STATE OF CONNECTICUT

CONNECTICUT SITING COUNCIL

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December 16, 2004

TO: Parties and Intervenors

FROM: S. Derek Phelps, Executive Director

RE: **DOCKET NO. 272** - The Connecticut Light and Power Company and The United Illuminating Company application for a Certificate of Environmental Compatibility and Public Need for the construction of a new 345-kV electric transmission line and associated facilities between the Scovill Rock Switching Station in Middletown and the Norwalk Substation in Norwalk, Connecticut.

Enclosed herewith please find the resumes of KEMA, Inc. witnesses (CSC Exhibit 7).

SDP/laf

Enclosure

c: Council Member

Richard A. Wakefield, Ph.D.

Profession:	Senior Executive Consultant
Years of Experience:	27
Position on Team:	
Nationality:	U.S. Citizen
Date of Birth:	
Education:	Ph.D.E.E./1975/University of Washington, Seattle, Washington
	M.S.E.E./1970/University of Illinois
	B.S.E.E./1969/University of New Hampshire (Magna Cum Laude)

Key Qualifications:

Dr. Richard Wakefield has more than 25 years of experience in energy and utility systems, both as a consultant and as an independent researcher. His areas of expertise include transmission access and use; transmission costs and pricing; development and evaluation of power system expansion plans; technical and economic evaluation of new power system technologies; development of electric power data and information systems; technical and economic studies of cogeneration and decentralized power sources; and analysis of on-site power production technologies and applications.

Professional Experience:

KEMA, Inc., Fairfax, Virginia: 1998 to Present
Vice President, Transmission & Regulatory Services (2004 to Present)
Vice President, Management Consulting (2003 to 2004)
Vice President, System Research and Planning (2002)
Vice President, Management Consulting Services (1998 to 2001)
CSA Energy Consultants, Inc., joined KEMA Consulting on August 1998

CSA Energy Consultants, Inc., Arlington, Virginia: 1981 to 1998
Chairman of the Board (1997 to 1998)
President (1991to 1998)
Senior Vice President (1988 to 1990)
Vice President (1981 to 1988)

Responsible for technical consulting activities, with specialization in the following areas:

- Provided expert evaluations of utility plans and the need for proposed transmission additions in Virginia, New Jersey, New Mexico, Florida, and New York. Assisted in providing similar advice on transmission lines proposed in Pennsylvania and New England. These proposed additions included AC transmission lines varying from 115 kV to 765 kV, and a proposed 450 kV DC tie between Hydro Quebec and New England Power Company. This work has involved consideration of technical, economic, and institutional issues associated with both near- and long-term expansion plans. Advised state officials in New Mexico on the technical and engineering implications of alternative electric power system plans. Evaluated long-term peak load forecasts for 12 utilities in the Missouri-Kansas (MOKAN) Power Pool.
- Participated in evaluations of the use of one utility's transmission system by another in numerous cases, involving both arbitration disputes and mergers. Specifically, provided expert testimony on behalf of Central and Southwest Services in its dispute with East Texas Electric Cooperative (ETEC) over ETEC's eligibility to receive a capital cost credit for its transmission facilities as a network customer of southwestern Electric Power Company. Served as Public Service Company of New Mexico's expert

witness in its arbitration with El Paso Electric Company over the use of the Northern New Mexico transmission system. Also represented the New Mexico Attorney General in assessing the effects of the Central and Southwest merger with El Paso Electric Company on the New Mexico transmission system.

- Responsible for overall management of the consulting effort to develop a comprehensive Transmission Services Costing Framework for the Electric Power Research Institute (EPRI). This framework was developed for use by all major parties involved in the transmission access and pricing debate. Subsequently assisted Centerior Energy Corporation in applying this framework to the development of open access tariffs for transmission and ancillary services. Managed various other efforts to assist major North American utilities in the development of new transmission tariffs, rate schedules, and pricing arrangements to provide for increased access in competition. Participated in providing up-to-date information on U.S. transmission pricing and regulation to utilities in France, Germany, and Japan.

- Responsible for assisting numerous utilities in restructuring their operations. Advising a group of municipal utilities in Georgia on the cost and benefits to its members from participation in the SETrans RTO. Assisted a Canadian provincial utility in restructuring its generation, marketing, and operational functions. Assisted Ontario Hydro Services Company in reviewing transmission arrangements proposed by the Market Design Committee. Assisted Ohio Edison Company in unbundling its economic energy transactions.

- Provided guidance and information to numerous independent power producers that wished to interconnect their facilities with the utility grid in order to obtain transmission services. Also provided information and consulting services to cooperatively-owned utilities that were considering the use of transmission facilities owned by other companies.

- Actively advising DOE in its efforts to improve the Federal Government's data and information systems related to electric power supply and use. Previously managed efforts to develop a comprehensive interregional transmission system database for DOE's Energy Information Administration. Directed the development of the Electric Rate Book, a publication that summarized rate tariffs and provisions of over 120 investor-owned utilities throughout the United States. Directed the development of Electric Rates in Major U.S. Cities, a collection of rate abstracts for 63 electric utilities serving 60 major U.S. cities. This publication is published in cooperation with the Edison Electric Institute (EEI). Led a comprehensive review of all Federal electric power data requirements and needs for DOE's Energy Information Administration (EIA). Directed a number of data management studies for EEI. Developed a directory of all on-line electric power data to facilitate staff access and use for EEI.

- Led contract efforts to evaluate ongoing power system research programs on distribution automation, superconducting power transmission, and superconducting generators by DOE's Electric Energy System Division. Investigated and analyzed the views of the utility, financial, and regulatory communities on a new small nuclear power plant concept for DOE's Nuclear Energy Division. Performed a review of ways in which utilities are modifying equipment and operating practices to "get more out of existing systems" for a utility trade association. Assisted with an investigation of the future availability of electricity for electric vehicles for EPRI. Advised DOE on ways to facilitate the transfer of new power system technologies from the research and development stage to actual implementation.

- Provided advice to the Pacific Gas & Electric Company on the technical and economic impact of employing gas turbine cogeneration in conjunction with the expansion of its district heating system. Analyzed the technical and economic feasibility of a district heating and cooling system to serve Providence, Rhode Island's redevelopment area for Providence Gas Company. Analyzed the feasibility of cogeneration as an alternative heat source in conjunction with steam district heating for San Diego Gas and Electric Company. Examined the economic and technical aspects of cogeneration and small power production projects for a national bank in order to identify those factors that must be present in order for such ventures to succeed economically. This project included the preparation of a case study on a self-contained cogeneration system for a large Florida hospital.

Mathtech, Inc., Arlington, Virginia: 1977 to 1981
Senior Engineer and Project Manager

Responsible for studies of energy and utility systems. Performed comprehensive assessment of all DOE projects related to the electric sector. Managed efforts to develop computer-based estimates of electrical utility fuel use by region of the United States for DOE. Managed a study of cogeneration applications of utility-owned, grid-connected fuel cell power plants for EPRI. Evaluated fuel cell cogeneration systems that are totally isolated for the utility grid while providing reliability equivalent to that of the utility for NASA's Lewis Research Center. Investigated fuel cell cogeneration at natural gas pipeline compression stations for DOE. Assessed load management policy options for EPRI. Performed engineering and economic analyses in support of HUD's Modular Integrated Utility System program..

Air Force Avionics Laboratory, Wright-Patterson Air Force Base, Ohio: 1973 to 1977
Project Engineer

Responsible for investigating the feasibility of reducing airborne electronic system life cycle costs using standardized, modular avionics. Led efforts aimed at standardizing avionic power supplies and navigation systems. Served for six months as Acting Technical Manager of the System Concepts Group, a team of engineers and scientists, investigating operations and fault tolerant computing. Appointed Lead Engineer for Standardization in December of 1976.

University of Washington, Seattle, Washington: 1971 to 1973
Pre-doctoral Research Associate

Developed multi-year computer model to evaluate the long-term feasibility of utility-owned cogeneration facility that would provide low-cost heat to city buildings. Model includes an embedded optimization subprogram to dispatch the cogeneration plant or unit together with hydroelectric generation and power purchases.

University of Washington, Seattle, Washington: 1970 to 1971
Pre-doctoral Teaching Associate

Responsible for instructing undergraduate electronics and electrical engineering students and assisting in lecture sessions.

University of Illinois, Urbana, Illinois: 1969 to 1970
Research Assistant

Responsible for design, construction, and test of signal processing hardware for a radio spectrometer for the University of Illinois, Vermilion River Observatory.

University of New Hampshire, Durham, New Hampshire: 1966 to 1969
Engineering Assistant (part-time)

Responsible for design, layout, construction, and test of electronic circuits to support NASA and Air Force sponsored space research efforts.

Professional Affiliations:

Senior Member, Institute of Electrical and Electronics Engineers (IEEE)

Conférence Internationale des Grands Réseaux Électriques a Haute Tension (Cigré)

Awards:

Tau Beta Pi Freshman Engineering Award, 1966

Tau Beta Pi membership, 1967

General Dynamics Corporation Award for Outstanding Achievement in the Air Force R.O.T.C., 1967

Air Force R.O.T.C. Tuition Scholarship, 1967 – 1969

Phi Kappa Phi membership, 1968

Hamilton Watch Award to University of New Hampshire student who best combines proficiency in engineering or science with achievement in the social sciences and humanities, 1969

Armed Forces Communications and Electronics Association Honor Award (Awarded to Senior R.O.T.C. Student), 1969

National Defense Service Medal, 1973

National Capital Award by the D.C. Council of Engineering and Architectural Societies for Work in Cogeneration and Avionics Standardization, 1982

Perske Award, presented by the Community Living Association for the Mentally Retarded, for volunteer service to retarded citizens in the State of Virginia, 1983

Key Committee Assignments:

Chair, IEEE Energy Policy Committee

U.S. Representative to CIGRE Working Group 37-33: (Development of Dispersed Generation and Consequences for Power Systems)

IEEE Power Engineering Society Liaison to the U.S. Energy Association

Professional Papers:

1. Final Report on AEP's Application to Construct a 765 kV Transmission Line in Southwestern Virginia for the Virginia State Corporation Commission, Expert Report with P. Jeffrey Palermo, submitted to the Virginia State Corporation Commission Staff on April 10, 2000

2. Transmission in a Restructured Electric Industry, presented at the Energy Information Dissemination Program, Engineering Energy Laboratory, Oklahoma State University, Stillwater, Oklahoma, April 6, 1999.

3. A Transmission Services and Pricing in the United States, presented at the Cigré Working Group 37-18 Workshop on Transmission Services and Pricing, Neptun, Romania, September 17, 1997.

4. Transmission Planning in an Open Access Environment, with J.A. Gutiérrez, prepared for EPRI, under Project No. 3573, EPRI TR-108215, June 1997.

5. A Transmission Services Costing Framework, with J.S. Graves and A.F. Vojdani, presented at the 1996 IEEE/PES Winter Meeting, Baltimore, Maryland, January, 1996.

6. Application of EPRI's Transmission Services Costing Framework to the Development of Open Access Transmission Tariffs, with S.F. Szwed, et al., prepared for Centerior Energy Corporation and EPRI, under Project No. 3216-01, EPRI TR-105971, January, 1996.

7. Transmission Services Costing Framework, Volume 2: Framework Description and Application, with H.D. Limmer, et al., prepared for EPRI, under Project No. 3216-01, EPRI TR-105121-V2, April 1995.

8. Transmission Services Costing Framework, Volume 1: Technical and Economic Fundamentals, with H.D. Limmer, et al., prepared for EPRI, under Project No. 3216-01, EPRI TR-105121-V1, April 1995.

9. Transmission Pricing in the United States Effects of Increased Competition Among Suppliers, The Cigré Colloquium, Tokyo, Japan, May 18, 1995.

10. Survey of Innovative Rates: 1994 Update, with D. J. LeKang and C. D. Bowman, prepared for the Electric Power Research Institute, Research Project Number 2343-11, October 1994.

11. Innovative Rates Revisited The 1993 Survey - What's New in DSM Rates?, with L. J. White, presented at the 1994 Innovative Electricity Pricing Conference, Tampa, Florida, February 3, 1994.

12. Innovative Rates, An Important Determinant in DSM Program Effectiveness, with L. J. White, presented at the Sixth National Demand-Side Management Conference, March 25, 1993.

13. Negotiating a Wheeling Agreement, The Developer's Perspective, presented at the Infocast, Inc. Power Transmission: Access, Pricing & Regulation Conference, Washington, D.C., April 22-23, 1991.

14. Transmission System Limitations and Their Impact on the Cogeneration and Independent Power Market, presented at the Fourth Annual Cogeneration and Independent Power Market Conference, New Orleans, Louisiana, April 10-11, 1989.

15. Utility-Cogenerator Interface: The Impact of Expanded Access and Deregulation on Coordination Requirements, The Cogeneration Journal, Vol. 4, No. 1, Winter 1988-89.

16. Consideration of the Public Interest in Evaluating Bids for Electric Power Generation, with H. D. Limmer and P. J. Palermo, Proceedings of the Sixth NARUC Biennial Regulatory Information Conference, Vol. 2, Columbus, Ohio, September 16, 1988.

17. FERC Proposed Policies on Restructuring the Electric Power Industry, with J. A. Casazza, IEEE Power Engineering Review, Vol. 8, No. 7, July 1988.

18. Impact of Expanded Access and Deregulation on Utility Coordination Requirements, presented at 1988 Cogeneration Congress, Atlantic City, New Jersey, June 16, 1988.

19. Power Pools and Cogeneration: Guidelines for Coordination Between Cogenerators and the Utility Grid, Cogeneration:Current Prospects & Future Opportunities, 6th Edition, Government Institutes, Inc., Rockville, Maryland, October 1987.

20. District Heating and Cooling, A Technology That Reduces Costs in New Buildings, Urban Land, October 1985.

21. Nuclear Power: Some Economic Effects of Institutional and Technical Changes, with J. A. Casazza, Proceedings of the 19th Intersociety Energy Conversion Engineering Conference, San Francisco, California, August 1984.

22. Determination of Electric Transmission Requirements from Production Costing Models, with P. J. Palermo, presented at World Systems Conference, Caracas, Venezuela, July 1983.

23. Review of Electric Power Data Requirements, with J. A. Casazza, J. P. Price, et. al., Final Report to DOE's Energy Information Administration under Union Carbide Subcontract #62X-04166C, August 16, 1982.

24. Cross-Cutting Analysis of the Electric Sector -- Phase II -- A Survey of Public and Private Sector R&D Programs and Budgets, with K. C. Hoffman and V. V. Tekumalla, Draft Final Report to DOE's Office of Electrical Systems, under DOE Contract No. DEAC-0179-PE70039, August 1981.

25. Study of Technical and Economic Feas ibility of Fuel Cell Cogeneration Applications by Electric Utilities, with W. S. Ku, IEEE Transactions on Power Apparatus and Systems, Vol. PAS-100, No. 10, October 1981.

26. Study of Fuel Cell On-Site Integrated Energy Systems in Residential/Commercial Applications, with S. Karamchetty, et. al., Final Report to NASA Lewis Research Center on Contract No. DEN3-89, October 1980.

27. Cogeneration/Total Energy Case Studies, Final Report to U. S. Department of Housing and Urban Development, with N. R. Friedman and E. M. Zabek, prepared under HUD Contract No. H-2412, July 1980.

28. An Assessment of Alternative Fuel Cell Designs for Residential and Commercial Cogeneration, 1980 Region 6 Conference Proceedings, IEEE, San Diego, California, February 1980.

29. Electric Utility Regional Fuel Use Analysis: Fuel Use Tables, with N. R. Friedman, et. al., Interim Report to DOE's Economic Regulatory Administration, Office of Utility Systems, under Contract No. EB-78-C-01-6681, February 1980.

30. An Analysis of the Application of Fuel Cells in Dual Energy Use Systems, with D. R. Limaye, et. al., Final Report on Electric Power Research Institute Contract No. RP 1135, EPRI EM -981, Mathtech, Inc., February 1979.

31. Application of Fuel Cells to Dual Energy Use Systems, with J. A. Orlando, et. al., National Fuel Cell Seminar, San Francisco, California, July 11-13, 1978.

32. Comprehensive Community Planning for Energy Management and Conservation, Design of Community Energy Demand Generator, Final Report on the Energy Demand Profile Amplification and Aggregation Models, with M. H. Fallah and D. R. Limaye, a report to Hittman Associates, Inc., for the U. S. Department of Energy, Mathtech, Inc., December 1977.

33. A Top Down Approach to Avionics Standardization, Air Force Avionics Laboratory Technical Memorandum, AFAL-TM-77-38-AAA, Wright-Patterson AFB, Ohio, July 1977.

34. Standard Modular Power Supplies for Avionics, Proceedings of the IEEE 1976 National Aerospace and Electronics Conference, Dayton, Ohio, May 18-20, 1976.

35. Total Energy System Long Term Feasibility, Proceedings of the Sixth Annual Pittsburgh Conference on Modeling and Simulation, University of Pittsburgh, Pittsburgh, Pennsylvania, April 24-25, 1975.

36. DAIS Hot Bench/Sensor Simulation Interface Design, Air Force Avionics Laboratory Technical Report AFAL-TR-74-298, Wright-Patterson Air Force Base, Ohio, April 1975.

37. A Dynamic Study of Total Energy System Long-Term Feasibility, Ph.D. Dissertation, University of Washington, Seattle, Washington, March 1975.

38. A Multichannel Radio Spectrometer for the Vermilion River Observatory, M.S. Thesis, University of Illinois, Urbana, Illinois, August 1970.

Profession: Principal Consultant:
Power System Design and Analysis

Years of Experience: 24

Education: BS (Electrical and Electronic Engineering), Rand Afrikaans University (RAU), Johannesburg, RSA, 1981.

MS (Electrical and Electronic Engineering) (Cum Laude), RAU, Johannesburg, RSA, 1983. Dissertation: "Structure, behaviour and control of systems for optimal utilisation of electric energy generation from the wind".

Ph.D. (Electrical and Electronic Engineering), RAU and RWTH Aachen, Germany 1988. Thesis: "Determination and dynamic compensation of fictitious power in electric power systems".

Position On team: Project Manager

Key Qualifications:

Power Quality Mitigation and Energy Storage
Johan Enslin has over 20 years experience in the economic feasibility, research, design, development, implementation and consulting in power quality mitigating devices. These include Active Power Filters (APF) (also for HVDC terminals) and Sag mitigating devices. He commercialized high power electronic converters for the integration of flow-battery energy storage devices, lead-acid batteries, high-speed flywheels and super-conducting magnetic energy storage (SMES) devices.

Wind Power Interconnections
Johan is well experienced in the interconnection issues of large-scale on-shore and offshore wind parks to the high and medium voltage electrical grids. These include analysis, dynamic modeling, stability, transient, grid upgrades, power balancing and harmonic system studies for different on- and offshore grid topologies using HVDC, HVAC and energy storage technologies. He performed recently key projects in this regards for Dutch on-shore and offshore wind parks up to 6000 MW ratings. Previously he also designed, developed and commercialized back-to-back power electronic converters for wind generators.

High Power Electronic Converters
He has extensive experience in the design, development, testing and applications of high power electronic converters, including control and software modeling, converter design, simulation and analysis. He was on several occasions the leading scientist in the development of hardware and software for power electronic converters in the multi-megawatt power ratings. Several new converter topologies and control algorithms have been proposed, developed, industrialized, evaluated in the field, published in the literature and patents have been issued. He is also the Associate Editor for the IEEE Transactions on Power Electronics, in the area of High Power Converters.

Distributed Power
He is also experienced in distributed power technologies, including system design and sizing, feasibility and network interaction of micro-turbines, fuel-cells, photovoltaic, energy storage, wind and micro-hydro energy, stand-alone (RAPS) and grid connected systems. He designed, developed and commercialized converters and renewable energy systems for distributed power applications.

HVDC, FACTS, Reactive Power Compensation
Johan is the principal consultant at KEMA for high power converter design, analysis, dynamic modeling, stability, transient and harmonic system studies, network positioning, feasibility studies and conceptual design of HVDC and Flexible AC Transmission Systems (FACTS). These devices include HVDC converters, Static Var Compensators (SVC), Shunt and series capacitor installations, Medium Voltage DC links (MVDC), Static Synchronous Compensators (STATCOM), Unified Power Flow Converters (UPFC) and active filters for HVDC systems. These also include EMC generation of high power FACTS devices. He recently performed key projects in this regards for the USA in Connecticut, in the UK and Europe. Some of these projects include system designs for the BritNed HVDC link, FACTS and VAr support devices for several European utilities and STATCOM and C-Type filters for the Dutch and Southwestern Connecticut system. Previously he also performed development, testing and consulting work for ESKOM on the Cahorra Bassa HVDC link in Southern Africa.

Executive, Development leader and Lecturer
Dr. Enslin has combined his career with activity in industry and university, as an executive and consultant for private business operations and serving as a full-professor in electrical and electronic engineering for 15 years. He was in several high power electronics development and testing projects the leading scientist. He has also been the technical director at several power electronics manufacturing and consulting companies.

He is an experienced lecturer on power electronics, power systems and modern control systems. He developed and delivered several under- and graduate courses, as well as continued education short courses on power electronics, electrical networks, electrical drives, Power Quality, FACTS, Custom Power, Distributed Power, Renewable Energy, control and digital signal processing. He also presented several technical papers, including keynote addresses at international conferences. He was the supervisor and co-supervisor for 45 M.S. and 12 Ph.D. students at several universities in South Africa, Europe and USA.

Papers and Patents

He authored and co-authored more that 70 technical journal papers and 150 international conference papers in the IEEE and other organizations. He holds 13 final and pending international patents.

IEEE Activities

He successfully organized, chaired and participated at several international IEEE and other conferences. He is the Associate Editor for High Power Electronics for the IEEE Power Electronics Transactions. He was Technical Chair of the IEEE Workshops on the Future of Electronic Power Processing and Conversion in South Africa in 1991 and 1998. He was also Technical Chair of IEEE AFRICON'92, as well as General Chair of IEEE AFRICON'96 and Vice Chair of IEEE AFRICON'99.

Dr. Enslin has also been a technical topic chair at IEEE Power Electronics Specialist Conferences (PESC).

Experience:

2000 - Present KEMA T&D Consulting
Principal Consultant. Business development, project leader and Team Leader responsible for Power System Planning and Analysis projects, including Reactive Power Compensation, FACTS, HVDC and wind power. Co-ordinate power projects for KEMA worldwide. Power Electronics expert, project manager, consultant and lecturer in HVDC, FACTS, distributed power and Power Quality.

1997 - 1999 ESKOM, TSI (SAPSSI), South Africa
Technical Manager: Distribution for SAPSSI (Joint venture between ESKOM and EPRI). Leading business unit performing detailed system studies and network upgrades on HVDC, FACTS and Power Quality projects in Southern Africa. Developed human power development plan for ESKOM. Doing research management on distribution projects for ESKOM.

1991 - 1999 Dept. of Electrical and Electronic Eng., University of Stellenbosch, South Africa
Full-Professor: Energy Group Chairman: Lecturing, research, supervisor of graduate students, management and industry consultant. Chair of Power Electronics R&D Group. This Stellenbosch University Power Electronics Research Group (40 scientists) performed contract research work for local and international companies in the area of power electronic converters, HVDC, FACTS, distributed power, power quality and power system studies.

1996 - 1998 AMS Power Electronic Converters (APEC) Pty (Ltd), South Africa
Director: Business development, converter design and development leader.

1994 Dept. ECE, Oregon State University, Corvallis, Oregon, USA.
Invited Visiting Professor: Research, lecturing, supervision of graduate students

1992 - 1999 EETA Consulting Services CC, South Africa
Owner: Power system consulting and power electronic converter design.

1988 - 1991 Laboratory for Advanced Engineering (LGI) Pty (Ltd), RSA
Director: Business development, consulting, converter design.

1986 - 1991 Dept. of Electrical Eng., University of Pretoria, RSA
Full-Professor and Departmental Chairman: Departmental management, lecturing, research, and supervisor of graduate students, as well as industry consultant. Chair of Power Electronics Research Group. This Pretoria University Power Electronics Research Group (10 scientists) performed contract research work for industry in the area of power electronic converters, renewable energy and power quality.

1984 - 1985 SA Signal Corps, SADF, RSA
Project Engineer (Lt): Military service, military operations, project management, project engineering.

1981 - 1985 SPOORNET, RSA
Engineer: Railway system design, locomotive specifications, engineering.

Professional Affiliations:

IEEE Senior Member: Power Electronics, Power Systems, Industry Applications and Industrial Electronics Societies.
CIGRé: Member of several CIGRé Working Groups, recently on 14-28: "Active Filters for HVDC terminals".
SAIEE Senior Member: South African Institute of Electrical Engineers (SAIEE)
Registered Professional Engineer: Engineering Council of South Africa (ECSA)

Technical Papers:

Full list of more than 200 technical papers are available upon request.

Selected List Of Recent KEMA Projects:

Consulting for Phase II, Construction of 345 kV Transmission Network (Connecticut Siting Council, CT, USA) (2004): An independent technical review, load-flow and harmonic analysis study for the application to construct Phase II 345 kV transmission facilities in Southwestern Connecticut was investigated. The maximum length of the proposed Phase II 345 kV cable that could be installed was evaluated on a technical feasibility study. In addition, several mitigation schemes, including STATCOMs and C-Type harmonic filter configurations, to improve the system harmonic performance were proposed and studied. The project scope included aspects of transmission planning, FACTS technology evaluation, HV cable technologies, harmonic performance analyses and load flow studies using PSS/E and PowerFactory. Expert testimonies on the results of these system studies and reviews were provided at several hearings.

Transmission planning of voltage support strategy for the PDO system (Petroleum Development, Oman) (2004): The overall aim of this transmission planning study (based on a PSS/E analysis) was to provide a management development plan regarding voltage support and reactive power compensation for the PDO power system (220 kV and 132 kV). KEMA developed a voltage support strategy with the following objectives: Inform PDO of the expected operating and capital expenditure requirements; Recommendation of the optimum development plan for the PDO power system. This study assumed the 2003 Master Plan as starting point. Three demand growth scenarios of the 2003 Master Plan were considered.

Intermittent Wind Generation Report of Impacts on Grid System Operations (California Energy Commission) (2004): Large-scale wind power interconnection is growing very fast on world-wide levels. In this study the following issues were addressed for high levels of wind power interconnection for California and the WECC regions: Provided empirical data of large-scale wind integration projects in Europe, Japan and the US; Compare the transmission system characteristics in Europe with transmission characteristics in WECC and specifically in the California ISO systems; Evaluate how wind generation will affect the physical operations of the network.

Grid Interconnection Studies for the BritNed HVDC Link on the Dutch 380 / 220 kV transmission network. (BritNed/TenneT) (2002 - 2003): BritNed has requested permission to connect a HVDC converter station to the Maasvlakte 380 kV substation. KEMA helped TenneT to write a technical requirement

document for BritNed, concerning this connection. KEMA has also done a detailed harmonic impedance study at Maasvlakte, the landing point and substation location of the HVDC link. Several network configurations, including changes to the high voltage cable network, were investigated. These changes dramatically influence the network characteristic and were therefore studied. The harmonic impedance at Maasvlakte is provided for 11 different cases with 4 different network situations expected over the next 6 years. These results were used to finalize the technical requirement specification and designing the harmonic filter rating of the HVDC. Electrical environmental impacts on existing electrical equipment, including EMI were also performed.

System analysis, design and implementation of reactive power compensation units for the 380 kV and 220 kV Dutch National Grid (TenneT) (2001 - 2003): An extensive system study, design, high voltage harmonic measurement, specification development, tender evaluation and consultancy during commissioning for complete transmission system reactive compensation project was performed. This project started off with the complete system study and design phase (load-flow, dynamic generator interaction study, harmonic impedance calculations and transient switching) for 1.5 GVAr reactive power compensation units on the 380 and 220 kV transmission grid of TenneT. Static VAr Compensators (SVCs) were evaluated against mechanically switched shunt capacitor compensators. A new C-Type filter configuration was proposed to mitigate the harmonic resonance and interconnection problems and was accepted by TenneT. A full specification was developed after some high voltage harmonic measurements, tenders were evaluated and consultancy service during the commissioning phase was supplied.

Feasibility of 6000 MW of offshore wind power (Novem) (2002 – 2003): The Dutch government has set a goal of developing 6000 MW of offshore wind energy by 2020. In co-operation with the Technical University of Delft, and by order of Novem (Netherlands Agency for Energy and the Environment), KEMA was hired to assess the technical, economic, financial, and legal impacts of this expanded offshore capacity. KEMA's study found that the target was technically and economically feasible, although modifications to the electricity grid would be necessary. These required grid upgrades were quantified with grid system studies evaluation different interconnection options and reactive power compensation options. KEMA also found that uncertainties arising from short-term wind fluctuations could be overcome, but that long-term fluctuations are likely to increase, resulting in a need for additional grid capacity. The study concluded that the need for this additional capacity could be limited by carefully evaluating wind forecasts and calculation methodologies. Different interconnection technologies, including HVDC, HVDC Light, FACTS and 380 / 150 kV offshore substations were evaluated as part of the interconnection options.

Reliability Evaluation of Wind Power Equipment (Shell) (2003): Shell Global Solutions requested KEMA to do a reliability evaluation of the different onshore and offshore wind power equipment on component and system level. Wind turbine project developers, wind farm owners and operators are eager to have insight in wind turbine reliability and failure figures to be able to predict wind farm economics in detail. KEMA has investigated wind turbine failure data and down times based on literature surveys and up-to-date information from owners and specialized wind turbine services & maintenance companies. Also the reliability of AC and DC interconnections to the network were investigated. At KEMA the wind power group operates the "Wind monitor" program, collecting performance

data of about 75% of the wind turbines sited in the Netherlands. KEMA also developed and managed a database (NESTOR) in the Netherlands with reliability figures for electrical components in distribution and transmission grids (voltage 0,4 up to 380 kV). Both databases provide practical information about the failure- and reliability statistics of wind farm and their connections to the grid. Failure statistics of the following main wind turbine components were included: Rotor blades and hub, blade pitch mechanism and tip brakes, gearbox and nacelle, brakes, generators, Yaw system, hydraulic system, control system including communications, sensors, transformers, power cables and power electronics and converters. Based on interviews with major wind turbine suppliers, a maintenance program was provided.

Review of Transmission Planning Criteria (ESKOM) (2003): Reviewed the entire ESKOM transmission planning document and provided recommendations from both technical and strategic perspectives. A specific emphasis was on the treatment of reliability criteria and the economic impact of poor reliability on customers.

Training courses on Wind Energy Technology, HVDC and FACTS Technology: (Shell) (2002): Two training courses on wind energy technology and HVDC and FACTS technology, with the main focus on off-shore applications were developed for Shell. These courses included the development of the course material and presenting the course to Shell operations engineers.

Design review of 750 kW back-to-back wind power converters: (Lagerwey) (2001): Lagerwey had developed a new series of direct drive wind turbines, interconnected to the network with a 750 kW back-to-back IGBT converter. This converter was tested and improvements were proposed to make the converter more reliable. As a second part of this project a patent and literature search were conducted on the control and design of these systems.

Electrical Supply of Offshore Platforms by Voltage Source Converter (VSC) HVDC Link: (Shell) (2002): Traditionally the electricity on the offshore platforms is supplied by generators on the platforms. In recent years the technology of electricity transmission via direct current (DC) links has undertaken significant development, particularly the HVDC links based on voltage source converters with the respect to enabling systems of lower capacity and physical size at competitive costs. This offers potential opportunities for offshore electricity supply. KEMA has done a study for Shell to find out in how far this new technology is competitive with respect to the traditional options, from both technical and economical point of view. The approach of this study was the following: A literature survey is conducted; Meetings with ABB, Siemens and Alstom were held; An interview with the Troll A (gas pre-compressor on offshore platform) project team in Norway was conducted; A telephone interview with Pirelli cables; The information collected was analyzed; Future development trends were identified.

Electricity storage in the Dutch energy market: (E-On/Essent/Reliant) (2002): This study focused on application areas of storage of electricity with the focus of storage in electricity trading (APX). A selection of storage technologies with this purpose is made and the investment cost and operation cost of the chosen storage technologies were determined. A simulation tool was developed to calculate the earnings per MW in the considered period of a storage technology with given efficiency, storage capacity and given APX-values for each hour in the considered period. Power rating for this study was selected at 20 MW

and the storage size was variable between 1 and 8 hours. The secondary applications of Black-start availability, stop-start reduction of a generating unit, UPS operation and wind energy stabilization were also considered in combination with the primary trading application.

Survey and Comparison of different FACTS devices for the Belgium National Grid (Elia) (2001 – 2002): FACTS (Flexible AC Transmission Systems) devices are currently receiving a lot of international interest, thanks to recent technological advances in voltage source converters. These devices are poised to achieve a breakthrough in the operation of high-voltage networks and in solving problems in congestion and stability of these networks. KEMA has done a detailed study on FACTS devices relevant to the Belgium (Elia) high voltage network. The purpose of this detailed FACTS study was to uncover a broad range of technical and economical aspects, which are encountered during specification, procurement, and operation of these selected FACTS devices. The study concerns FACTS devices for application in following fields: Dynamic voltage stability; Congestion mitigation and loop power flow control; Reduction of the short-circuit power level; Mitigation of voltage unbalance due to single-phase loads. For these application fields, the following equipment has been studied in detail in this report: Static Var Compensator (SVC); Static Synchronous Compensator (STATCOM); Phase Shifting Transformer (PST); Thyristor Controlled Series Compensator (TCSC); Unified Power Flow Controller (UPFC); Interphase Power Controller (IPC). As part of this study, an extensive survey and visits have been done together with international network operators and equipment manufacturers, experienced with installing and operating FACTS devices

System studies for the installation of 150 MVAr capacitor banks on the 150 kV NUON Grid: (NUON) (2002): In order to deregulate the reactive power requirements and improve voltage regulation in the Dutch 150 kV grid, NUON decided to install capacitor banks for reactive power compensation. To substantiate the design, system studies were performed. The studies were done using a dynamic model of the Western European high-voltage grid. The model was assembled from existing Client models and UCTE data. Various power flow scenarios and dynamic events and fault situations were investigated to ascertain the system's stability and to determine technical requirements for the capacitor banks. Further investigation was done in to the effects of generator voltage control in relation to the use of capacitor banks. The project had 3 sections: Dynamic generator interaction system study to determine the generator interactions; Switching transient studies to evaluate the existing insulation levels, check the TRV levels of the breakers; Harmonic study to determine possible system resonances, and damping of high voltage control signals.

System studies for the implementation of several 115 MVAr capacitor banks on the 150 kV ENECO Grid: (ENECO) (2000 – 2003): A number of studies were performed for ENECO over a 4-year interval. In order to deregulate the reactive power requirements and improve voltage regulation in the Dutch high-voltage grid, ENECO (REMU) decided to install capacitor banks for reactive power compensation. To substantiate the design, system studies were performed at 3 different substations. The studies were done using a dynamic model of the Western European high-voltage grid. The model was assembled from existing Client models and UCTE data. Al these studies had 2 sections: Dynamic generator interaction system study to determine the generator interactions; switching transient studies to evaluate the existing insulation levels and check the TRV levels of the breakers.

Harmonic Interaction between Large Numbers of Photovoltaic Inverters and the LV Network: (NUON/NOVEM) (2001-2002): KEMA has done an investigation to identify and explain the dominating mechanisms of interaction between PV inverters in large populations and the electrical distribution network. Some demonstration projects with large populations of small PV-inverters in the LV network, showed high levels of voltage distortion. In some cases there is a relation between the level of harmonic pollution and populations of PV inverters, although the emission level of an individual PV inverter satisfying the IEC 61000-3-2 test specification. Measurements in these networks showed that these inverters, under certain circumstances, switched off undesirably, or exceeded the harmonic regulations. The general objective for this investigation was therefore: Identify and explain the domination mechanisms of these problems and the interaction of these inverters with the network. The possibility of a resonance between the inverters and the network should also be evaluated. Furthermore effective measures and guidelines, which may be a contribution to a future product standard for inverters, should be proposed. So far, there are only studies performed based on single or a few parallel inverters. The interaction between the inverters and the network was not investigated. Therefore the main object of this study is to analyze the observed phenomena concerning harmonic interference in large populations of inverters and deliver a possible reasoning whether this can be explained by resonance between existing network components and the inverters. This project was divided in several tasks: Analysis of the resonance phenomenon between the inverters and the network; Modeling of the different PV inverters used in this project; Experimental validation of these inverter models with measurements on an experimental network simulator; Modeling of the network; Simulation of the complete network with a sinusoidal voltage supply, voltage distortion based on the Dutch average voltage distortion, voltage distortion based on the EN 50160 maximum allowable voltage. KEMA proposed guidelines for the use of multiple PV inverters in networks and provide input suggestions to the IEC 61000-3-2 and NEC 82 standards committee.

Distributed Power projects for Dutch Ministry of Economic Affairs (2001-2003): He was involved at KEMA on several R&D type projects and investigations on different considerations and specially the impact of Distributed Power on the electrical network. KEMA also did an Electricity Technology Roadmap in 2002 in which a coherent long-term vision was given of the development of the electricity supply system of the Netherlands for the next 25 years. It gives the opportunities and threads for the digital economy and a translation to technological developments. Based on input of a number of workshops with a broad representation of the Dutch industrial society and limited scenario analysis, targets were identified and from this a number of initiatives and goals for a sustainable society were presented. Other distributed power projects include the feasibility of an AC-DC hybrid low-voltage network for residential applications, the impact of distributed power on the power quality and grid reliability.

Feasibility study of a Vanadium Redox Battery (VRB) in Essent's Network for Kashima-Kita Electric Power, Japan (2000): The goal of this project was to define whether the VRB battery is capable of solving Power Quality related problem in the Essent Network in The Netherlands. A technical and economic feasibility was done on the cost recovery and technological risks for such a project in The Netherlands.