William R. Morrow III, P. E., Ph.D.

WRMorrow@lbl.gov 510.495.2027

LAWRENCE BERKELEY NATIONAL LABORITORY Berkeley, CA
Principle Scientific Engineering Associate 2010 – Present
Environmental Energy Technologies Division; Energy Analysis Department

Sustainable Energy Systems Group, International Energy Studies Group & the Emerging Technology Assessment Team

Developing resolution to complex technical problems where analysis of situations or data requires an in-depth evaluation of various factors, and uses scientific/engineering concepts in accordance with organizational objectives to solve complex problems in creative and effective ways in the following areas:

- Developing forward looking techno-economic projections and conceptual frameworks for evaluating potential industrial energy efficiency opportunities in both the U.S. and international industrial sectors.
- Creating the intellectual and modeling framework for evaluating U.S. DOE Advanced Manufacturing Office investments in the industrial sector as they potentially impact the full life-cycle (industrial, residential, commercial, transportation, and electricity) of products in the commercial and residential buildings and transportation sectors of the U.S. economy.
- Advancing analysis capacity for estimating technological and infrastructure pathways necessary for economies to evolve towards a low-carbon future.
- Modeling and estimating future biomass supplies and potential biofuels production (both costs and energy output) and anticipating potential economic risks a changing climate might impose on future biofuels industries.
- Maintaining LBNL's ArcGIS licenses as well as providing GIS analysis support to several groups at LBNL including the appliance standards group and the electricity markets and policy groups.
- Contributing to the development of a transportation sector analysis capability at LBNL.

ENERGY & ENVIRONMENTAL ECONOMICS, INC. San Francisco, CA
Senior Consultant 2007 – 2010

- Greenhouse Gas Mitigation Analysis – develop a multi-sector infrastructure model to evaluate technology options for achieving California's legislated year 2050 Greenhouse Gas (GHG) emission reduction targets.
- Renewable Energy & Long-Distance Transmission Line Analysis – develop and support a long-distance transmission line policy analysis model which evaluates the relative value of alternative long-distance power lines linking renewable energy resource development potential to demand loads throughout the WECC.
- Rate Design - support a large regulated electric utility's application for electric rate designs that are both equitable and encourage conservation within their residential and large general service commercial customer classes.
- Marginal Electricity Emissions Modeling for Buildings – worked with a consultant to estimate California's marginal electricity emissions factors to demonstrate the benefits of load reductions in buildings.

- Renewable Project Development – develop a linear programming (LP) model used for the evaluation of potential renewable energy project developments.
- Energy Efficiency, Distributed Generation, and Demand Side Management Analysis – develop models to evaluate the potential cost effectiveness of energy efficiency measures, distributed generation technologies, and demand side management programs.

U. S. DEPARTMENT OF ENERGY (DOE) Pittsburgh, PA
National Energy Technology Laboratory (NETL) 2006-2007
Office of Systems Analysis and Planning
Appointment through the Oak Ridge Institute of Science and Education
Post-doctoral Research Fellow

"Biomass Allocation Model" development and analysis

- Development of a linear programming bioenergy (biomass-energy) resource forecast model within NETL's Office of Systems Analysis and Planning. The model consists of:
  - A bioenergy resource geo-dataset – a regionally detailed bioenergy resource GIS database.
  - Bioenergy process models for ethanol production (corn (wet and dry mills) and cellulosic-based processes) and electricity generation (co-firing with coal in existing coal-fired power plants).
  - Econometric infrastructure investment tools, including transportation and distribution parameters, and microeconomic models for bioenergy industrial sectors.
  - Macroeconomic model for estimating bioenergy industry sectors' affect on fossil energy resource demand and carbon emissions.
- Wrote a report presenting detailing policy analysis results and linear program model technique. See *DOE/NETL2008/1302*

CARENGIE MELLON UNIVERSITY, GREEN DESIGN INSTITUTE Pittsburgh, PA
Visiting Scholar 2006-2007

- Collaborated with Carnegie Mellon University's Engineering and Public Policy and Carnegie Electricity Industry Center researchers on Plug-Hybrid-Electric-Vehicle (PHEV) research: estimating energy resource demand, infrastructure requirements, economic impacts, and environmental performance from a large-scale shift towards PHEV dominated light-duty vehicle fleet.

WILLIAM R. MORROW AND ASSOCIATES St. Louis, MO
Mechanical Engineering Consultant 1999-2002

- **Clients (multiple project with each client):**
  Mead Johnson, Evansville, IN; Infant Nutritional Products; Sigma-Aldrich, St. Louis, MO; Biopharmaceutical Products; Anheuser-Busch, St. Louis, M; Brewery; Warrenton Products, Warrenton, MO; Beverage Bottling; Semi-Bulk Systems, St. Louis, MO; Process Equipment Manufacture

- **Engineering:**
  Project Scope Development (Process Flow Diagrams, Piping and Instrumentation Diagrams); Process Engineering (Design and Specification of: Tanks & Agitators, Pumps, Heat Exchangers, Bulk Transfer Equipment, Powder/Liquid Blending, Packaging Equipment); Utility Engineering

(Design and Specification of: HVAC systems, Steam and Condensate, Boilers, Chillers, Air Compression, Hot Water Sets, Pneumatic Air Systems for process controls); Piping Engineering (Design and Specification of: Piping Specs, Sizing, Process Control Devices, Stress Analysis, Layout and Routing Design)

- **Project Management:**
  Scope, Budgets, Procurement, Contractor Bidding, Construction Support and Plant Start-Up

PEAK TECHNICAL SERVICES Pittsburgh, PA
Mechanical Engineering Consultant 1995-1999

- **Clients (and Projects):**
  Stone & Webster, Boston, MA; (*Harquahala Power Project NGCC);* Fru-Con Engineering and Construction, St. Louis, MO (*Procter & Gamble Project, MEMC Technologies Project, Monsanto Project);* Jacobs Engineering, Cincinnati, OH (*Genentech Project);* Power Engineering, Haley, ID (*Micron Technologies Project);* Chiyota International, Seattle, WA (*South Korea Petrochemical Refinery Project)*

- **Engineering:**
  Piping Systems Design using 3_D engineering Plant Design Software (Piping Specs, Sizing, Process Control Devices, Stress Analysis, Layout and Routing Design)

RUST ENGINEERING Birmingham, AL
Mechanical Engineering Consultant 1993-1995

- **Clients (and Projects):**
  GE (Lexan Plastic Plant Expansion), Burkville, AL; International Paper (Greenfield Recycle Fiber and Paper Machine Project), Mansfield, LA; 3M (Glue Products Plant Expansion), Decatur, AL; Connecticut Power (Greenfield MSW Power Generation Project), Lisbon, CT; Gulf States Paper (Lime Kiln and Re-Causticing Plant), Demopolis, AL

- **Engineering:**
  Process, Utilities, and Piping Engineering (Design and Specification of: Tanks & Agitators, Pumps, Heat Exchangers; Steam and Condensate Systems; Piping Specs, Sizing, Stress Analysis, Layout and Routing Design)

Education

Carnegie Mellon University Pittsburgh, PA
Ph.D., Civil and Environmental Engineering 2006
Thesis Title: "U.S. Biomass Energy: An Assessment of Costs & Infrastructure for Alternative Uses of Biomass Energy Crops as an Energy Feedstock"

Carnegie Mellon University Pittsburgh, PA
M.S., Civil and Environmental Engineering 2003
Research Topic: CHP Economic Feasibility Assessment

Georgia Institute of Technology (Georgia Tech) Atlanta, GA
B.S., Mechanical Engineering, Minor in Philosophy 1993

Publications and Working Papers

REFEREED JOURNAL ARTICLES

Lewis, S., Gross, S., Visel, A., Kelly, M., Morrow, W. "Fuzzy GIS-based multi-criteria evaluation for U.S. Agave production as a bioenergy feedstock", Submitted to Global Change Biology – Bioenergy

Morrow, W., Hasanbeigi, A., Sathaye, J., Xu, T. "Assessment of Energy Efficiency Improvement and CO_2 Emission Reduction Potentials in India's Cement and Iron & Steel Industries", Submitted to The Journal of Cleaner Production

Morrow, W., Gopal, A., Fitts, G., Lewis, S., Dale, L., Masanet, E. "Feedstock Loss from Drought is a Major Economic Risk for Biofuel Producers", Submitted to Biomass and Bioenergy

Hasanbeigi, A., Morrow, W., Masanet, E., Sathaye, J., Xu, T. "A Bottom-Up Model to Estimate the Energy Efficiency Improvement and CO2 Emission Reduction Potentials in the Chinese Iron and Steel Industry" Energy, In Press

Masanet, E., Chang, Y., Gopal, A., Larsen, P., Morrow, W.R., Sathre, R., Shihabi, A., Zhai, P., "Life-Cycle Assessment of Electric Power Systems", Annual Review of Environment and Resources, In Press

Hasanbeigi, A., Morrow, W., Masanet, E., Sathaye, J., Xu, T. "Energy efficiency improvements and CO_2 emission reduction opportunities in the cement industry in China" Energy Policy, 57, 2013, Pages 287-297

Williams, J., DeBenedictis, A., Ghanadan, R., Mahone, A., Moore, J., Morrow, W. R., Price, S., Torn, M.S. "The technological path to deep greenhouse gas emissions cuts by 2050" Science, January 2012, Vol 335, Pages 53-59

Morrow, W. R., Griffin, W. M., and Matthews, H. S. National-level infrastructure and economic effects of switchgrass co-firing with coal in existing power-plants for carbon mitigation. Environmental Science and Technology, 2008, 42, (10), 3501-3507

Morrow, W. R., Griffin, W. M., and Matthews, H. S. State-level infrastructure and economic effects of switchgrass co-firing with coal in existing power-plants for carbon mitigation. Environmental Science and Technology, 2007, 41 (19), 6657-6662.

Morrow, W. R., Griffin, W. M., and Matthews, H. S. Modeling Switchgrass Derived Cellulosic Ethanol Distribution in the United States. Environmental Science & Technology, 2006, 40 [9], 2877-2886

REFEREED CONFERENCE PROCEEDINGS

Hasanbeigi, A., Morrow, W.R., Masanet, E., Xu, T., Sathaye, J., Price, L. A bottom-up technology-level analysis for assessing the energy efficiency potential in China's Iron and Steel industry. ECEEE 2012 Summer Study on energy efficiency in industry, September 11-14 2012, Arnhem, Netherlands

Hasanbeigi, A., Morrow, W.R., Fridley, D., Masanet, E., Xu, T., Sathaye, J., Zheng, N., Price, L. Energy efficiency potential for China's cement industry: a bottom-up technology-level analysis. 19th CIRP International Conference on Life Cycle Engineering, May 23-25 2012, University of California Berkeley, Berkeley, California

Morrow, W.R., Gopal, A., Masanet, E., McKone, T., Dale, L., McMahon, J. Early-Stage economic and life-cycle analysis for salt-and drought-tolerant switchgrass derived biofuels. Life-Cycle Analysis, XI (LCA XI) October 4-6th, 2011, Chicago, IL

Morrow, W. R., Mahon, A., Price, S. Woo, CK. California's Electricity Sector Planning: Making early investments in Carbon Capture and Storage (CCS) to lower the long-term cost of achieving a GHG reduction target. 32nd International Association of Energy Economics International Conference, June 21-24, 2009, San Francisco, CA

Mahon, A., Morrow, W. R., Price, S. Woo, CK. Long-term greenhouse gas reductions in California: vehicle electrification and electricity generation in 2050. 32nd International Association of Energy Economics International Conference, June 21-24, 2009, San Francisco, CA

Morrow, W. R., Hanson D., Balash P. Comparing alternative uses of scarce biomass energy resources using the AMIGA model. 27th Annual Conference of the United States Association of Energy Economics/ International Association of Energy Economics, September 16-19, 2007, Houston TX

Morrow, W. R., Griffin, W. M., and Matthews, H. S. "Alternative Transportation Fuels: Modeling National-Scale Ethanol Production and Distribution," Institute for Operations Research and the Management Sciences, Annual Meeting, November 5 - 8, 2006, Pittsburgh, PA

NON-REFEREED REPORTS, JOURNALS, AND CONFERENCE PROCEEDINGS

Orans, R., M. King, C.K. Woo and W. Morrow. "Inclining for the Climate: GHG Reduction via Residential Electricity Ratemaking," Public Utilities Fortnightly, May 2009, 41-45

Price, S., DeBenedictis, A., Mahone, A., Morrow W.R., Williams, J. "Meeting California's Long-Term Greenhouse Gas Goals," Energy and Environmental Economics Inc. Report (http://ethree.com/documents/GHG6.10/CA_2050_GHG_Goals.pdf)

Morrow, W. R., Griffin, W. M., and Matthews, H. S. "Modeling Cellulosic Ethanol Production and Distribution in the U.S.," 27th Symposium on Biotechnology for Fuels and Chemicals, May 1-4, 2005, Denver, CO

LBNL REPORTS

Morrow, W., Marano, J., Sathaye, J., Xu, T. "Assessment of Energy Efficiency Improvement in the United States Petroleum Refining Industry" LBNL-XXXX Lawrence Berkeley National Laboratory, In Press

Morrow, W., Hasanbeigi, A., Sathaye, J., Xu, T. "Assessment of Energy Efficiency Improvement and CO_2 Emission Reduction Potentials in India's Cement Industry" LBNL-XXXX Lawrence Berkeley National Laboratory, In Press

Morrow, W., Hasanbeigi, A., Sathaye, J., Xu, T. "Assessment of Energy Efficiency Improvement and CO_2 Emission Reduction Potentials in India's Iron and Steel Industry" LBNL-XXXX Lawrence Berkeley National Laboratory, In Press

Shehabi, A., Morrow, W., Qi, W., Masanet, M." United States Industrial Sector Energy End Use: Trends and Observations of MECS Data" LBNL- 5993E Lawrence Berkeley National Laboratory, October 2012

Hasanbeigi, A., Morrow, W., Masanet, E., Sathaye, J., Xu, T. "Assessment of Energy Efficiency Improvements and CO2 Emissions Reduction Potential in the Steel Industry in China" LBNL-5535E Lawrence Berkeley National Laboratory, July 2012

Hasanbeigi, A., Morrow, W., Masanet, E., Sathaye, J., Xu, T. "Assessment of Energy Efficiency Improvements and CO2 Emissions Reduction Potential in the Cement Industry in China" LBNL-5536E Lawrence Berkeley National Laboratory, July 2012

David Fridley, Nina Zheng, Nan Zhou, Jing Ke, Ali Hasanbeigi, Bill Morrow, and Lynn Price "China Energy and Emissions Path to 2030" LBNL-4866E, Lawrence Berkeley National Laboratory, January 2011

NETL REPORTS

Morrow, W. R., Balash P. Biomass Allocation Model – Comparing alternative uses of scarce biomass energy resource through estimations of future biomass use for liquid fuels and electricity. U.S. Department of Energy and the National Energy Technology Laboratory Report, 2008, DOE/NETL2008/1302

PRESENTATIONS

Morrow, W. R., Gopal, A. – Biofuel Feedstocks from Marginal Lands: Modeling Biofuel Supply Chains to Help Focus Genetic Research. Carbon Cycle 2.0 Seminar Series, LBNL, Berkeley, CA, September 6rd, 2012

Morrow, W. R. – Biomass Energy in A Carbon Constrained Future. Environmental Energy Technologies Division Seminar, LBNL, Berkeley, CA, September 3rd, 2010

Professional Engineering License

Mechanical Engineering, Thermal Fluid Systems;
Missouri: # 2002003211; Pennsylvania: # PE 073901

Citizenship

United States