JAMES F. MANWELL

Research Associate Professor
Director, Renewable Energy Research Laboratory
Department of Mechanical and Industrial Engineering
University of Massachusetts
Amherst, MA 0l003

EDUCATION:

Western Reserve Academy, Hudson, Ohio, 1965
Brentwood School, Brentwood, Essex, England, 1966
B.A. Biophysics, Amherst College, l970 (cum laude)
M.S. Electrical and Computer Engineering, University of Massachusetts, l977
Ph.D. Mechanical Engineering Department, University of Massachusetts, 1981

PROFESSIONAL SOCIETY MEMBERSHIP:

World Wind Energy Association (WWEA)
American Wind Energy Association (AWEA)
International Solar Energy Society (ISES)
American Solar Energy Society (ASES)

HONORS AND AWARDS:

U. S. Department of Energy, Wind Powering America Program, Wind/Diesel Systems Pioneer Award, 2002
American Wind Energy Association Award for Academic Achievement, 1994: "For Continuing Contribution to Wind Technology Teaching and Research"
Department of Energy - Energy Traineeship, l978-l979
English Speaking Union Exchange Student Fellowship, l965-l966
Sigma Xi, Tau Beta Pi

RECENT PROFESSIONAL EXPERIENCE:

1987-Present Research Associate Professor and Director, Renewable Energy Research Laboratory, University of Massachusetts.

1985-1986 Visiting Professor, National Engineering University, Managua, Nicaragua: taught course on wind energy (in Spanish), worked on development of micro-hydropower projects for rural electrification.

1982-1987 Assistant Director, Energy Analysis and Diagnostic Center, Mechanical Engineering Department, University of Massachusetts.

TEACHING EXPERIENCE:

Teaching experience includes a variety of courses and special projects related to thermodynamics, fluid mechanics and energy, taught at the Dept. of Mechanical Engineering at the University of Massachusetts. These are listed below. In addition, I developed and taught a course on wind energy (w/ D. Cromack) through the Video Instructional Program at the University of Massachusetts. Other recent teaching includes short courses on hybrid power systems at the National Renewable Energy Laboratory in Golden, CO and at two Latin American universities.

Courses Taught at the University of Massachusetts

ME 230	Thermodynamics I
ME 302	Mechanical Engineering Laboratory (w/ L. Ambs)
ME 3l0	Dynamics
ME 340	Fluid Mechanics I
ME 34l	Fluid Mechanics II (w/ R. Kirchhoff)
ME 354	Heat Transfer
ME 570	Solar and Direct Energy Conversion
ME 573	Engineering of Windpower Systems
ME 574	Advanced Energy Conservation
ME 597B	Advanced Windpower Engineering

RECENT MAJOR RESEARCH ACTIVITIES AND ACCOPMPLISHMENTS

Hull Utility Scale Wind Turbine

Principal Investigator on a project resulting in the installation in 2001 of the largest wind turbine (660 kW) to yet be installed in New England. The installation is owned and operated by the Hull Municipal Light Plant. The project was developed by the Hull Light Plant and the Renewable Energy Research Laboratory with support from the Massachusetts Division of Energy Resources.

Advanced Wind Turbine Control

Principal Investigator on development, implementation of an advanced wind turbine controller. The controller is designed to operate the wind turbine at variable speed in a way that maximizes energy production while reducing fatigue damage. The method being investigated employs fuzzy logic techniques to facilitate near optimal control in the presence of noisy inputs.

Hybrid Power System Simulation

Principal Investigator on the development of a comprehensive simulation code for predicting the performance of hybrid power systems. These systems typically consist of renewable energy sources, storage, control systems, and conventional generators, used for supplying electric power in remote applications and developing countries. The resulting computer code, Hybrid2, was developed in close cooperation with the Hybrid Power Program at the National Renewable Energy Laboratory. I was the primary architect of the simulation engine, formulated the majority of the algorithms, and did most of the coding of the simulation engine.

Wind Turbine Drive Train Dynamic Analysis
Principal Investigator on a National Renewable Energy Laboratory sponsored research project investigating the response of wind turbine drive trains to dynamic and transient events. The research involved development of a computer code to model the behavior of wind turbine rotor, gearbox, generator and brakes under a variety of starting, stopping, and operating conditions. Validations of the code using field test data were also carried out.

Large Wind Turbine Installation and Operation
Principal Investigator for the upgrade and installation of a 250 kilowatt wind turbine on Mt. Tom in Holyoke, MA. The turbine was until recently the largest operating wind turbine in New England, and one of the largest of its type to be installed in a Northern climate. The ongoing project involves integrating an advanced controller, assessing long term operation and evaluating options for design improvements appropriate to remote sites.

Battery Performance Modeling
Developer of a physical principles based, analytical model for the performance of lead acid and nickel cadmium batteries. Together with readily obtainable operating data, the model can predict voltage and capacity of batteries during various charging and discharging conditions. The model is becoming the preferred one throughout the world in hybrid power simulation applications.

Massachusetts Strategic Envirotechnology Program
Principal Investigator on a Massachusetts Division of Energy Resources program to assist companies in the development and commercialization of environmentally beneficial technologies. The focus of the effort is specifically on those technologies which enhance the efficiency of energy use, or involve the supply of energy requirements from renewable sources.

Brazilian Educational Cooperation in Renewable Energy
Initiated a cooperative program between the University of Massachusetts College of Engineering and the Wind Energy Program at the Federal University of Pernambuco (Recife, Brazil). The program involved exchange of students and faculty. Support was provided by Brazilian utilities, research facilities, and the U.S. National Renewable Energy Laboratory.

LANGUAGES:

Spanish, German

SELECTED PROFESSIONAL ACTIVITIES:

2003-	Advisor to the National Academy of Sciences on Offshore Wind Energy Technology

2002-	US Representative to International Electrotechnical Commission Technical Committee 88 Working Group on Design Standards for Offshore Wind Turbines
2002	2002 World Wind Energy Conference Technical Program Co-Chairman
2000-present	Advisory Committee Workshops on Offshore Transmission Systems, Stockholm, Sweden
2000-present	American Society of Mechanical Engineers Wind Energy Technical Committee
1993-1995	Istituto di Richerche per le Energie Rinnovabli e il risparmio Energetico, CONPHOEBUS, Catania, Italy: Design of hybrid power system simulator
1993-1994	Government of Estonia: Options for the implementation of utility wind generation on the island of Saaremaa
1992-1994	Center for Renewable Energy Resources, Greece: Hybrid power system design and assessment of renewable energy driven desalination systems.
1989-1991	United Nations Development Program: Computer modeling of wind and solar electric systems for remote applications.
1987-1992	United States representative to International Energy Agency Annex VIII (Autonomous Wind Electric Systems)
1987-1989	Empire State Electric Energy Research Corporation: evaluation of wind machines for application to New York State electric utilities.
1986-1994	US Representative to International Energy Agency Wind Energy Program, Annex VIII: Wind/Diesel Systems
1986-1992	Danish Center for Renewable Energy: applications of renewable energy in developing countries.
1981-1982	New York State Energy Office: wind site analysis for two Long Island sites including site instrumentation and data analysis.
1981-1982	City of New Bedford, MA: wind power data collection, analysis and feasibility study.
1979-1980	Tennessee Valley Authority: wind resource evaluation, site selection, and equipment specification.

SELECTED PUBLICATIONS:

Book: Wind Energy Explained: Theory, Design and Application, Wiley InterScience, Chichester, UK, June, 2002 (w/ J. G. McGowan, A. L. Rogers)

Book: contributing author to Wind/Diesel Systems: A Guide to the Technology and its Implementation (edited by R. Hunter and G. Elliot), Cambridge University Press, Cambridge, UK, 1994

Encyclopedia Article: "Hybrid Energy Systems", Encyclopedia of Energy, Publication expected 2003

"Investigation of the Applicability of SODAR for Wind Resource Measurements in Complex and Inhomogeneous Terrain," AIAA/ASME Wind Energy Symposium, Reno, NV, January, 2003 (w/ Rogers and Grills)

"Design Requirements for Medium Sized Wind Turbines for Remote and Hybrid Power Systems," Renewable Energy, 26, No. 2, pp. 157-168, 2002 (w/ Rogers, Ellis and McGowan

"A Year 2000 Summary of Offshore Wind Development in the United States," Energy Conversion and Management, 44, pp. 215-229, 2003 (w/ Rogers and McGowan)

"Potential for Wind Energy Development on New England Islands," Proc. of World Wind Energy Conference, Berlin, WIP-Munich, July 2002 (w/Blanco and Rogers)

"Design and Modeling of Dispatchable Heat Storage in Remote Wind/Diesel Systems", Proc. of World Wind Energy Conference, Berlin, WIP-Munich, July 2002 (w/McGowan, Johnson, Abdulwahid and Rogers)

"Design and Modeling of Dispatchable Storage in Wind/Diesel Systems," Proc. of the 2002 AWEA Annual Conference, Portland, OR, June, 2002 (w/ Johnson, Abdulwahid and Rogers)

"A Feasibility Study for Wind/Hybrid Power System Applications for New England Islands," Proc. of the 2002 AWEA Annual Conference, Portland, OR, June, 2002 (w/ Blanco and McGowan)

"Review of Power Transmission Options and Issues for Offshore Wind Farms in the United States," Proc. of the 2002 AWEA Annual Conference, Portland, OR, June, 2002 (w/ Wright, Rogers and Ellis)

"An Offshore Wind Resource Assessment Study for New England," Renewable Energy 27 (2002) 175-187 (w/ Rogers, McGowan, and Bailey)

"Assessment of the Southern New England Offshore Wind Energy Resource," Proc. of the 2001 AWEA Annual Conference, Palm Springs, CA, June, 2001. (w/ McGowan, Rogers, and Bailey)

"Status of Offshore Wind Energy Development in the United States," Proc. of the Second International Workshop on Transmission Systems for Offshore Wind Farms, Stockholm, SE, March, 2001

"Experimental Investigation of Yaw Damping on a Downwind Turbine," Proc. of the ASME Wind Energy Symposium, Reno, NV, January, 2001 (w/ Rogers, Ellis, Abdulwahid and Solomon)

"Assessment of the Massachusetts Offshore Wind Energy Resource," Proc. of the European Wind Energy Conference, Copenhagen, DK, July 2001 (w/McGowan, Rogers and Bailey)

"Hybrid Wind Diesel System Research at the University of Massachusetts," Wind Engineering, Nov. 2000 (w/ McGowan and Rogers)

"Simplified Performance Model for Hybrid Wind/Diesel Systems, Renewable Energy, September, 2000 (w/ McGowan and Abdulwahid)

"UMass Mini-Codes for Wind Energy Engineering Applications," Proc. AWEA Annual Conference, May, 2000, (w/ Rogers and McGowan)

"A Fresh Look at Offshore Wind Opportunities in Massachusetts," Proc. AWEA Annual Conference, May, 2000, (w/ Rogers, McGowan, Ellis, Abdulwahid, and LaCroix)

"Wind Turbine Gearbox Evaluation," Proc. European Wind Energy Association Conference, Nice, France, March, 1999 (w/ Rogers)

"Icing of Wind Turbines: Effects and Options for Mitigation", Proc. Canadian Wind Energy, Conference, September 1999 (w/ Lacroix)

"Hybrid Wind/PV/Diesel Experience," Proc. World Renewable Energy Conference, Florence, Italy, September, 1998. (w/ McGowan)

"Requirements for Medium and Large Wind Turbines for Remote and Hybrid Power Systems," Proc. 1st Annual Brazilian Wind Energy Conference, Recife, Brazil, October, 1998 (w/Rogers)

"Development of a Wind Turbine Controller Testing Environment," Proc. AWEA Annual Conference, June, 1998, (w/ Goldstein and Rogers).

"Operational Experience with a 250 kW Teetered Rotor Wind Turbine on an Inland New England Ridge Top," Proc. of the 1998 ASME Wind Energy Symposium, Reno, NV, January, 1998 (w/ Rogers, Ellis and Goldstein)

"Hybrid Wind/Diesel/PV Systems," Renewable Energy (accepted 1998, w/McGowan)

"Development of a Graphical Interface Model for Wind Turbine Drive Trains," Proc. European Wind Energy Conference, Dublin, October, 1997 (w/ Abulwahid, Rogers, McNiff and McGowan).

"Computer Control for Remote Wind Turbine Operation," Proc. American Wind Energy Association Annual Conference, Austin, TX, June, 1997 (w/Rogers Adulwahid, and Driscoll).

"Development of a Dynamic Model for No Storage Wind/Diesel Systems," Wind Engineering, 20, No. 1, pp 27-38, 1996 (w/ Jeffries and McGowan).

"Wind Diesel System Simulation: A Screening Level Model," International Journal of Solar Energy, 17, pp 223 - 240, (w/ McGowan).

"Hybrid2- The Hybrid Power System Simulation Model," Proc. AWEA Wind Power 1996, pp 497- 506, (w/ Baring-Gould, Green, and van Dijk).

"Design and Evaluation of Hybrid Wind/PV/Diesel Power Systems for Brazilian Applications," Proc. AWEA Wind Power 1996, pp 507- 516, (w/ McGowan, Avelar, and Warner)

"Design Improvements to the ESI-80 Wind Turbine," Proc. AWEA Wind Power 96, pp 563- 572 (w/ Rogers, Kleeman and McGowan).

"A Graphical Interface Based Model for Wind Turbine Drive Train Dynamics, Proc. AWEA Wind Power 96, pp 583- 592, (w/ Abdulwahid, McNiff, Rogers and McGowan).

"Hybrid Wind/PV/Diesel Hybrid Power Systems Modeling and South American Applications," Renewable Energy, 9, No. 1-4, pp 836-847 (w/ McGowan, Avelar, and Warner).

"Development of Dynamic Models for No Storage Wind/Diesel Systems," Proc. of the 17th British Wind Energy Association Conference, July ,1995 (w/ Jeffries and McGowan).

"Modeling of Wind/Diesel/Hybrid Systems," Energy Environment Monitor, 11, No. 1, pp 47-58, 1995 (w/ McGowan).

"Recent Progress in Battery Models for Hybrid Wind Power Systems," Proc 1995 AWEA Annual Conference, March 1995 (w/ McGowan, Baring-Gould and Stein).

"Hybrid2- A Versatile Model of the Performance of Hybrid Power Systems, Proc of the 1995 AWEA Annual Conference, pp 437- 226, March 1995 (w/ Green)

"Bringing Wind Power Back East: Redesign, Installation and Initial Operating Results for the Original ESI-80 in Massachusetts, Proc 1995 AWEA Annual Conference, pp 489- 498, March 1995 (w/ Baring-Gould, Ellis, and Stein).

"Hybrid Systems Modeling: Development and Validation," Wind Engineering 18(5), 1994, pp 241- 255 (w/ McGowan).

"A Combined Probabilistic/ Time Series Model for Wind Diesel Systems Simulation," Solar Energy, 53(6), 1994, pp 481- 490 (w/ McGowan).

"Extension of the Kinetic Battery Model for Wind/Hybrid Power Systems," Proc. European Wind Energy Conference'94 Thessaloniki, Greece, October, 1994 (w/ McGowan).

"A Markov Process Based Performance Model for Wind/Diesel/Battery Storage Systems, "Proc. European Wind Energy Conference'94 Thessaloniki, Greece, October, 1994 (w/ Deng and McGowan).

"Evaluation of Battery Models for Wind/Hybrid Power Systems," Proc. European Wind Energy Conference'94 Thessaloniki, Greece, October, 1994 (w/ McGowan).

"Development of an Experimental Hybrid Power System Incorporating a Variable Speed Diesel Generator," Proceedings of the 1994 AWEA Annual Conference, Minneapolis, MN, 1994 (w/ Stein, Rogers, Jeffries and McGowan).

"Hybrid Systems Modeling: Development and Validation," Proceedings of the 1994 AWEA Annual Conference, Minneapolis, MN, 1994 (w/ McGowan, Baring-Gould, Jeffries, and Stein).

"A Techno-Economic Evaluation of Hybrid Power Systems," Proceedings of the 1994 AWEA Annual Conference, Minneapolis, MN, 1994 (w/ McGowan, O'Donovan, and Stein).

"Development of a Wind Turbine Drive Train Analysis Code," Proceedings of the 1994 AWEA Annual Conference, Minneapolis, MN, 1994 (w/ McNiff and Xie)

"Experimental Validation of the University of Massachusetts Wind/Diesel System Simulation Code, HYBRID1," Proc. 13th ASME Wind Energy Symposium, January, 1994 (w/Baring-Gould, Jeffries, and Stein).

"Teetered Rotor Dynamics in Complex Terrain," Proceedings of the 13th ASME Wind Energy Symposium, New Orleans, LA, January, 1994 (w/ Bywaters)

"Bringing Wind Power Back East: A New Life for the Original ESI-80 in Massachusetts", Proceedings of the AWEA Annual Conference, San Francisco. CA. 1993 (w/ Stein and McNiff)

"Modeling and Validation of Advanced and Conventional Wind/ Diesel Systems," Proc. Wind Energy Penetration into Weak Electricity Networks, British Wind Energy Assoc., June 1993 (w/ McGowan).

"A Screening Level Model for Wind/Diesel System Simulation," Proceedings of the American Solar Energy Society Conference, Washington, April, 1993 (w/ McGowan)

"Experimental Testing of Variable Speed Diesels for Wind/Diesel Systems," Proceedings of the 12th ASME Wind Energy Symposium, Houston, TX, January, 1993 (w/ Rogers, Stein and McGowan)

"A Power Electronics Based Power Shedding Control for Wind/Diesel Systems," International Journal of Ambient Energy, Vol. 13, No. 2, 1992 (w/ Stein and McGowan)

"An Investigation of Variable Speed Operation of Diesel Generators in Hybrid Energy Systems," Renewable Energy, Vol. 2, No. 6, 1992 (w/ Stein, Rogers and McGowan)

"A Combined Probabilistic/Time Series Model for Wind/Diesel System Simulation," Proceedings of AWEA/CanWEA Wind Diesel Conference, June, 1992 (w/ McGowan).

"Advances in Quasi-Steady Wind/Diesel System Modeling," Proceedings of the 11th ASME Wind Energy Symposium, Houston, TX, January, 1992 (w/ McGowan)

"Variable Speed Operation of Diesel Generators in Hybrid Energy Systems: Potential Fuel Savings," Proceedings of the 11th ASME Wind Energy Symposium, Houston, TX, January, 1992 (w/ Stein, Rogers and McGowan)

"Limitations and Recommendations Regarding the Shinozuka Method for Simulating Wind Data," Wind Engineering, Vol. 15, No. 3, 1991 (w/ Jeffries and Infield)

"Investigations into Power Fluctuations of a Horizontal Axis Wind Turbine," Proceedings of the European Wind Energy Conference, Amsterdam, October, 1991 (w/ Jeffries, McGowan and Stein).

"Status of Renewable Energy Driven Desalination of Water in North America," Proceedings of the Seminar on New Technologies for the Use of Renewable Energy Sources in Water Desalination, Athens, Greece, September, 1991 (w/ McGowan).

"Comparison Using Time Step Simulation of Free Wheeling vs. Anemometer Controlled Wind Turbine Generators," Proceedings of the AWEA Annual Conference, Palm Springs, CA, September, 1991 (w/ Stein).

"A New Battery Storage Model for Wind/Diesel Systems," Proceedings of the AWEA Annual Conference, Palm Springs, CA, September, 1991 (w/ McGowan).

"Power Fluctuations from a Horizontal Axis Wind Turbine," Proceedings of the 10th ASME Wind Energy Symposium, Houston, TX, January, 1991 (w/ Jeffries and McGowan).

"Developments in Battery Storage for Wind/Diesel Systems, "Proceedings of the 6th Annual Battery Conference on Applications and Advances, University of California at Long Beach, January, 1991 (w/ McGowan).

"Electrical/Mechanical Options for Variable Speed Wind Turbines", Solar Energy, Vol. 46, No. 1, pp. 41-51, 1991 (w/ McGowan and Bailey).

"Wind/Diesel Village Scale Electric Power Systems: The Performance and Economic Analysis of a Simulated Village System," Solar and Wind Technology, Vol. 7, No. 4, pp. 423-439, 1990 (w/ Connors and McGowan).

"A Simplified Method for Predicting the Performance of a Horizontal Axis Wind Turbine Rotor," Proceedings of the Annual Conference of the American Wind Energy Association, Washington, D.C., September, 1990.

"Pulse Width Modulated Dump Load Control for Wind/Diesel Systems, Proceedings of the European Community Wind Energy Conference, Madrid, Spain, September, 1990 (w/ Stein, McGowan, and Jeffries)

"A Comparison of Alternative Approaches for the Generation of a Wind Speed Time Series," Proc. 9th ASME Wind Energy Symposium, New Orleans, 1990 (w/ Kaminsky, Kirchoff, and Syu)

"Development of Quasi-Steady Analytical Models for Wind/Diesel Systems," Proc. 9th ASME Wind Energy Symposium, New Orleans, 1990 (w/ McGowan, Rogers, and Jones)

"Experimental Data from the Block Island Wind/Diesel Project," Wind Engineering, Vol. 13, No. 3, 1989 (w/ McGowan and Jeffries)

"Experimental Modelling with a Wind/Diesel System Simulator," Proceedings of Windpower '89, San Francisco, CA, September, 1989 (w/ McGowan, Stein and Rogers.)

"Developments in Experimental Simulation of Wind/Diesel Systems," EWEC '89 Proceedings, Glasgow, Scotland, July, 1989 (w/ McGowan, Stein and Rogers).

"Hardware Options for Variable Speed Wind Turbines," Proceedings of the ASES Conference, Boulder, CO, July, 1989 (w/ McGowan).

"International Market Prospects for Wind/Diesel Systems," Proc. AWEA/CanWEA Wind/Diesel Workshop, White River Junction VT, May, 1989 (w/ McGowan).

"New Perspectives on the Block Island Wind/Diesel System," Proceedings of Rutherford Appleton Laboratory Workshop on Wind Turbines in Diesel Powered Networks, Didcot, UK, May 1989 (w/ McGowan and Jeffries).

"Synthetic Generation of a Windspeed Time Series," Proceedings of Rutherford Appleton Laboratory Workshop on Wind Turbines in Diesel Powered Networks, Didcot, UK, May 1989 (w/ Kaminsky, Kirchhoff and Syu)

"Limitations of the Shinozuka Method for Simulating a Random Process," Proceedings of Rutherford Appleton Laboratory Workshop on Wind Turbines in Diesel Powered Networks, Didcot, UK, May 1989 (w/Jeffries)

"Development of the University of Massachusetts Wind/Diesel Simulator," Proceedings of the 8th ASME Wind Energy Symposium,, Houston, January, 1989 (w/ Stein, McGowan, Rogers, Jones and Jeffries)

"A Case Study of a No Storage Wind/Diesel System," Proceedings of the 8th ASME Wind Energy Symposium, presented at the 12th Annual ASME Energy

Sources Technology Conference, Houston, January, 1989 (w/ McGowan, Jeffries, and Kirchhoff)

"The University of Massachusetts Wind/Diesel Simulator: Initial Experimental Results," Proceedings of the Canadian Wind Energy Association Conference, October, 1988 (w/ Stein, Rogers, Jones and McGowan).

"Wind Diesel Energy Systems: Review of Design Options and Recent Developments.," Solar Energy, 41, No. 6, 1988 (w/ Connors and McGowan).

"Recent Developments in Micro-Hydro Electric Power", Proc. of the First International Conference on Renewable Energy and Local Production, The Danish Center for Renewable Energy, Thy, Denmark, September, 1988.

"Techno-Economic Study of Autonomous Wind Driven Reverse Osmosis Desalination Systems," Solar and Wind Technology, 5, No. 5, 1988 (w/ Warfel and McGowan).

"Wind/ Diesel Energy Systems: Review of Systems, Options, and Recent Developments," Proceedings of the American Solar Energy Society Annual Meeting, Cambridge, Mass., June, 1988 (w/ McGowan and Connors).

"Wind/ Diesel Bibliography", Proceedings of the AWEA/Canadian Wind Energy Association Wind/Diesel Meeting, May 1988 (w/ McGowan).

"Wind/ Diesel Energy Systems: Review of System Architectures," Proceedings of the AWEA/Canadian Wind Energy Association Wind/Diesel Meeting, May 1988 (w/ McGowan).

"Hybrid Diesel/ Wind Systems: A Developing International Market," Proceedings of the 7th ASME Wind Energy Symposium, presented at the 11th Annual ASME Energy- Sources Technology Conference, January, 1988 (w/ McGowan)

"Wind Diesel Energy Systems: Problems and Prospects," Proceedings of the Energy Sources and Technology Conference, American Society of Mechanical Engineers, New Orleans, January, 1988 (w/ McGowan).

"Estimating the Wind Energy Potential of Western Massachusetts," Proceedings of the Annual Conference of the American Wind Energy Association, San Francisco, CA, September, 1987 (w/ Kirchhoff, Kaminsky and James).

"Wind Energy Developments in Central America," Proceedings of the Annual Conference of the American Wind Energy Association, San Francisco, CA, September, 1987 (w/ McGowan).

"Wind Energy from Turbulence: Constant Tip Speed Ratio Operation," Solar Energy, 34, No. l, pp. 59-67, l985 (w/ Kirchhoff).

"Utility/Wind Farm Applications at a Coastal Urban Site," Proceedings of the ASME Wind Energy Symposium, New Orleans, LA, February l984 (w/ McGowan and Bowcock).

"Analytical Modeling of a Variable Stroke Water Pumping Windmill," Proc. 1984 AWEA Annual Meeting, 1984 (w/ Schnall and McGowan)

Understanding Wind Energy, Prepared for Volunteers in Technical Assistance, Arlington, VA, 1984 (w/ Cromack)

"Wind Siting for the Tennessee Valley Authority," Proc. of the Wind Energy Technology Conference, University of Missouri, Kansas City, MO, March l98l (w/ Owens, McGowan and Cromack).

"A Design Procedure for Wind-Powered Heating Systems," Solar Energy, 26, No. 5, 1981 (w/McGowan)