

## STEPHEN R. CONNORS

THE LABORATORY FOR ENERGY AND THE ENVIRONMENT  
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### EDUCATION

S.M., Masters in Technology and Policy. MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

February 1989. Concentrations in electric power systems planning, energy and the environment, and the use of technical information in complex decision-making processes. (GPA: 4.8/5.0)

B.S. Mechanical Engineering cum Laude. UNIVERSITY OF MASSACHUSETTS, AMHERST.

February 1986. Concentrations in energy systems, solar, wind, hydrogen, water, thermodynamics, and fluid mechanics. (GPA: 3.76/4.0).

B.A. Magna cum Laude. UNIVERSITY OF MASSACHUSETTS, AMHERST. Major: Anthropology.

May 1980. Concentrations in economic development, technology and change, applied and biological anthropology. (GPA 3.64/4.0)

### EXPERIENCE

DIRECTOR, AGS ENERGY FLAGSHIP PROGRAM April 2005 to Present

M.I.T. Laboratory for Energy and the Environment (LFEE)

The ALLIANCE FOR GLOBAL SUSTAINABILITY (AGS) is a partnership among MIT, THE SWISS FEDERAL INSTITUTE OF TECHNOLOGY, the UNIVERSITY OF TOKYO, and CHALMERS UNIVERSITY OF TECHNOLOGY in Sweden. In 2005, the AGS launched its *Near-Term Pathways to a Sustainable Energy Future* "energy flagship" research, education and outreach program. This program builds upon past AGREA and AGS energy scenario research to identify and communicate cost-effective, and implementable portfolios of energy technology and policy options to local and regional decision makers. Mr. Connors is responsible for the coordination Energy Flagship activities across the four universities.

DIRECTOR/RESEARCH ENGINEER February 1989 to Present

Analysis Group for Regional Energy Alternatives (AGREA), M.I.T. Energy Laboratory

Responsibilities include all technical, logistical and analytic aspects for a series of projects developing multi-attribute analytic methods for electric power systems planning. The projects focus upon providing quality information to a policy environment comprised of utility executives, regulators, and businesses, environmental and consumer groups. The planning process includes computer modeling of the operation of regional and utility-specific electric power systems, economic analysis of technological options, and the preparation and presentation of results to non-technical industry stakeholders and policymakers. (Projects listed below.)

DIRECTOR, ELECTRIC UTILITY PROGRAM July 1993 to October 1998

Electric Utility Program (EUP), M.I.T. Energy Laboratory (Co-Director, Sept. 1992-June 1993)

The Energy Laboratory's Electric Utility Program facilitated collaborative research on electric power related topics such as power systems analysis and planning, combustion, emissions reduction and characterization, building systems, and nuclear power. Each year over thirty participating organizations attend workshops, reviewing the progress of current research, and develop parallel, collaboratively funded projects to explore common areas of interest.

## **AGREA PROJECTS**

### **OFFSHORE WIND COLLABORATIVE PILOT PROJECT (2004-2005)**

*Economic and Environmental Performance of Potential Northeast Offshore Wind Energy Resources*

This pilot project for the Offshore Wind Collaborative, sponsored by the Massachusetts Renewable Energy Trust, GE Energy, and the U.S. Dept. of Energy uses windspeed data collected by NOAA to examine near versus far offshore wind regimes. Looking at the daily, seasonal, and multi-year magnitude and variability of offshore winds, the power generation and avoided emissions potential of offshore wind farms can be compared with anticipated costs of siting wind farms further from shore, and in deeper water. This research is being done in collaboration with the *Renewable Energy Research Laboratory* at the UNIVERSITY OF MASSACHUSETTS, AMHERST.

### **TRANSES–NORTHERN EUROPE (2003 to present)**

*TRANSES – Alternatives for the TRANSition to Sustainable Energy Services in Northern Europe*

A collaboration among M.I.T., The NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY (NTNU) and CHALMERS UNIVERSITY OF TECHNOLOGY in Sweden, this project will explore a broad range of technology portfolios addressing the reduction in emissions from an already low emissions energy infrastructure. Unique to this project is the combination of detailed competitive energy market, time and space specific analyses of end-use, combined heat and power and renewable energy systems, and carbon capture and storage.

### **NATIONAL ASSESSMENT OF EMISSIONS REDUCTION OF PHOTOVOLTAIC POWER SYSTEMS (2002-2003)**

Sponsored by the U.S. ENVIRONMENTAL PROTECTION AGENCY, this project looked at the hourly emissions from the U.S.'s fossil-fueled generation units, and by NERC sub-region determined the emissions avoided by electricity generated by PV systems, based upon hour by hour solar and generation system status information.

### **MEXICO CITY INTEGRATED ASSESSMENT CASE STUDY (1999-2004)**

This effort, supported by the AGS, the FORD-MIT ALLIANCE and the GOVERNMENT OF MEXICO, brought together researchers from M.I.T., the HARVARD SCHOOL OF PUBLIC HEALTH and numerous Mexican universities and research institutions to look at the integrated energy, transportation and lifestyle effects on pollution, health and productivity. At its core it employed AGREA's multi-attribute approach to integrate these diverse topics with an aim of informing regional stakeholders and governmental policy-makers.

### **CETP SHANDONG CASE STUDY (1998-2003)**

Supported by ABB via the AGS, the CHINA ENERGY TECHNOLOGY PROGRAM Shandong Case Study applied AGREA's scenario-based multi-attribute tradeoff analysis approach to Shandong province in Eastern China. This project also includes the LCA and environmental impact assessment skills of the AGS's Swiss participants.

### **COMPETITIVE POWER SYSTEMS RESEARCH GROUP (1996-2002)**

This series of projects examined the technical performance of alternative market structures for competitive electric industries. Issues explored by the research team included congestion management, market dynamics and the technical, topological, regulatory and economic aspect of competition on the distribution level. Mr. Connors's responsibilities focused on coordination and outreach of highly technical information to less technical audiences. The group was led by Prof. Marija Ilic.

### **SESAMS SWISS CASE STUDY (1997-2000)**

*SESAMS – Strategic Electric Sector Assessment Methodology under Sustainability Conditions.* This project supported by the ALLIANCE FOR GLOBAL SUSTAINABILITY (AGS) brought together the M.I.T. AGREA research team with researchers at the SWISS FEDERAL INSTITUTES OF TECHNOLOGY, to apply the multi-attribute tradeoff analysis approach to Switzerland, incorporating the life-cycle assessment (LCA) methods developed at the Paul Scherrer Institut and ETH-Zürich.

MENDOZA ARGENTINA WATER RESOURCE PLANNING (1996-1997)

Performed in conjunction with the M.I.T. TECHNOLOGY AND DEVELOPMENT PROGRAM, this project used the multi-attribute tradeoff analysis approach to look at the combined energy, agricultural, industrial and residential uses of water from the two principal rivers supplying the province of Mendoza in Western Argentina. It was supported by the Government of Mendoza, Argentina.

TENNESSEE VALLEY AUTHORITY ENERGY VISION 2020 REVIEW GROUP (1995)

In this project, Mr. Connors assisted in TVA's application of the multi-attribute tradeoff analysis approach, interpreting scenario results for the stakeholder advisory group. Supported by TVA.

ENEL BIOMASS PROJECT (1992-1994)

In close cooperation with the Italian national electric utility ENEL, this two year project examined the cost, emissions and labor impacts of scenarios incorporating different types and levels of bio-fueled generation. Year One looked at Italian strategies. Year Two looked at strategies for Western Europe. Supported by the European Commission and ENEL.

NEW ENGLAND AREA PROJECT (1988-1996)

Supported by New England electric utilities, the National Renewable Energy Laboratory, and the Raytheon Co., this project evaluated a broad array of scenarios including new generation technologies (including wind and photovoltaics), various types and levels of demand-side management, fuel switching, early retirement and repowering of existing generation (nuclear and fossil), NOx emissions retrofits and seasonal and geographic NOx cap and trade environmental regulations, carbon taxes, and the emissions reduction effectiveness of electric vehicle fleets. The project's stakeholder advisory group included utility representatives, utility and environmental regulators and business and environmental groups.

COMMONWEALTH ELECTRIC PROJECT (1988-1992)

This project applied AGREA's multi-attribute tradeoff analysis approach to a single utility, interacting with a series of customer advisory groups, examining a broad array of technology options. In addition to evaluating environmental externality regulations, this project developed lay-oriented performance attributes. Supported by Commonwealth Electric.

### ***SELECT JOURNAL ARTICLES, BOOK CHAPTERS AND PROCEEDINGS***

"Future Electricity Supplies: Redefining Efficiency from a Systems Perspective." by S. Connors, K. Martin, M. Adams and E. Kern for MIT Engineering Systems Symposium, accessible via <http://esd.mit.edu/symposium/papers>. Cambridge MA, 29-32 March 2004.

"Electric Sector Simulation: A Tradeoff Analysis of Shandong Province's Electric Service Options." by S. Connors, W. Schenler, C. Cheng, C. Hansen, and A. Gheorghe in Integrated Assessment of Sustainable Energy Systems In China: The China Energy Technology Program (CETP): A Framework for Decision Support in the Electric Sector of Shandong Province, pp. 201-274. Kluwer, 2003.

"Windpower – A Turn of the Century Review," by J. McGowan and S. Connors. Annual Review of Energy and the Environment, Vol. 25, pp. 147-197, November 2000.

"Ensuring future energy alternatives: the role of resource planning in forming long-range energy and environmental policies," by S. Connors. International Journal of Global Energy Issues, Vol. 12, pp. 120-130. 1999

"Climate Change and Competition - On a Collision Course? Technology Development and Deployment in a Competitive Electric Industry," by S. Connors and W.W. Schenler. Proceedings of the 60th American Power Conference, Vol. I, pp. 17-22, April 14-16 1998, Illinois Institute of Technology. Chicago, IL.

"Competitive Electric Services and Efficiency", by S. Connors. In Restructuring, Power Systems Engineering and Economics, ed. by M.D. Ilic, F. Galiana, and L. Fink. pp. 385-401. Kluwer Academic Publishers, 1998.

"Windpower in New England: Modeling and Analysis of Non-Dispatchable Renewable Energy Technologies," by J.B. Cardell, S. Connors. IEEE Transactions on Power Systems. PE-888-PWRS-2-06-1997.

- “Informing decision makers and identifying niche opportunities for windpower: Use of multiattribute trade off analysis to evaluate non-dispatchable resources,” by S. Connors. Energy Policy. Vol. 24, No. 2. pp.165-176. (Feb. 1996)
- “The Electric Car Unplugged,” by R. De Neufville, S. Connors, F. Field III, D. Marks, D. Sadoway, R. Tabors. Technology Review. Vol. 99. No. 1. (Jan. 1996)
- “Integrating Renewables into Integrated Resource Planning: Emissions Reduction Potential from Wind and Solar Generated Electricity in New England,” by S. Connors, J.B. Cardell. Proceedings of the National Regulatory Conference on Renewable Energy, October 3-6, 1993 Savannah, GA, pp. 293-314.
- “Externality Adders and Cost-Effective Emissions Reductions: Using Tradeoff Analysis to Promote Environmental Improvement and Risk Mitigation,” by S. Connors. Proceedings of the American Power Conference, Vol. 1, pp. 697-702. April 13-15, 1993, Chicago, IL.
- “Existing Capacity—The Key to Reducing Emissions,” by C.J. Andrews, S. Connors. Energy Systems and Policy, Vol.15, pp. 211-235, 1992 (also MIT Report No.: MIT-EL 91-001WP)
- “System-Wide Evaluation of Efficiency Improvements: Reducing Local, Regional and Global Environmental Impacts,” by S. Connors, C.J. Andrews. Energy and the Environment in the 21st Century, eds. J.W. Tester, D.O. Wood and N.A. Ferrari, MIT Press, Cambridge MA, 1991.
- “Integrated Energy Systems for Accelerated Development,” by S. Connors. Proceedings of the World Energy Council Regional Energy Forum for East and Southern African Countries, Harare, Zimbabwe, November 12-14, 1990.
- “Wind/Diesel Village-Scale Electric Power Systems: The Performance and Economic Analysis of a Simulated Village System,” by S. Connors, J.G McGowan, J.F. Manwell. Solar and Wind Technology, Vol.7, pp.423-439, 1990.
- “A Framework for Integrated Resource Planning: The Role of Natural Gas Fired Generation in New England,” by R.D. Tabors, S. Connors, C.G. Bespolka, D.C. White, C.J. Andrews. IEEE Transactions on Power Systems, Vol.4, No.3 , p.1010, 1989.
- “Wind/Diesel Energy Systems: Review of Design Options and Recent Developments,” J.G McGowan, J.F. Manwell, S. Connors. Solar Energy, Vol.41, pg. 561, 1988.

### ***SELECT REPORTS AND CONTRACTED PUBLICATIONS***

- Economic and Environmental Performance of Potential Northeast Offshore Wind Energy Resources, by M. Berlinski and S. Connors, MIT LFEE 2006-02 RP. Jan. 2006.
- National Assessment of Emissions Reduction of Photovoltaic (PV) Power Systems, by S. Connors, E. Kern, M. Adams, K. Martin and B. Asiamah-Adjei. U.S. Environmental Protection Agency. January 2004 .
- Strategic Electric Sector Assessment Methodology under Sustainability Conditions: A Swiss Case Study, by W. Schenler, A. Gheorghe, S. Connors, P-A. Haldi, S. Hirschberg. Swiss Federal Institutes of Technology, April 1998.
- Review of Renewable Energy Technologies for Massachusetts, by J.G. McGowan and S. Connors. University of Massachusetts at Amherst Renewable Energy Research Laboratory. Report to the Massachusetts Division of Energy Resources. February 1998.
- First Approach to Identifying Wind Generated Electricity Penetration Limits in New England: Simplified Steady-State Analysis and Economic Evaluation. by J. Lacalle-Melero, S. Connors, E. Festa, N. La White, C. Acosta-Colon. (NREL Final Report – January 1995)
- Project Report – Phase II: Analysis of Biomass Penetration in the European Electricity Market, by W.W. Schenler, P. Moncada P.C., S. Connors, R.D. Tabors. MIT Report No.: MIT-EL 94-002, July 1994.
- Project Report – Phase I: Analysis of Biomass Penetration in the Italian Electricity Market, by W.W. Schenler, P. Moncada P.C., S. Connors, R.D. Tabors. MIT Report No.: MIT-EL 93-005, November 1993.
- Final Report for Phase One – The Commonwealth Electric Open Planning Project, with C.J. Andrews, D.L. Greenberg, W.W. Schenler, R.D. Tabors, D.C. White. MIT, Cambridge, MA, 1991.

## **OTHER ACTIVITIES**

### **THESIS ADVISOR/READER:**

Lisa Engblom, *Scenario Analysis of Retrofit Strategies for Reducing Energy Consumption in Norwegian Office Buildings* (MIT-BT, 2006); Michael Berlinski, *Quantifying Emissions Reductions from New England Offshore Wind Energy Resources* (MIT-TPP, 2006); Wen Feng, *Driving Segments Analysis for Energy and Environmental Impacts of Worsening Traffic* (MIT-TPP, 2006); Michael Adams, *Data Management in Energy and Environment Systems: A Case Study of Web Services in the E.P.A's Clean Air Markets Division* (MIT-TPP, 2004); Alexander Okunev, *Optimal Structure of US Power Transmission System for Targeted Investments* (MIT-MOT, 2004); Rory Foster, *False Optimism for the Hydrogen Economy and the Potential of Biofuels and Advanced Energy Storage to Reduce Domestic Greenhouse Gas Emissions* (MIT-ME, 2004); Shaheer Hussam, *Design and Implementation of a Solar Power System in Rural Haiti* (MIT-ME, 2004); Arnob Bhattacharyya, *An Analytic Structure for Sustainable Energy in Competitive Electricity Markets* (MIT-EECS, 2003); Andres Flores Montalvo, *Emissions Reductions from the Commercial and Informal Sectors in Mexico City* (MIT-TPP, 2003); Srinivas Chilukuri, *Analysis of Issues and Trends in the Growth of Fuel Cell Firms* (MIT-MOT, 2003); David Tsay, *Feasibility Study of Fuel Cell Residential Energy Stations* (MIT-MOT, 2003); Omid Kassiri, *Options for Sustainable Energy Generation in the Developing World: Financing Mechanisms, Technologies and Policies* (MIT-TPP, 2003); Baafour Asiamah-Adjei, *Acquisition and processing of data for use in determining the impact of grid-connected photovoltaic systems on emissions from power plants* (MIT-ME, 2003); Kellyn Roth, *The Air Pollution Implications of the Residential Sector: Case Study of the Mexico City Metropolitan Area* (MIT-TPP/DUSP, 2003), Ricardo Forcano, *Removal of Barriers to the Use of Renewable Energy Sources for Rural Electrification in Chile* (MIT-TPP, 2002); Jennifer Barker, *Planning for Economically and Environmentally Sound Electricity Service in Shandong Province, China* (MIT-DUSP, 2001); Barclay Gibbs, *Increasing the Gasoline Tax in Mexico City: A Potential Policy Option to Supplant Early Implementation of Tier 2 Tailpipe Standards* (MIT-TPP, 2001); Nikolaos Iliadis, *Possible effects of various modes of restructuring of the electricity sector on energy supply – Shandong Case study* (Ecole Polytechnique Federale de Lausanne, 2001); Graham Ault, *A Planning and Analysis Framework for Evaluating Distributed Generation* (University of Strathclyde, 2000); Ali Shirvani-Mahdavi, *Energy-Intensity Factors for Shanxi Province and China: Shift-Share and Interregional Structural Decomposition Analysis* (MIT-DUSP, 1999); Christopher Russo, *A Multi-Attribute Analysis of Electrical System Expansion Options for China* (MIT-TPP, 1999); Karina Funk, *Information Networking as an Instrument of Sustainable Development: The Photovoltaic Example* (MIT-TPP, 1997); Erin O'Neill, *Cost Effective Strategies for Nitrogen Oxides Reduction: Ozone Attainment Policy for New England* (MIT-TPP, 1996)

**INVITED REVIEWER:** Proceedings of the IEEE, Journal of Air and Waste Management, U. S. Environmental Protection Agency/Office of Air Quality Planning and Standards, Oak Ridge National Laboratory/Energy Division, National Renewable Energy Laboratory, MIT Press, Annual Review of Energy and the Environment, John Wiley and Sons.

**VOLUNTARY TECHNICAL ASSISTANCE:** U.S. DOE Wind Program Peer Review Panel; Peer Review Panelist and member of the Industrial Support Investment Committee for the Massachusetts Renewable Energy Trust; Co-Organizer, AltWheels Alternative Transportation Festival; Council Member 2001 and 2002 United States Association of Energy Economics (USAEE); USAEE 21<sup>st</sup> Annual North American Conference (Program Committee)

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