COMPANY OVERVIEW

GLOBAL ENERGY CONCEPTS, LLC (GEC) is a multi-discipline engineering and technology consulting firm providing services to clients involved in the energy industry. Recognized as leaders in the wind energy industry, the firm specializes in the analysis, design, testing, and management of wind energy systems and projects. Our experience includes both utility-scale and small-scale applications of wind energy technologies. GEC combines technical expertise, managerial capabilities, and common-sense financial and business knowledge to provide comprehensive consulting services to assist our clients in meeting their objectives.

GEC offers a broad range of services including:

- Independent engineer and due diligence services
- Project feasibility & economic assessments
- Wind resource monitoring
- Power curve, noise, power quality, and loads measurement and documentation
- Wind flow and wake modeling
- Energy projections, site optimization, and visualization
- Component and turbine specification, design, analysis, test and certification
- Education and outreach materials
- International training & development support
- Litigation support and dispute resolution
- Project performance evaluation & reporting
- Database management & data analysis software
- Technical project management

CLIENTS

GEC provides consulting services to a broad spectrum of clients, including all sectors of the domestic and international energy industry. Our clients include electric utilities, investors, banks, wind turbine owners, insurance companies, equipment manufacturers, developers, law firms, the U.S. Department of Energy, the World Bank, the Electric Power Research Institute, the National Renewable Energy Laboratory, the U.S. Agency for International Development, and other public institutions both in the United States and abroad.

STAFF AND COMPANY RESOURCES

GEC personnel have been providing services to the wind industry for over 20 years. Staff members are internationally recognized for their work, are on industry advisory committees, have written numerous reports and papers, and frequently testify and lecture before industry audiences.

The staff is supported by extensive library and computer facilities, including current software and specialized wind energy analysis tools. We maintain extensive files on equipment suppliers, specifications, and turbine performance. Our inventory of test equipment, which includes data loggers, sensors, and towers, is available for lease to our clients.

We also maintain affiliations with technical, regulatory, economic, and environmental experts from leading industry and academic positions. The frequent use of this expertise to support project implementation and enhance the staff qualifications provides for additional flexibility and responsiveness to our clients.

PROJECT EXPERIENCE

WIND RESOURCE ASSESSMENT

GEC has performed renewable energy resource assessment studies for utilities, government agencies, and private developers throughout the United States and abroad. We have worked with all the major monitoring equipment suppliers, have developed customized software for quality control and data processing, and have established a network of installation crews across the country.

New Mexico Energy, Minerals, and Natural Resources Department, 1999 to Present: Wind measurement study including the installation and monitoring of six stations for between two and three years.

Wisconsin Wind Energy Task Force, 1997 to Present: Statewide wind resource assessment study including site selection, lease negotiation, permitting, equipment installation and operation, data collection and analysis, and reporting for 13 wind monitoring stations in Wisconsin. Developed monitoring plan, quality assurance plan, and operations and maintenance manual.

- SITE SELECTION
- METEOROLOGICAL EQUIPMENT INSTALLATION AND O&M
- DATA COLLECTION AND QUALITY CONTROL
- DATA ANALYSIS

National Park Service, National Renewable Energy Laboratory, 2000 to Present: Wind resource monitoring study for the "Green Energy Parks Program." Additional analysis of relative humidity and horizontal solar radiation to optimize the designs for renewable energy and energy efficiency systems.

Tucson Electric Power Company, 1995 to 1999: Wind resource assessment including site selection for three wind measurement stations, equipment installation, monitoring and reporting. Also provided training for utility personnel and general support.

Colorado Office of Energy Conservation and a consortium of Colorado utilities, 1995 to 1999: Statewide wind resource assessment including site selection through data analysis and reporting for 10 monitoring stations. Candidate sites were identified through wind mapping and use of a Geographical Information System.

Nebraska Power Association (NPA), 1994 to 1999: Four-year wind resource assessment for the State of Nebraska. Site selection and monitoring of eight sites for consortium of Nebraska utilities, government agencies, and public organizations. Included sensor installation on new and existing tall towers. Conducted research on mitigating lightning impacts on sensors and data loggers.

State of Hawaii, Department of Business, Economic Development & Tourism, 1992 to 2001: Renewable energy resource assessment and development program for the state. Field surveys; measurement of wind and solar resource data at 13 sites; development of resource supply curves for wind, solar, biomass, ocean thermal, wave, and hydro resources; and development of state's renewable energy integration plan.

Private Developers, 1995 to Present: Wind resource assessment and monitoring activities for several private developers to support their bid and development activities. Installed and collected data from dozens of stations throughout the U.S. and abroad. Work includes regional site surveys and detailed micrositing tasks.

GEC

PROJECT EXPERIENCE

INDEPENDENT ENGINEER, DUE DILIGENCE, & PROJECT SUPPORT

GEC has conducted due diligence studies and provided independent engineer services for a number of debt and equity investors in wind energy projects. Our experience also includes technical evaluations, financial and economic analyses, utility interconnection and generation expansion plan reviews, permitting, and environmental impact assessments for wind energy projects worldwide.

IE ACTIVITIES

- DESIGN REVIEW
- TURBINE INSPECTIONS
- ENERGY ESTIMATES
- DOCUMENT REVIEW
- CONSTRUCTION MONITORING
- O&M AUDITS AND COST PROJECTIONS
- PERFORMANCE MONITORING
- FAILURE ANALYSIS

ABB Energy Ventures, 2001 to Present: Providing due diligence support and independent engineer services for two commercial wind projects in the U.S. Work includes turbine design review, energy production estimates, construction monitoring, documentation review, O&M cost analysis, commissioning inspections, and O&M audits.

The City of Seattle, Seattle City Light Department, 2000 to Present: Provided support for renewable energy proposal evaluation and wind energy power purchase contract negotiation. Proposals covered several renewable energy technologies.

Wisconsin Public Service, 1998 to 2001: Developed project design, turbine layout, and energy projections for three project areas. Investigated permit requirements and identified landowners. Recommended final project area for development and completed final site layout and design for 9.2 MW project in Lincoln, Wisconsin.

Project Developers*, 1999 to Present: Completed project layouts, wind flow modeling, and energy estimates for multiple projects in the U.S. and abroad.

Attorneys*, 1986 to Present: Provided expert testimony and litigation support to numerous attorneys and their clients. Work included failure analysis, repair cost estimates, valuations, revenue losses, performance projections, and retrofit requirements.

Private Insurance Companies*, 1995 to Present: Provided technical support for claims investigations under commercial insurance policies. Conducted failure analyses, component inspections, O&M audits, loss revenue estimates, repair cost estimates, and valuations.

Banks and Private Investment Groups*, 1987 to Present: Performed economic feasibility studies and due diligence of energy projects ranging in size from 1 to 130 MW. Work has included estimation of project capital costs, operating costs, and project revenues. Due diligence activities included evaluations of the structural integrity and potential problems on candidate turbines and overall project designs, cash flow reviews, document reviews, and construction and operations monitoring.

PROJECT SUPPORT

- FEASIBILITY STUDIES
- WIND FLOW MODELING AND ENERGY ESTIMATES
- BID DOCUMENT PREPARATION AND EVALUATION
- PROJECT DESIGN
- VISUALIZATION
- ACCEPTANCE TESTING

Project Operators and Maintenance Organizations*, 1994 to Present: Developed computer programs to record wind turbine O&M log sheets in a consistent and easily-manipulated manner including customized data entry screens, pull down menus, parts tracking capability, and data transfer options. Analyzed and reported project performance data.

****Due to the proprietary nature of this work, specific clients are not identified.***

GEC

PROJECT EXPERIENCE

MARKET ASSESSMENTS & OTHER STUDIES

Renewable Technology Market and Benefits Assessment, Electric Power Research Institute & California Energy Commission, 2000 to 2002: Identified current market needs for renewable energy generation and analyzed future market trends in renewable technology. Work included cataloging existing and planned projects, determining current status of technology and likely impact of future advances in terms of cost and performance. Technologies included wind, solar, geothermal, biomass, and hydroelectric.

Wind Energy Productivity Improvement and Procurement Guidelines, Electric Power Research Institute, 2002. Developed guidelines for utilities, operators, and owners of wind projects to address performance improvements for wind projects. Subjects included operation and maintenance strategies, staffing levels, and parts inventory; severe weather impacts; use of SCADA systems; performance evaluation and trending analyses; specification and procurement considerations; warranties; and other topics.

Study of Offshore Wind Energy Potential in the U.S., National Renewable Energy Laboratory, 1999 to Present: Developed wind resource, performance, and cost estimates for offshore wind energy applications in the U.S. Work included review of European experience, development of methods for estimating offshore wind resources, and use of parametric relationships to estimate costs in various water depths and distances offshore.

U.S. Wind Capacity Database, National Renewable Energy Laboratory, 1999 to Present: Maintaining the domestic wind capacity database and maps in conjunction with the American Wind Energy Association. Database includes details on existing and planned wind projects in the U.S. Work includes communication and coordination with industry developers and equipment suppliers, creation of maps and statistics for each state and the U.S. as a whole, and tracking status of new and proposed projects.

Analysis of Wind Energy Procurement Opportunities for Federal Agencies, Federal Energy Management Program, 2000 to 2002: Conducted market assessment and analysis of procurement mechanisms for Federal facilities to acquire wind energy. Included an assessment of specific opportunities on federal land and a recommended list of facilities. Also investigated various contracting mechanisms available to Federal agencies for procuring energy services and equipment.

Investigation of Wind Energy Potential on Native American Lands, Colville, Walker River Paiute, and Shoalwater Tribes, 2001 to 2002: Conducted technical and economic assessments of the wind energy potential on Indian lands for several tribes.

Electric Power Research Institute, 1995: Developed a utility wind power primer to provide a complete reference and assist utilities in bringing wind power plants on-line. Includes all aspects of resource assessment, siting, planning, implementation, and operation of a wind plant.

Electric Power Research Institute, 1987 to 1990: Documented lessons learned from commercial wind power experience. Activities included analyzing performance and maintenance data, describing equipment failures, evaluating the design and operations of wind power stations, and recommending future improvements.

PROJECT EXPERIENCE

PROGRAM MANAGEMENT & SUPPORT

Wind Turbine Verification Program, Electric Power Research Institute-U.S. Department of Energy, 1994 to Present: Primary technical support contractor providing engineering advice, management recommendations, and project documentation for EPRI-DOE Utility Wind Turbine Verification Program (TVP). Work includes producing monthly and annual reports that summarize the experiences for each utility wind project during the project development phase and three subsequent years of operation.

- FEDERAL AND STATE PROGRAM SUPPORT
- STRATEGIC PLANNING
- MEETING FACILITATION AND LOGISTICS

TVP technical support also includes developing methodologies and providing technical assistance for performance evaluation tasks. GEC has facilitated dozens of individual and joint TVP project review meetings and site visits, drafted meeting summaries, and conducted follow-up activities. TVP participants include Central and South West, Green Mountain Power, Wisconsin Public Service, Nebraska Public Power District, KBR Rural Public Power District, Algona Municipal Utilities, Cedar Falls Utilities, Kotzebue Electric Association, York Research Corporation, TXU Electric and Gas, and others. GEC has developed methodologies and specialized wind turbine data processing software to evaluate project performance.

Federal Energy Management Program Technical Support Contractor, 1996 to Present: Conducting technical evaluations of wind energy applications at federal facilities. Recent work included analysis of a wind energy project at the Plum Island Animal Disease Control Center in New York and preliminary feasibility studies of wind projects in Gateway National Recreation Area at Sandy Hook, NJ, and Floyd Bennett Field, NY. Tasks include wind resource assessment, project layout and energy estimates, power purchase agreement negotiations, participation in public hearings, proposal preparation, and technical consulting.

Technical Training, Education, Outreach, and Market Support for Renewable Energy Technologies, New York State Energy Research and Development Authority (NYSERDA), 2001 to Present: Providing a variety of services to NYSERDA under multi-year support contract. Tasks include technical training and seminars, technical information and outreach, research papers, market assessments, and data collection and analysis. Specific tasks include an assessment of the impact of NYSERDA funding on the ability of developers to use the Federal Production Tax credit for wind projects. Also conducting outreach and education for local planning agencies, customers, and landowners on large and small wind applications. This work includes identifying sample ordinances and guidelines that impact wind development on a local level, creating a series of fact sheets for landowners, developing a guidebook for local agencies, and conducting workshops to educate various stakeholders about planning, developing, and implementing wind projects.

Wind Powering America (WPA) Program, U.S. Department of Energy/National Renewable Energy Laboratory, 2000 to Present: Providing technical assistance and strategic planning support to WPA program. Work includes planning, facilitation, and logistical coordination of multiple state wind interest group meetings; participation in strategic planning activities; initiation and coordination of Native American wind interest groups, installation of monitoring equipment, and providing input on outreach and educational materials.

Investor and Municipal Utilities, 1988 to Present: Conducted technical and economic feasibility studies for utilities interested in developing wind energy projects or purchasing power from wind projects. Work has included evaluating potential sites, developing and implementing resource assessment programs, estimating energy production, evaluating equipment options, determining capital and operating costs, and investigating operating impacts on the utility grid.

GEC

PROJECT EXPERIENCE

DESIGN, TESTING & ANALYSIS

Members of the GEC team have analyzed and tested wind turbines ranging in size from 8 kW to 3.2 MW and are familiar with the IEC and Germanischer Lloyd requirements for certification. GEC uses the latest software for aerodynamic, structural, and dynamic analysis. State-of-the-art SolidWorks software allows rapid design development, presentation of 3-D images, and export of models for finite element analysis. Our experience includes overseeing multiple wind turbine redesign, test, and retrofit implementation programs and developing, testing, and installing major structural retrofits on more than 500 wind turbines.

ANALYSIS SOFTWARE

- STRUCTURAL DYNAMICS (ADAMS & FAST)
- AERODYNAMICS (PROPID)
- DESIGN (SOLIDWORKS & CADKEY)
- FINITE ELEMENT (ANSYS)

Blade System Design Study, Sandia National Laboratories, 2000 to Present: Identified issues and constraints for the design, manufacture, and use of large wind turbine blades and evaluated alternative design, materials, and processes that may overcome those constraints. Developed design specifications for large blades, performed preliminary designs for 3.0 MW and 5.0 MW blades, developed recommendations for testing of materials, sub-components, and/or sub-scale blades.

Technical Support, The Wind Turbine Company, 1998 to 2001: Supporting design and development of an innovative advanced wind turbine. Activities include failure modes and effects analysis, tower preliminary designs, component test planning, execution and reporting, blade aerodynamic analysis, and certification support.

Technical Support, Commercial Developers and Manufacturers, 2000 to Present: Conducting turbine configuration evaluation and analysis, including loads assessment and overall cost of energy analysis. Also conducted detailed design and test work on blades, towers, and other wind turbine components. Includes wind tunnel and component qualification testing.

Certification Assistance, Bergey Windpower Company, Inc., 1999: Development of certification plans, including review of document preparation, review of current design and manufacturing practices, and identification of actions required to meet ISO 9000 and IEC design evaluation requirements.

Certification Assistance, Atlantic Orient Corporation, 1999: Development of certification plans, including review of document preparation, review of current design and manufacturing practices, and identification of actions required to meet ISO 9000 and IEC design evaluation requirements.

TESTING SERVICES

- POWER PERFORMANCE
- NOISE
- POWER QUALITY
- WIND TUNNEL
- COMPONENT QUALIFICATION
- LOADS

Power Performance Testing, 1999 to Present: Performed power performance tests for multiple turbine vendors on machines ranging from 275 kW to 1.8 MW. Developed innovative approach to anemometer mounting on freestanding towers to ensure compliance with IEC requirements. Conducted TVP power performance tests on seven turbine models ranging from 50 kW to 1.6 MW. Provided input into IEC power performance standards.

GEC

PROJECT EXPERIENCE

RESEARCH ACTIVITIES

GEC has been awarded numerous contracts from the National Renewable Energy Laboratory and other organizations for advanced wind energy research. As a result, GEC staff is familiar with the latest in wind energy design and analysis techniques.

WindPACT Tower Erection Study, National Renewable Energy Laboratory, 2000 to 2002: Researched commercial techniques for erecting large structures in other industries and examined their application for multi-megawatt scale wind turbines. Prepared detailed cost estimates and technical analyses.

WindPACT Turbine Rotor Design Study, National Renewable Energy Laboratory, 2000 to Present: Performed scaling studies for composite wind turbine blades for 80-120 m rotors. Determined the relative impact on cost of energy from changes in wind turbine rotor size and configuration, developed an understanding of the impact these changes have on rotor designs and system dynamics, and identified rotor design issues that may represent technology barriers for future rotor improvements.

WindPACT Transportation and Construction Logistics Study, National Renewable Energy Laboratory, 2000 to 2002: Analyzed the transportation, handling, and erection of multi-megawatt scale turbines. Included cost analyses and trade-off studies, identification of transportation breakpoints, summary of state-by-state limitations, and crane requirements and limitations.

WindPACT Turbine Drive Train Study, National Renewable Energy Laboratory, 2000 to Present: Studying potential drive train configurations and component technologies and identifying the most promising combination for multi-megawatt wind turbine drive trains. Activities include the design, build, and testing of this configuration with the objective of demonstrating the technology and validating the study results. Multi-year, multi-million dollar study involving multiple industry subcontractors.

Wind Turbine Controls Research, X-cel Energy, 2002: Awarded research grant to improve wind turbine control design capabilities by developing new techniques for identification of linearized wind turbine dynamics models. Improved control design capabilities will allow for further advances in lightweight turbine designs and use of technologies such as pitch-twist coupled blades.

Advanced Research Turbine, National Renewable Energy Laboratory, 1999 to 2000: Developed hub design and evaluated loads for the Advanced Research Turbine to permit operating in a variety of hub configurations. Developed configurable multi degree of freedom hub design that would permit operation of turbine in a variety of hub configurations.

Blade Property Extraction Study, Sandia National Laboratory, 2001 to Present: Developed tools to more correctly model exact blade properties including features such as flap-twist coupling. Reduced properties of 3-dimensional blade structures to a series of equivalent beams which can be incorporated into aero-elastic models of the complete wind turbine.

Small Business Innovative Research Grant, U.S. Department of Energy, 2002: Examining innovative uses for carbon fiber in wind turbine blades. Study focuses on the most effective combinations of carbon fiber with fiberglass to enable increased energy capture while mitigating turbine system loads.

REPRESENTATIVE CLIENTS

UTILITIES

- American Electric Power
- Electric Power Research Institute
- Green Mountain Power
- Hawaiian Electric
- Kotzebue Electric Association
- Lincoln Electric
- Manitoba Hydro
- Nebraska Public Power District
- Pacific Gas and Electric Company
- PacifiCorp Power Marketing
- Seattle City Light
- Southern California Edison
- Texas Utilities
- Tucson Electric Power
- Waverly Light and Power
- Wisconsin Public Service Company
- Xcel Energy

GOVERNMENT

- California Energy Commission
- Federal Energy Management Program
- National Park Service
- National Renewable Energy Laboratory
- New York State Energy Research & Dev. Authority
- New Mexico Department of Energy, Minerals, and Natural Resources
- Sandia National Laboratories
- State of Colorado Office of Energy Conservation
- State of Hawaii, Department of Business, Economic Development & Tourism
- State of Washington, Department of Natural Resources
- U.S. Department of Agriculture
- U.S. Department of Defense
- U.S. Department of Energy

FINANCIAL INSTITUTIONS

- ABB Energy Capital
- ABB Equity Ventures
- Barclays
- Commonwealth Development Corporation
- Credit Suisse
- Interamerican Development Bank
- International Finance Corporation
- US West Financial Services
- World Bank

PRIVATE SECTOR

WIND TURBINE VENDORS

- Bergey Windpower Company
- GE Wind Energy Systems
- NEG Micon
- Nordex
- The Wind Turbine Company
- Vestas

DEVELOPERS

- AEP Energy Services
- Clipper
- FPL Energy
- GE Wind Energy Systems
- Northern Alternative Energy/Navitas
- SeaWest

LAW FIRMS/INSURANCE COMPANIES

- Baker & McKenzie
- Weston Benshoof
- Mendes & Mount
- Seltzer, Caplan, Wilkins & McMahon
- Chubb Group
- Underwriters Adjusting Company

ENGINEERING COMPANIES

- Black & Veatch
- Burns and Roe
- Garrad Hassan
- Mortenson

INTERNATIONAL

- Ceylon Electricity Board (Sri Lanka)
- China State Economic and Trade Commission
- Comision Federal de Electricidad (Mexico)
- Indian Renewable Energy Development Agency
- Institute of International Education (Jamaica, Brazil, Honduras)
- Instituto Costarricense de Electricidad (Costa Rica)
- Interamerican Development Bank (Costa Rica)
- Nat'l Rural Electric Cooperative Assn. (Guatemala, India)
- OLADE (Latin America); CEPEL (Brazil)
- Organization of American States
- State Energy Commission of Victoria (Australia)
- State Energy Commission of Western Australia
- U.S. Agency for International Development
- United Nations
- World Bank (China, India, Mexico, Costa Rica, Cape Verde)

GEC

INTERNATIONAL PROJECT EXPERIENCE

GEC has conducted a wide range of wind energy consulting and technology transfer projects in numerous countries worldwide, including:

ARMENIA	CANADA	ECUADOR	MAURITANIA
AUSTRALIA	CAPE VERDE	EGYPT	MEXICO
BELIZE	CHINA	GUATEMALA	PHILIPPINES
BRAZIL	COSTA RICA	INDIA	SRI LANKA

China State Economic Trade Commission (SETC), World Bank: Provided technical assistance to the SETC, World Bank, provincial utilities, and other government agencies in China on the development and evaluation of five wind energy projects totaling 190 MW. GEC's work included wind resource assessment, feasibility studies, economic analysis, energy projections, and other technical consulting. In addition, GEC prepared pre-qualification and bid documents.

NRECA, Asian Development Bank, Indian Renewable Energy Development Agency (IREDA), India: Provided the wind energy expertise on a project team consisting of renewable energy specialists that worked with IREDA to develop project appraisal guidelines for use in evaluating projects funded by the Asian Development Bank. Worked with IREDA counterparts in India for one month to provide training and technical assistance as needed and developed a project appraisal procedure for wind energy projects.

United Nations Development Program, China: Specified and procured wind resource assessment equipment, provided technical input, and conducted training program.

World Bank and Garrad Hassan, Cape Verde: Provided technical and economic analyses to support the evaluation of proposed wind energy projects in Cape Verde. Work included economic and financial analysis of a series of wind projects on three islands. The unique aspects of the project included the incorporation of wind energy at a high penetration level in a small island grid.

Ceylon Electricity Board (CEB), Sri Lanka: Conducted a comprehensive feasibility study environmental impact assessment of a 3 MW wind project for CEB. Identified monitoring locations, evaluated future expansion potential, and analyzed technical and economic feasibility. Prepared technical specifications and bidding documents according to World Bank guidelines and assisted with bid evaluations.

NRECA, Central American Rural Electrification Support Program (CARES), Guatemala: Provided technical guidance to NRECA/CARES personnel on the important considerations for feasibility and pre-feasibility analysis of three different wind energy applications: wind-electric water pumping, remote village electricity supply, and the addition of wind-electric generation to an existing diesel system.

Comision Federal de Electricidad (CFE), Mexico: Conducted wind resource assessment activities, energy projections, and project layout trade-off activities for CFE. Worked with local university to conduct wind mapping and siting tasks.

U.S. Agency for International Development–Site Assessment, Philippines: Developed site screening criteria, conducted field surveys, and educated utility personnel on wind energy site selection process in the Philippines.

SolarEn International, Armenia: Conducted technical and economic analyses for pre-feasibility study of wind project in Armenia. Work focused on establishing requirements for power purchase contracts and identifying barriers to development.

GEC

INTERNATIONAL PROJECT EXPERIENCE

ReTech International, Belize: Conducted pre-feasibility study of wind energy applications in Belize. Work also included regional site surveys, development of a comprehensive monitoring plan, equipment installation, and conduct of wind resource assessment program.

Burns & Roe (U.S. AID), Egypt: Provided the wind energy expertise for a pre-feasibility study of five regions along the Red Sea Coast. GEC personnel were directly involved in all aspects of the study, including economic analysis, environmental assessments, in-country manufacturing evaluation, grid interconnect issues, and local institutional assessments. Approximately 40 person-days spent in Egypt.

Interamerican Development Bank (IDB), IDEA (U.S. AID), Costa Rica: Conducted pre-feasibility and feasibility studies for a 20 MW wind energy project in Costa Rica. Evaluated wind resource information, developed project layouts, predicted hourly project performance, estimated project costs, evaluated project economics, and developed recommendations. The work also included the development of bidding documents for the project. Approximately 50 person-days spent in Costa Rica.

State Energy Commission of Victoria (SECV), Australia: Provided wind power project design services and developed indicative wind farm layouts at two potential project sites in Victoria for different land availability scenarios and wind turbine types. The project included siting the turbines, substations, electrical interconnection, and access roads for each scenario. GEC personnel also assisted in the evaluation of registrations of interest from prospective project developers and provided supporting information on various aspects of the wind industry.

Renewable Energy Growth Assistance Entity, Dominican Republic: Developed energy estimates and cost analyses for a wind project in the Dominican Republic.

Organization of American States, Caribbean: Provided analysis and documentation for a Regional Wind Energy Venture concept paper to evaluate the cost effectiveness, technical merits, and infrastructure requirements of a regionally managed wind energy venture in the eastern Caribbean.

International Finance Corporation, Commonwealth Development Corporation (UK), Mexico and Costa Rica: Conducted technical and financial due diligence for multiple private power projects in Central America. Conducted a review of wind resource assessment work, energy estimates, costs, construction, and O&M plans of several private power projects.

United Nations Development Program and Groupe de Recherche et d'echanges Technologiques, Mauritania: Conducted a small wind application technology survey. Collected data and technical specifications on available small wind-electric equipment and suppliers with interest in forming commercial collaborations with Mauritanian enterprises.

Independent Power Producers' Society of Ontario (IPPSO), Canada: Estimated the technical potential for wind energy development in the province of Ontario and provided supporting information on the status and reliability of wind energy technology and its application in Ontario. GEC personnel also estimated capital costs and operation and maintenance costs for projects of various sizes and configurations.

Manitoba Hydro, Canada: Provided information regarding capital costs, operation and maintenance costs, performance, and siting to Manitoba Hydro to support their investigation of wind energy utilization.

Renewable Energy and Efficiency Fund, Costa Rica: Conducted turbine inspections, developed O&M projections, and provided due diligence services.

GEC

WIND ENERGY TRAINING

GEC develops, coordinates, and presents training courses covering all aspects of wind energy project development and operation, including wind resource assessment, data analysis and interpretation, policy impacts, feasibility analyses, site selection, project design, energy estimations, contract considerations, equipment design, environmental impacts, economic and financial analyses, maintenance strategies, performance monitoring, operations, and reporting.

GLOBAL ENERGY CONCEPTS ***has provided wind energy training programs for utility, government, and private sector agencies throughout the world. Participants have included decision makers from over 20 countries on five continents:***

Argentina	***China***	***Ecuador***	***Indonesia***
Australia	***Chile***	***Ghana***	***Jamaica***
Bolivia	***Columbia***	***Guatemala***	***Mexico***
Botswana	***Costa Rica***	***Haiti***	***Philippines***
Brazil	***Cyprus***	***India***	***South Africa***
	and others		

Course materials and presentations have been translated into Chinese, Spanish & Portuguese.

United Nations Development Program, Wind Resource Assessment-Data Analysis and Equipment Installation, People's Republic of China, April 2002: A 5-day course presented to representatives from China.

Utility-Scale Wind Energy Technology Overview (part of Wind Energy Fundamentals), Portland, Oregon, June 2002 and Washington DC, June 2001: A pre-conference seminar for the American Wind Energy Association.

Wind Energy: Regulation and Commercialization, Fortaleza, Brazil, October 2001: A one-week training course presented to over 100 utility, government, and private sector participants.

Utility Wind Project Development and Feasibility Studies, People's Republic of China, July 1999: A comprehensive 10-day course for approximately 50 participants from utilities, financial organizations, research institutes, and government agencies representing provinces throughout China. Included in-depth case studies, individual project consulting and hands-on exercises.

Wind Energy Applications and Training Symposium, United States, 1990 to 2001: Conducted sessions for annual training symposium on wind resource assessment, siting considerations, wind energy project feasibility, experiences in developing countries, and economic analysis for the American Wind Energy Association. Participants consisted of international energy representatives from targeted countries.

Renewable Energy Project Development Workshop, U.S. Agency for International Development, Organizacion LatinoAmericana de Energia (OLADE), Kingston, Jamaica, October 14-18, 1996: A one-week training course presented to utility, government, and private sector participants.

GEC

WIND ENERGY TRAINING

Brazil Grid-Connected Renewable Energy Training Program, Institute for International Education, Centro de Pesquisas Electricas (CEPEL), Rio de Janeiro, Brazil, October 14-25, 1996. A one-week training course presented to utility, government, and private sector participants.

Proyectos de Desarrollo de Energia Renovable, U.S. Agency for International Development, Organizacion LatinoAmericana de Energia (OLADE), Tegucigalpa, Honduras, March 15-19, 1996. A one-week training course on both large- and small-scale wind technology applications.

Renewable Energy Project Development Workshop, U.S. Agency for International Development, Organizacion LatinoAmericana de Energia (OLADE), Quito, Ecuador, March 18-22, 1996. A 10-day training course on large and small wind applications.

Wind Data Collection and Computer Analysis, Wind Energy Resource Assessment and Siting Considerations, Performance Projections, and Equipment Usage Training Comision de Federal Electricidad, Morelia, Michoacan, Mexico, 1993 to 1998: Conducted training, including classes for engineering staff and utility personnel, on wind resource assessment techniques, data processing, and energy projection methodology. Developed anemometer siting plan and assisted with data logger selection and installation. Provided technical support for wind mapping project using a Geographical Information System.

Wind Energy Conversion Course, Institute for International Education (IIE) Energy Training Program, 1995: Developed, coordinated, and conducted 8-week wind energy training course covering all aspects of wind energy development. Course topics included resource assessment, feasibility studies, economic and financial analyses, procurement, equipment design, bid evaluation, policy impacts, environmental effects, and other topics. Both large- and small-scale wind energy applications were covered. GEC prepared materials, organized field trips, developed exercises, and presented case studies as part of the work. Participants included decision-makers from utilities, government organizations, and research institutes representing approximately 12 countries and five continents.

Financial Due Diligence Workshop, U.S. Export Council for Renewable Energy and Comision de Federal Electricidad Morelia, Michoacan, Mexico, May 1994: Conducted training on financing geothermal and wind projects.

Wind Energy Technology Workshop, U.S. Export Council for Renewable Energy, Gaborone, Botswana, March 1994: Conducted training on opportunities for renewable energy development.

Renewable Energy in the Americas, Puerto Rico, 1994: Conducted sessions covering renewable energy project feasibility and economic analysis. Presented to energy officials from Latin America and Caribbean countries. Case studies and examples included wind, photovoltaic, solar thermal, biomass, and other renewable technologies.

Central America Wind Energy Seminar, Costa Rica, 1994: Conducted sessions covering site analysis and selection, small wind systems integration, and economic aspects of wind energy technology.

Encontro Tecnico de Energia Eolica, Centro de Pesquisas de Energia Electrica and the U.S. Department of Energy, Rio de Janeiro, Brazil, 1994: Conducted sessions on wind project development process and utility integration and applications issues for an audience of approximately 50 utility officials.

GEC

PUBLICATIONS AND PRESENTATIONS

GEC personnel have published and presented hundreds of technical documents and papers. Recent examples are listed below.

INTERNATIONAL CONFERENCES

Experiences with the U.S. Wind Turbine Verification Program (TVP). Global Windpower 2002, Paris, France, April 2002.

Advanced Wind Turbine Drive Train Concepts. Global Windpower 2002, Paris, France, April 2002.

The Potential for Offshore Wind Development in the United States. Second International Workshop on Transmission Networks for Offshore Wind Farms, Stockholm, Sweden, March 2001.

The Potential for Increasing Usage of Carbon Fibers in Wind Turbine Blades. Global Outlook for Carbon Fiber 2001, Bordeaux, France. October 2001.

Worldwide Experience in Installing and Operating the AOC 15/50 Wind Turbine in High Penetration and Low Penetration Wind Diesel Systems at Severe Sites. European Wind Energy Conference 2001, Copenhagen, Denmark, July 2001.

U.S. CONFERENCES

Windpower 2002 (AWEA), Portland, Oregon, June 2002

Advanced Wind Turbine Drive Train Concepts.

Applicability of Nacelle Anemometer Measurements for Use in Turbine Power Performance Tests.

Evaluation of Wind Shear Patterns at Midwest Wind Energy Facilities.

Evaluation of Numerical Models for Wind Speed Predication in Complex Terrain.

Lessons from the WindPACT Rotor Design Study.

Windpower 2001 (AWEA), Washington, D.C., June 2001

Characterizing the Effects of High Wind Penetration on a Small Isolated Grid in Arctic Alaska.

Power Performance Testing Progress in the DOE-EPRI Wind Turbine Verification Program.

Power Quality of Distributed Wind Projects in the Turbine Verification Program.

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WORKSHOPS AND SEMINARS

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For a more complete listing, please visit our website at www.globalenergyconcepts.com

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ADDITIONAL REFERENCES AVAILABLE ON REQUEST

GEC

GEC PERSONNEL

Karen Conover, CEO
Ms. Conover has over 15 years of experience with wind energy technology and other renewable energy applications. She is a Past President and current member of the AWEA Board of Directors and she served as Chair of WindPower '96. Her work includes wind resource assessment, project design, technical due diligence, site selection, feasibility studies, financial and economic analysis, bid preparation and evaluation, project development, policy evaluations, training, testing, construction oversight, performance evaluation, and O&M planning. Ms. Conover has conducted wind energy work for projects and programs in India, China, Mexico, Costa Rica, Guatemala, Ecuador, Brazil, Jamaica, Egypt, Sri Lanka, Australia, Canada, Cape Verde and other countries. Her clients include the World Bank, the International Finance Corporation, USAID, Interamerican Development Bank, Institute of International Education, numerous domestic and international utilities and developers, U.S. DOE, NREL, and EPRI. She has authored numerous publications on wind energy technology and applications, and is frequently asked to speak at technical meetings, training courses and conferences. Ms. Conover holds an M.S. in Energy Systems Engineering from the University of Arizona and a B.S. in Mechanical Engineering and Material Science from Duke University.

Robert Z. Poore, President
Mr. Poore has over 20 years of experience in the design, testing, and analysis of wind energy systems. He has led multiple due diligence investigations, engineering design and test programs, feasibility and economic analyses, wind resource assessment projects, research studies, and training programs. He has served as the Independent Engineer on multiple projects. In addition to his technical skills, he is experienced with the financial and institutional considerations of wind projects. His clients include financial institutions, turbine manufacturers, utilities, insurance companies, law firms and government agencies. In 1999, Mr. Poore received the AWEA award for technical excellence. He has served as a member of AWEA's Board of Directors, and he leads the wind industry's annual Research and Development (R&D) forum. Prior to GEC, Mr. Poore held positions as a systems engineer for the Boeing Wind Program and as the President of Advanced Wind Turbines, Inc., where his responsibilities included developing and managing design, test, and certification programs; providing operations and engineering oversight; guiding technology development from prototype to production; and establishing technology transfer programs with China and India. Mr. Poore holds a B.S. degree in Mechanical Engineering and an MBA in Finance and International Business.

Dr. David Malcolm, Senior Engineer/Analyst
Dr. Malcolm has over 25 years of professional experience in the design and analysis of complex structures, and is recognized as one of the wind energy industry's leading analysts, specializing in dynamic modeling and structural analysis. He also has extensive experience developing wind turbine loads, assessing causes of failures, evaluating turbine inflow characteristics, assessing the impact of extreme atmospheric events on structures, and developing certification documentation. Dr. Malcolm has developed dynamics models of several different wind turbine designs, has been responsible for structural analysis of blades, towers, welded and cast components, and has written a unique piece of software to identify and graphically display the structural modes of wind turbines. His experience includes application of fracture mechanics and reliability concepts to wind turbine design and analysis. Dr. Malcolm has published numerous papers and holds B.S., M.S., and Doctoral degrees in Engineering.

GEC PERSONNEL

Terry Lettenmaier, Senior Electrical Engineer
Mr. Lettenmaier is a registered Professional Engineer with over 10 years of power electronic design experience. He is currently leading a multi-million dollar technology development program to investigate innovative generator and power electronic architectures for wind turbines. Under this program, his responsibilities include oversight and management of multiple industry subcontractors, scheduling and budget tracking, documentation, engineering analysis, and testing. Mr. Lettenmaier's work also includes design and analysis of industrial variable speed drives, switching power supplies, and battery chargers. He has investigated power quality issues for wind turbines and co-authored several publications on this topic with staff from the National Renewable Energy Laboratory. He is experienced in all aspects of project engineering, including estimating, preparing specifications, preliminary and detailed design, documentation, and field testing. He holds an M.S.E.E. from the University of Wisconsin - Madison and a B.S.E.E. from the University of Washington.

Kevin Smith, Project Manager
Mr. Smith is a registered Professional Engineer with over 10 years of professional consulting, project management, and engineering experience in the environmental and wind energy industries. He has served as an independent engineer for several wind project investors and conducted feasibility analyses and wind energy siting activities in the U.S. and abroad. His recent work includes conducting a comprehensive assessment of the potential for offshore wind projects in the U.S. and serving as the principle investigator for a study of transportation and assembly logistics associated with multi-megawatt wind turbines. Mr. Smith has presented papers and research findings at U.S. and international conferences and workshops. His experience includes engineering design, power curve testing, contractor procurement, construction oversight, performance evaluation, feasibility assessment, and information dissemination. Mr. Smith has also conducted site assessment, work plan development, data analysis and interpretation, feasibility studies, economic analysis, and report preparation for environmental remediation projects. He holds a B.S. degree in Mechanical Engineering from the State University of New York at Buffalo.

Timothy McCoy, Senior Engineer/Analyst
Mr. McCoy has 14 years of experience in the analysis and testing of wind energy systems. His areas of expertise include test planning and conduct, test data analysis, loads development, finite element analysis and wind turbine controls. Mr. McCoy also has substantial experience in the evaluation of wind turbine wakes and wind energy resource assessment. He recently served as the lender's project engineering representative for a 30 MW wind energy project. He has developed and conducted test and certification programs on numerous wind turbines and their components and he has used the results of these tests to develop design loads and certification documentation. Mr. McCoy has provided customer support with troubleshooting problems in wind turbine controls, hydraulics and electrical systems. He has also developed, and validated through testing, numerous finite element models of complex structures. He has written custom computer programs to process and evaluate test data and he has extensively modified wind turbine controls software. Mr. McCoy holds B.S. and M.S. degrees in Mechanical Engineering.

GEC PERSONNEL

Dayton Griffin, Design and Analysis Engineer
Mr. Griffin has seven years of aerodynamic design and test experience. He has designed, conducted, and documented numerous wind energy testing programs, including turbine power performance tests, wind tunnel tests on vortex generators and aerodynamic braking devices, full-scale blade fatigue and static tests, field tests of vortex generator performance, and dynamometer-based gearbox efficiency tests. Mr. Griffin has also developed software to predict the dynamic behavior of trailing-edge aerodynamic brakes with both passive and active deployment systems and has developed loads and determined sizing for these systems. He has made analytical predictions of turbine performance and conducted trade studies on the effects of rotor size, speed, and geometry for both fixed-speed and variable-speed operation. His design experience includes detailed design and testing of bolted blade root connections, design of trailing edge aerodynamic braking devices, and development of design tools to simplify the parametric assessment of the relationship between blade aerodynamic and structural performance. Mr. Griffin has represented the U.S. at international standards development meetings addressing design safety (IEC 1400-1), performance measurement (IEC 1400-12), and wind turbine blade testing (IEC 1400-23). He has presented his work, by invitation, at several international wind industry symposiums. Mr. Griffin holds B.S. and M.S. degrees in Aeronautics and Astronautics and is currently completing doctoral work.

Rana Vilhauer, Senior Technical Analyst
Ms. Vilhauer has more than 15 years experience in the wind energy industry. She manages GEC's data analysis group and her work includes providing oversight on wind resource assessment programs, conducting site selection and feasibility studies, performing economic and financial analyses, and evaluating performance data. She also maintains GEC's wind data and turbine performance databases. Ms. Vilhauer has delivered wind energy training courses, spoken at conferences, and authored a number of wind energy publications. She has conducted wind energy work in several countries, including Belize, Mexico, and China, and she has specific expertise with small wind applications and village power. Ms. Vilhauer has also been involved in bid preparation and bid evaluation for wind energy equipment, project development activities, and project design services. She has worked with a wide variety of domestic and international clients, including U.S. DOE, NREL, EPRI, the United Nations Development Program, the World Bank, utilities and developers, and financial institutions. Ms. Vilhauer holds a degree in accounting and has completed additional course work in computer science, mathematics, management skills, and technical writing.

Gordon Randall, Technical Analyst
Mr. Randall has eight years of experience in professional consulting, statistical analysis, computer model development, regulatory compliance, and project management. His responsibilities at GEC include analysis and reporting of performance data, planning and conduct of turbine performance tests, and development of systems for evaluation of turbine data. Mr. Randall is also experienced with spatial analysis of data using geographic information systems, dispersion modeling, development of Internet-based information management systems, and risk analyses. He has conducted wind flow modeling, energy projections, site optimization studies, visualization, and wake estimations on a number of wind projects and he is familiar with several different commercially available software programs for wind modeling activities. His recent work has included an investigation of the operational impacts of wind energy projects on utility grids, analyses of nighttime wind shear values at Midwest project sites, and the development of methods for using nacelle anemometers to verify performance of wind turbines.

GEC PERSONNEL

Mark Young, Project Engineer
Mr. Young has more than four years of technical and project management experience in wind energy applications and related engineering fields. He has experience with power curve testing, solid modeling, loads and turbine performance prediction, manufacturing process improvement, the creation of technical manuals, and work using international design standards. He has conducted economic analyses, site assessment and feasibility studies, component failure analysis, Failure Modes and Effect Analysis (FMEA), and an assessment of operations and maintenance costs for wind turbines. Mr. Young has extensive field service, troubleshooting, and testing experience on wind equipment. He has conducted training courses on the installation of wind monitoring equipment and served as the field test engineer for a number of power curve tests on wind turbines ranging from 50 kW to 1.5 MW. Prior to GEC, Mr. Young worked for a wind turbine manufacturer where he gained experience with the design and improvement of wind turbine systems and components, including blades, towers, gearboxes, generators, and controllers. Mr. Young holds a B.S. degree in Mechanical Engineering from the Pennsylvania State University.

Sarah Meyer, Project Coordinator
Ms. Meyer has been working in the renewable energy industry for more than three years. She coordinates GEC's wind resource assessment programs and has primary responsibility for data collection, archive, quality control, analysis, and reporting of meteorological data from wind monitoring stations in more than a dozen different states and countries. She creates and edits deliverables for a number of GEC's clients, including the preparation and dissemination of the Quarterly TVP Bulletin, an electronic newsletter that summarizes performance data from seven wind energy projects and provides articles and analyses related to the TVP. She also provides logistical support and coordination of meetings and training courses, prepares technical specifications and procurement documentation, and develops computer graphics and illustrations. Ms. Meyer holds a B.S. degree in Environmental Studies – Natural Sciences from Northland College in Wisconsin.

Eli D. Reich, Project Engineer
Mr. Reich provides technical and analytical support on a number of different wind energy engineering and design projects. He also has experience in resource assessment and siting considerations for small wind energy systems. His recent work has focused on support for NREL's WindPACT rotor design project, reviewing and documenting performance from a small wind project in the Midwest, and analyzing meteorological data from a project site in the Northwest. He has also conducted research on permitting barriers for large and small wind turbines and documented local ordinances related to wind project installation in the U.S. Mr. Reich holds a B.S. degree in Mechanical Engineering from Cornell University.

In addition, GEC maintains affiliations with technical, regulatory, economic, and environmental experts from leading industry and academic organizations in order to provide additional depth, flexibility, and responsiveness to our clients.

INDUSTRY ACHIEVEMENTS & RECOGNITION

AWARDS

2002 Outstanding Commercial Achievement Award
American Wind Energy Association, presented to Global Energy Concepts
"For building one of the most respected wind energy consultancies in the world."

1999 Technical Excellence Award
American Wind Energy Association, presented to Robert Poore
"In recognition of exceptional and longstanding contributions to the advancement of wind energy technology."

APPOINTMENTS/ELECTED POSITIONS

President, Board of Directors, American Wind Energy Association, Karen Conover, 1998-1999

Member, Board of Directors, American Wind Energy Association, Karen Conover, 1995-2002

Member, Board of Directors, American Wind Energy Association, Robert Poore, 1999-2002

Founding Board Member, American Wind Power Institute, Karen Conover, 2001-2002

Chair, Windpower '96, Annual Conference of the American Wind Energy Association, Karen Conover

Chair, R&D Subcommittee, DOE-AWEA Liaison, Robert Poore, 2000-2002

U.S. Steering Committee Representative, Global Windpower Conferences, Karen Conover, 2002

Technical Committee Member, Global Windpower Conferences, Robert Poore, 2002

OTHER INDUSTRY COMMITTEES

Member of the U.S. Technical Advisory Group (TAG) to the ANSI/IEC organizations for wind energy standards

Wind Powering America Strategic Planning Committee

Windpower Conference Committee (AWEA)

Program Management Committee of the EPRI/DOE Turbine Verification Program