including conceptual transmission overlays.

Cape Wind Offshore Wind Farm Modeling, Cape Wind Associates – Provided support in developing a custom model for an off-shore wind farm to be built in Nantucket Sound, the first-ever facility in the United States. The model will be used by NSTAR, the local utility, to perform steady-state power flow and dynamic stability studies using the PSS/E analysis software. The model incorporates control and protection functions specific to the turbine technology utilized, in this case the GE Wind 3.6 MW turbine, as well as the associated underwater collection system. In addition to facilitating the construction of this pioneering wind generation facility, the model should serve as a basis for the development of future land-based and offshore wind projects.

Wind Integration Study, Xcel Energy/Minnesota Department of Commerce – Served as the project and technical lead for this study, which focuses on the potential technical and

economic impacts of operating up to 1,500 MW of wind generation on Xcel Energy's system in Minnesota, North Dakota, South Dakota, Wisconsin and Michigan. Building on a previous wind integration study conducted by the Utility Variable-Generation Integration Group (UVIG), this project is analyzing the impacts of significant amounts of large-scale wind generation on the real-time operations and short-term planning of Xcel Energy's electric power system. These functions are critical to reliable and economic operation of interconnected power systems and represent tangible costs to the utility. Key components of the project include accurate modeling and forecasting of wind patterns with simulation and analysis of power system operations. The overall effort began with a thorough science-based investigation of the wind patterns in Xcel Energy's control area in the Upper Midwest to yield the most accurate models possible. Wind generation forecast accuracy was also evaluated with the results forming a basis for the power system operational analysis.

Wind Integration Study, Xcel Energy/Public Service Company of Colorado (PSCo) – Directed a wind integration study for Xcel Energy's control area in Colorado. Techniques developed in the 2004 study for Xcel Energy were augmented and expanded to consider the impacts of significant wind generation on the scheduling and operation of PSCo's supply portfolio. Of particular interest was the effect of wind variability and uncertainty on the day ahead nomination of natural gas for PSCo's gas-heavy generation portfolio. As with the earlier Xcel study, a formal technical review team was assembled to guide and critique the project as it unfolded.

Wind Plant Interconnection Support, Nebraska Public Power District (NPPD) – Provided support on a number of tasks to facilitate the interconnection of a proposed 60 MW wind farm. Reviewed NPPD's interconnection guidelines and process for conducting interconnection studies, recommended changes to address technical issues relating to the intermittent nature of wind generation and provided support for modeling and simulation activities to support the interconnection study process. Also analyzed like dynamic reactive power compensation schemes that might come into play for various interconnection scenarios.

Wind Integration Study, New York State Energy Research and Development Authority (NYSERDA) – Provided consulting support to the NYSERDA on a high penetration wind integration study for New York State. Offered advice and recommendations on study scope and approach, wind turbine and wind plant models to be used by the study contractor and provided ongoing support on analysis of the study results.

Study of Wind Power Impacts on Power System Operation, Utility Variable-Generation Integration Group (UVIG) – Played a key role in this research project to determine the impact wind generation has on the real-time operations and short-term planning of electric power systems. Funded by UVIG, the Electric Power Research Institute (EPRI), Xcel Energy,

Western Area Power Administration (WAPA), the American Public Power Association and the National Rural Cooperative Association, this study examined this impact, which can compel utilities to charge wind plant owner/operators for the perceived cost of additional cost capacity, an economic barrier to broader deployment of wind as a generation source. The study focused particularly on the Bonneville Power Administration and Northern States Power (Xcel Energy) power systems. The study calculated costs of ancillary services due to additional regulation duty load following and operating reserve requirements.

Missouri River Wind/Hydro Integration Analysis, US Department of Energy National Renewable Energy Laboratory (NREL) – Bob is leading this project to qualitatively assess the impact of significant wind generation on the operation of the WAPA's control area, especially considering the economic impacts on hydropower, which constitutes a significant amount of the generation base. EnerNex is determining the level of wind generation that can be accommodated by the current generation deployment scenario for ancillary services such as regulation and load following or real-time balancing. A key goal of this project is to identify the constraints on the Missouri River system that could further limit wind generation deployment due to control area operating issues, explore ways to maximize availability of the hydroelectric system to provide ancillary services for wind generation and to provide recommendations on how the study findings can be utilized to investigate transmission capacity within and outside the WAPA control area.

System Analysis and Expert Testimony Support – ISO New England and Northeast Utilities – EnerNex played a key role in this effort to perform extensive harmonic and transient analysis of the southwest Connecticut power system on behalf of ISO-New England and Northeast Utilities (the operating companies) to evaluate the maximum amount of underground 345-kV cable that could safely be used in a major expansion of that system. The analysis required running tens of thousands of cases and developing the automation systems to validate and process the results. Bob provided expert testimony on the results to the Connecticut Siting Council which is the body with the authority to approve the expansion of project design. Key elements of the testimony included devising a method to graphically and intuitively describe complex electromagnetic phenomena to an audience of widely varying backgrounds. The Connecticut Siting Council ultimately approved the project as recommended by the operating companies, EnerNex, and the other consultants involved in the project (GE Power Systems and PB Power).

Later, Bob conducted a feasibility study for ISO-New England on a proposed generator expansion in the area, which involved an additional 345-kV cable. Electromechanical dynamic models of these generators, including the excitation systems, were included in the transient overvoltage studies.

Expert Testimony for Patent Infringement Suit – Provided expert witness testimony in a patent infringement suit (Kenetech Corporation vs. Enercon GMB, United States International Trade Commission, Investigation No. 337-TA-376) for a domestic wind turbine manufacturer.

Previous Professional Experience

Electrotek

At Electrotek, Bob consulted for a number of Electrotek clients, including EPRI, the NREL, major U.S. electric utilities, and private corporations. His technical responsibilities included distribution system and end-user power quality and power electronics, motor and drive technology and applications, power quality and power quantity measurements and renewable energy applications. Bob managed technical operations in Electrotek's Mountain View, California office from late 1992 until 1996, when he transferred to a sister company, Basic Measuring Instruments (BMI). In 1997, he returned to Electrotek. In addition to consulting, Bob's responsibilities included new corporate product development, sales and marketing of Electrotek products and services and development of new business areas and ventures. Highlights of consulting activities at Electrotek included:

- Contributor to a series of projects directed at determining the impacts of substantial amounts of intermittent wind generation on the real-time operations and short-term operations planning functions of utility control areas. The basic analytical and simulation methodologies were extended to cover the full range of possible impacts (from unit governor operations to weekly unit commitment) or application to the Big Island of Hawaii.
- Served as Secretary of EPRI-sponsored National Motor and Drives Steering Committee. This committee was founded by EPRI to provide a forum for electric motor and drive users, researchers and manufacturers to discuss and exchange information on motor drive market needs, technology, research and applications. As Secretary, Bob was responsible for coordinating all aspects of the committee's activities, including meetings, technical presentations and working group activities (1991 - 1995).

Publications

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