

David Harrison **Senior Vice President**

Dr. David Harrison is Senior Vice President and co-head of NERA's global environment practice. He has extensive experience evaluating a wide range of energy and environmental policies as a consultant, academic and government official.

Dr. Harrison has extensive experience over more than two decades evaluating the costs and benefits of environmental policies and other social regulatory policies, including various health and safety regulations. These studies have been done for a large number of sectors, including electricity, automobile, trucking, marine, chemical, iron and steel, petroleum, pulp and paper, small utility engines, small handheld equipment, snowmobiles, construction equipment, and others. The results of these analyses have been presented to company officials, government agencies, and the media.

Dr. Harrison has been active in the development and economic assessment of climate change policies around the world. Building upon more than two decades of experience with emissions trading programs, he has participated in the development or evaluation of major greenhouse gas emission trading programs and proposals in the United States, including those in California, the Northeast, the Midwest and various federal initiatives, as well as programs in Europe and Australia. He and his colleagues have assisted the European Commission and the UK government with the design and implementation of the European Union Emissions Trading Scheme and national European programs related to climate change, renewable policies, and energy efficiency policies. He also has directed numerous projects for individual companies and trade associations, including those in electricity, oil and gas, refining, petrochemical, pulp and paper, cement, iron and steel, chemical, aluminum and other sectors. Dr. Harrison and his colleagues have evaluated the impacts of climate change, renewable and energy efficiency policies on company and sector revenues and costs and assessed company investment and other strategies in light of climate change policies. He has lectured frequently on climate change and related topics at numerous conferences in the U.S. and abroad.

Dr. Harrison has directed benefit-cost analyses related to fisheries impacts under Section 316(b) of the Clean Water Act for more than a decade. He has evaluated the commercial and recreational fishing benefits and the social costs of changes to the water intake structures of numerous facilities. These have included facilities on the major water bodies, including the Atlantic Coast, the Great Lakes, the Pacific Coast, and various rivers. The power plants have included numerous nuclear and fossil units. These assessments have included estimates of the potential impacts on electricity cost and reliability using detailed electricity market models in various electricity regions of the United States. Dr. Harrison has testified regarding these cost-benefit assessments in numerous state workshops and administrative hearings. He also has assisted the Utility Water Act Group (UWAG), the Edison Electric Institute (EEI) and individual utilities in their evaluation of the EPA 316(b) regulations. He has presented the results of these assessments to senior EPA and OMB officials. Dr. Harrison was a co-signer of an Amicus Brief submitted to the Supreme Court of the United States regarding the comparison of benefits and costs under Section 316(b) of the Clean Water Act.

Dr. Harrison has led approximately 50 assessments of the impacts of major economic activities and policies on local, state, regional and national economic metrics, including employment, gross regional product, personal income and tax revenues. Dr. Harrison has directed studies of the economic impacts of major energy infrastructure (power plants, natural gas pipelines and others), transportation infrastructure (airports, highways), manufacturing activities (including chemical, petrochemical, automotive and many others), and large commercial and retail developments. In addition, he has directed studies evaluating the economic impacts of numerous energy and environment policies. These assessments have used a wide range of economic models, including state-of-the-art regional models such as that developed by Regional Economic Models, Inc. (REMI) as well as customized models based upon available data. The projects have been developed for numerous areas in the U.S. and abroad including Arkansas, California, Colorado, Connecticut, Florida, Georgia, Hawaii, Illinois, Indiana, Iowa, Maine, Massachusetts, Michigan, Minnesota, Missouri, Montana, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and Wisconsin as well as the U.S. as a whole and various countries and sub-regions in Africa, Europe, and the Caribbean.

Before joining NERA, Dr. Harrison was an Associate Professor at the John F. Kennedy School of Government at Harvard University, where he taught microeconomics, energy and environmental policy, cost-benefit analysis, transportation policy, regional economic development, and other courses for more than a decade. He also served as a Senior Staff Economist on the U.S. government's President's Council of Economic Advisors, where he had responsibility for environment and energy policy issues. He is the author or co-author of two books on environmental policy and numerous articles on various topics in professional journals.

Dr. Harrison received a Ph.D. in Economics from Harvard University, where he was a Graduate Prize Fellow. He holds a B.A. *magna cum laude* in Economics from Harvard College, where he was a member of Phi Beta Kappa, and a M.Sc. in Economics from the London School of Economics, where he was the Rees Jeffreys Scholar.

Education

Harvard University

Ph.D., Economics, 1974

M.A., Economics, 1972

London School of Economics and Political Science

M.Sc., Economics, 1968

Harvard University

B.A., Economics, *magna cum laude*, 1967

Professional Experience

- 1988- **National Economic Research Associates, Inc.**
Senior Vice President, Vice President. Directs projects in the economics of the environment, energy, transportation, regional economic development and other areas.
- 1987-1988 **Putnam, Hayes & Bartlett, Inc.**
Senior Associate. Directed projects in the economics of energy, antitrust, and other areas.
- 1985-1987 **Dun & Bradstreet Technical Economic Services**
Director of Product Development. Directed economic studies in energy, transportation, and industrial location.
- 1980-1985 **John F. Kennedy School of Government, Harvard University**
Associate Professor. Areas of instruction: microeconomics; benefit-cost analysis; environment; energy; natural resource economics; urban economics; public finance; transportation; law and economics. Participant, Harvard Faculty Project on Regulation. Faculty Steering Committee, Energy and Environmental Policy Center. Principal investigator in research grants.
- 1979-1980 **President's Council of Economic Advisors**
Senior Staff Economist. Worked with other White House staff and agency officials on domestic issues. Areas of responsibility included energy, environment and transportation. Principal staff on the Regulatory Analysis Review Group. Principal White House staff for the review of Administration policy regarding the automotive industry.
- 1974-1979 **Department of City and Regional Planning, Harvard University**
Assistant and Associate Professor. Areas of instruction: microeconomics; statistics; econometrics; transportation; environment; urban development; and

housing policy. Participant, MIT-Harvard Joint Center for Urban Studies. Faculty Chairman, Concentration in Land Use and Environment.

National Bureau of Economic Research

1974 *Research Associate*. Co-author of benefit-cost study of automotive air pollution prepared by the National Academy of Sciences for the Committee on Public Works, U.S. Senate.

U.S. Department of Transportation

1973-1974 *Economist*. Performed economic studies of transportation issues, including urban mass transportation, automobile emission and safety programs, and highway finance.

Department of Economics, Harvard University

1970-1974 *Teaching Fellow and Assistant Head Tutor*. Areas of instruction: microeconomics; macroeconomics; econometrics; transportation; public finance; environmental policy; and housing policy.

The Urban Institute

1971 *Research Economist*. Participated in econometric studies as participant in the Program on Local Public Finance.

U.S. Department of Housing and Urban Development

1969 *Economist*. Participated in economic evaluations of HUD infrastructure programs, primarily the water and sewer grant program.

Honors and Professional Activities

Summa Cum Laude, Senior Honors Thesis, Harvard University.

Phi Beta Kappa, Harvard University.

Rees Jeffreys Scholar in the Economics of Transport, London School of Economics.

Graduate Prize Fellowship, Harvard University.

Member, American Economic Association.

Member, Association of Environmental and Resource Economists.

Member, International Association of Energy Economists.

Member, Public Policy for Surface Freight Transportation Study, Transportation Research Board, National Research Council.

Member, Advisory Committee, Massachusetts Department of Environmental Quality Engineering.

Member, Peer Review Panel, National Acid Precipitation Assessment Program.

Member, Public Health and Socio-Economic Task Force, South Coast Air Quality Management District (Los Angeles).

Member, Marketable Permits Advisory Committee, South Coast Air Quality Management District (Los Angeles).

Member, Socioeconomic Technical Review Committee, South Coast Air Quality Management District (Los Angeles).

Member, Harvard Graduate Society Council.

Member, RECLAIM Advisory Committee (Los Angeles).

Member, Board of Trustees, Cambridge Health Alliance (Harvard Medical School Teaching Hospital).

Participant, Aspen Institute Dialog on Climate Change.

Member, U.S. Government Accountability Office Expert Panel on International Greenhouse Gas Emissions Trading.

Consultant to the following public and private organizations:

U.S. Environmental Protection Agency; U.S. Department of Transportation; Massachusetts Port Authority; Organization for Economic Cooperation and Development (OECD, Paris); European Commission Directorate-General Environment; Civil Aeronautics Board; Italian Ministry of Environment; Massachusetts Department of Environmental Protection; UK Department of Transport; UK Department for Environment, Food and Rural Affairs, UK Department of Trade and Industry, City of Chicago Department of Aviation; Conference Board of Canada; South Coast Air Quality Management District; Massachusetts Department of Environmental Management; and numerous state and local governments, trade associations, and private firms.

Reviewer for the following professional journals:

American Economic Review; Review of Economics and Statistics; Journal of Political Economy; Journal of Environmental Economics and

Management; Journal of Urban Economics; Journal of Regional Science;
Journal of Policy Analysis and Management; and Public Policy.

I. Publications

A. Books

Who Pays for Clean Air. Cambridge, MA: Ballinger Publishing Company, 1975.

The Automobile and the Regulation of Its Impact on the Environment (co-author). Norman, OK: Oklahoma University Press, 1975.

B. Articles and Published Reports

“Economic Policy Instruments for Reducing Greenhouse Gas Emissions” (with Andrew Foss, Per Klevnas, and Daniel Radov), chapter in *Oxford Handbook of Climate Change*, edited by David Schlosberg, John Dryzek, and Richard Norgaard, August 2011.

Climate Change Risks and Opportunities: How Companies Can Develop Information to Comply with SEC Guidance Regarding Climate Change Disclosure (with Andrew Foss), NERA Economic Consulting, February 2010.

A Victory for Economic and Environmental Rationality: Supreme Court Allows Cost-Benefit Analysis in Setting Important Clean Water Act Standards, NERA Economic Consulting, May 2009.

What Every Company Should Do to Prepare for a Mandatory US Greenhouse Gas Cap-and-Trade Program, in *Climate Policy Economics Insights*, NERA Economic Consulting, March 2009.

Now the Hard Work: How to Get the “Biggest Bang for the Buck” from the Federal Economic Stimulus Package, NERA Economic Consulting, February 2009.

Evaluation of Borrowing as a Method to Contain Costs in a Greenhouse Gas Emissions Cap-and-Trade Program (with Albert Nichols), Electric Power Research Institute, December 2008.

“Using Emissions Trading to Combat Climate Change: Programs and Key Issues” (with Per Klevnas, Albert Nichols and Dan Radov) in *Environmental Law Reporter*, June 2008.

Complexities of Allocation Choices in a Greenhouse Gas Emissions Trading Program (with Per Klevnas and Dan Radov), International Emissions Trading Association (IETA), September 2007.

“State Restrictions on Mercury Trading Could Prove Expensive, Ineffective” (with James Johndrow) in *Natural Gas Electricity, Volume 24, Number 2*. Isabelle Cohen, Hoboken, NJ: Wiley Periodicals, Inc., September 2007.

“Experience for Member States in Allocating Allowances: United Kingdom” (with Dan Radov) in *Allocation in the European Emissions Trading Scheme*. A. Denny Ellerman, Barbara K. Buchner and Carlo Carraro, Cambridge, UK: Cambridge University Press, 2007.

Interactions of Cost-Containment Measures and Linking of Greenhouse Gas Emissions Cap-and-Trade Programs, Electric Power Research Institute, November 2006.

Interactions of Greenhouse Gas Emission Allowance Trading with Green and White Certificate Schemes, European Commission Directorate-General Environment, November 2005.

Carbon Markets, Electricity Prices and “Windfall Profits”—Emerging Information from the European Union Emissions Trading Scheme, Electric Power Research Institute, September 2005.

Economic Instruments for Reducing Ship Emissions in the European Union, European Commission, Directorate-General Environment, June 2005.

Evaluation of the Feasibility of Alternative Market-Based Mechanisms to Promote Low-Emission Shipping in European Union Sea Areas, European Commission, Directorate-General Environment, March 2004.

“Assessing the Financial Consequences to Firms and Households of a Downstream Cap-And-Trade Program to Reduce U.S. Greenhouse Gas Emissions” in *A Climate Policy Framework: Balancing Policy and Politics*, John A. Riggs, ed., Washington, DC: The Aspen Institute, 2004.

Alternatives for Implementing the UK’s National Allocation Plan, Department for Environment, Food and Rural Affairs, with AEA Technology and SPRU, August 2003.

Report on UK’s Implementation of the CO₂ National Allocation Plan Under the European Union Greenhouse Gas Emissions Trading Programme, Department for Environment, Food and Rural Affairs, with AEA Technology and SPRU, July 2003.

“Ex Post Evaluation of the RECLAIM Emissions Trading Program for the Los Angeles Air Basin,” National Policies Division, OECD Environment Directorate, June 2003.

Emission Trading in the U.S.: Experience, Lessons, and Considerations for Greenhouse Gases. (with Denny Ellerman and Paul Joskow). Pew Center on Global Climate Change, May 2003.

“Carbon Emission Trading: Creating a New Traded Commodity Market in Europe,” in *WorldPower*, October 2002.

“A Groundbreaking Proposal: European Greenhouse Gas Emissions Trading,” in *Infrastructure Journal*, August 2002.

“Europe Warms to Emissions Trading,” in *Energy Regulation Brief*, NERA Economic Consulting, April 2002.

Evaluation of Alternative Initial Allocation Methods in a European Union Greenhouse Gas Emissions Cap-and-Trade Programme, European Commission Directorate-General Environment, March 2002.

“Economics Issues In Section 316(B) Decisions,” in *A Towering Challenge*, C. Richard Bozek, Electric Perspectives, January/February 2002.

“Tradable Permit Programs for Air Quality and Climate Change,” in *International Yearbook of Environmental and Resource Economics, Volume VI*, Henk Folmer and Thomas Tietenberg (Eds.). London: Edward Elgar, 2002.

Energy-Environment Policy Integration and Coordination Study (contributor), Palo Alto, CA: Electric Power Research Institute, December 2000.

Critical Issues in International Greenhouse Gas Emissions Trading: Setting Baselines for Credit-Based Trading Programs-Lessons Learned from Relevant Experience. Palo Alto, CA, Electric Power Research Institute, June 2000.

“Tradable Permits for Air Pollution Control: The United States Experience,” in *Domestic Tradable Permit Systems for Environmental Management: Issues and Challenges*, J.P. Barde and T. Jones (Eds.). Paris: Organization for Economic Cooperation and Development, 1999.

“Emissions Trading: Turning Theory Into Practice in the Los Angeles Air Basin,” in *Pollution for Sale: Emissions Trading and Joint Implementation*, S. Sorrell and J. Skea (Eds.). London: Edward Elgar, 1999.

“Commentary: International Greenhouse Gas Trading and the Kyoto Protocol,” in *Climate Change Policy: Practical Strategies to Promote Economic Growth and Environmental Quality*, C. Walker, M. Bloomfield and M. Thorning (Eds.). Washington, DC: The American Council for Capital Formation Center for Policy Research, May 1999

“Priorities for the Development of GHG Trading Programs: Implications of the U.S. Experience,” in *Global Climate Change: Science, Policy, and Mitigation/Adaptation Strategies*, C.V. Mathai and J. Kinsman (Eds.). Washington, DC: Air & Waste Management Association, October 1998.

“Commentary on ‘Tradable Emissions Rights and Joint Implementation for Greenhouse Gas Abatement: A Look Under the Hood,’” in *The Impact of Climate Change Policy on Consumers: Can Tradable Permits Reduce the Cost?* C. Walker, M. Bloomfield, and M. Thorning (Eds.). Washington, DC: The American Council for Capital Formation Center for Policy Research, April 1998.

“Considerations in Designing and Implementing an Effective International Greenhouse Gas Trading Program,” Global Climate Coalition, October 1997.

“The Use of Externality Adders for Greenhouse Gas Emissions in Electric Utility Resource Planning,” in *Internalization of Social Costs of Energy Conversion and Transportation in the United States and Europe for a Sustainable Development*, O. Hohmeyer and R. Ottinger (Eds.). Berlin: Springer-Verlag, 1996.

“Environmental Adders in the Real World,” (with A. Nichols), in *Resources and Energy Economics*, December 1996.

“Recent Evidence on the Appropriate Timing of Reductions in Greenhouse Gas Emissions,” (with A. Nichols), Global Climate Coalition, July 1996.

The Distributive Effects of Economic Instruments for Global Warming. Paris: Organization for Economic Cooperation and Development, 1996.

The Distributive Effects of Economic Instruments for Environmental Policy. Paris: Organization for Economic Cooperation and Development, 1994.

“The Socioeconomic Effects of Externality Adders for Electric Utility Emissions,” in *Technical Review of Externalities Issues*. Electric Power Research Institute, December 1994.

“Utility Externalities and Emissions Trading: California is Developing a Better Way,” in *Social Costs of Energy - Present Status and Future Trends*, R. Ottinger and O. Hohmeyer (Eds.). Berlin: Springer-Verlag 1994.

“Who Wins and Who Loses from Economic Instruments?” *The OECD Observer* 180:29-31, February/March 1993.

“Tradable Permits and Social Costing: The California Experience,” prepared for the American Economic Association and Allied Social Science Association Meeting, Anaheim, California, January 6, 1993.

“Emissions Trading: A Better Way to Include Environmental Costs in Electric Utility Resource Planning,” American Planning Association and Edison Electric Institute, March 1992.

“Economists’ Contribution to the Environment,” *Journal of Air and Waste Management Association*, October 1991.

“Potential Cost Savings and Environmental Effects of Using Emissions Trading to Manage NO_x in Ontario,” (with A. Nichols), in *Air and Waste Management Through the 90’s*, R. E. Clement (Ed.), Air and Waste Management Association, Ontario, Canada, April 1990.

“Market-Based Approaches for Environmental Protection: Implications for Business,” (with A. Nichols), in *Special Report on Global Environmental Issues*, B. Gentry (Ed.). Washington, DC: The Bureau of National Affairs, 1990.

“Environmental Policy in Europe: Economic Lessons from the United States Experience,” in *Environmental Damages*. Rome, V. Polidoro (Ed.). Italy: Italian Government Printing Office, August 1990.

Comments before the Department of Interior on Advanced Notice of Proposed Rulemaking Regarding Revision of Natural Resource Damage Assessment Regulations, 43 CFR Part 11, (with J. Hausman), November 1989.

“To Live and Breathe in L.A.,” (with P. Portney, A. Krupnick, and H. Dowlatabadi), *Issues in Science and Technology* V(4):Summer 1989.

“Policy Approaches for Controlling Greenhouse Gases,” Energy Research Group, May 1989.

“Yes to Clean Air, But at What Cost?” *The New York Times*, March 26, 1989.

“Realistic Air-Quality Goals Will Prevent Cost Explosion,” *Los Angeles Times*, January 11, 1989.

“Put the Clock on Landing Fees,” *The Journal of Commerce*, November 10, 1988.

“Reforming Airport Pricing to Reduce Congestion,” Conference on Transportation Options for the 21st Century, Boston, Massachusetts, July 1988.

“Awaiting the Second Shoe at Congested Logan,” *The Boston Globe*, March 29, 1988.

“Banning Hazardous Material from Land Disposal Facilities,” *Hazardous Waste* 1(1984).

“Benefit-Cost Analysis of Environmental Regulation: Case Studies of Hazardous Air Pollutants,” (with J. Haigh and A. Nichols), *Harvard Environmental Law Review* 8(1984).

Research and Demonstration of Improved Methods for Carrying Out Benefit-Cost Analysis of Individual Regulations, Volumes I - IV, (Principal Investigator), prepared for the U.S. Environmental Protection Agency, Final Report, November 1984.

“Using the Hedonic Housing Value Method to Estimate the Benefits of Hazardous Waste Cleanup,” (with J. Stock), U.S. Environmental Protection Agency, November 1984.

“Using the Averting Cost Method to Estimate the Benefits of Hazardous Waste Cleanup,” (with M. O’Keeffe), U.S. Environmental Agency, November 1984.

“The Value of Acquiring Information Under Section 8(a) of the Toxic Substances Control Act: A Decision-Analytic Approach,” (with A. Nichols, L. Boden, and R. Terrell), U.S. Environmental Protection Agency, November 1984.

“Hedonic Housing Values, Local Public Goods, and the Benefits of Hazardous Waste Cleanup,” (with J. Stock), Discussion Paper, Energy and Environmental Policy Center, Harvard University, November 1984.

“The Regulation of Aircraft Noise,” in *Incentive Arrangements for Environmental Protection*, T. Schelling (Ed.). Cambridge, MA: MIT Press, 1983.

“Benefit-Based Flexibility in Environmental Regulation,” (with A. Nichols), Discussion Paper, Energy and Environmental Policy Center, Harvard University, April 1983.

“Who Loses from Reform of Environmental Regulation,” (with P. Portney), in *Reform of Environmental Regulation*, Wesley Magat (Ed.). Cambridge, MA: Ballinger Publishing Company, 1982.

“Regulatory Reform in the Large and in the Small,” (with P. Portney), in *Reforming Government Regulation*, LeRoy Graymer (Ed.). Beverly Hills, CA: Sage Publications, 1982.

“Imports and the Future of the U.S. Automobile Industry,” (with J. Gomez-Ibanez), *American Economic Review*, Papers and Proceedings 72 (May 1982).

“Regulation and Distribution: An Agenda for Research,” in *Creating An Agenda for Regulatory Research*, A. Ferguson (Ed.). Cambridge, MA: Ballinger Publishing Company, 1981.

“Cost-Benefit Analysis and the Regulation of Environmental Carcinogens,” in *Management of Carcinogenic Risk*, W. Nicholson (Ed.). New York: New York Academy of Sciences, 1981.

“Distributional Objectives in Health and Safety Regulation,” in *The Benefits of Health and Safety Regulation*, A. Ferguson (Ed.). Lexington, MA: D.C. Heath and Company, 1981.

“The Local Government Role in Energy Policy,” (with M. Shapiro), in *Energy and Environment: Conflict and Resolution*, R. Axelrod (Ed.). Lexington, MA: D.C. Heath and Company, 1981.

“Making Ready for the Clean Air Act,” (with P. Portney), *Regulation* 5(March/April 1981).

“Discussion of Robert C. Ellickson, ‘Public Property Rights: Vicarious Intergovernmental Rights and Liabilities as a Technique for Correcting Intergovernmental Spillovers,’” in *Essays on the Law and Economics of Local Government*, D. Rubinfeld (Ed.). Washington, D.C: The Urban Institute, 1979.

“Simulating the Impacts of Transportation Policy on Urban Land Use,” Discussion Paper, Department of City and Regional Planning, Harvard University, April 1979. (Presented at meeting of the Eastern Economics Association, May 1979.)

“Income and Urban Development,” Discussion Paper, Department of City and Regional Planning, Harvard University, April 1979.

“The Distribution of Benefits from Improvements in Urban Air Quality,” (with D. Rubinfeld), *Journal of Environmental Economics and Management* 5(December 1978).

“The Impact of Transit Systems on Land Use Patterns in the Pre-Automobile Era,” Discussion Paper, Department of City and Regional Planning, Harvard University, December 1978.

“The Air Pollution and Property Value Debate: Some Empirical Evidence,” (with D. Rubinfeld), *Review of Economics and Statistics* 60(November 1978).

“Transportation Technology and the Dynamics of Urban Land Use Patterns,” paper presented to the Conference on Urban Transportation, Planning, and the Dynamics of Land Use, Northwestern University, June 1978.

“Hedonic Housing Values and the Demand for Clean Air,” (with D. Rubinfeld), *Journal of Environmental Economics and Management* 5(March 1978).

“Controlling Automotive Emissions: How to Save More Than \$1 Billion per Year and Help the Poor Too,” *Public Policy* 2 (Fall 1977).

“Reply to Michelle White’s Comment on ‘Cumulative Urban Growth and Urban Density Functions,’” (with J. Kain), *Journal of Urban Economics* 4(January 1977).

“Cumulative Urban Growth and Urban Density Functions,” (with J. Kain), *Journal of Urban Economics* 1(January 1974).

II. Consulting Reports for Directed Projects

A. Climate Change

A Carbon Dioxide Standard for Existing Power Plants: Impacts of the NRDC Proposal, prepared for the American Coalition for Clean Coal Electricity, March 2014.

Linkage of a Potential South African GHG Cap and-Trade Program: Initial Scoping Study,” prepared for Sasol, June 13, 2013.

Economic Outcomes of a U.S. Carbon Tax, prepared for National Association of Manufacturers, February 26, 2013.

Environmental and Economic Impacts of the Second Amendment to the 2010 Integrated Resource Plan, prepared for Sierra Pacific Power, August 2012.

Analysis of EPA’s Proposed GHG, New Source Performance Standard for Electric Generating Units, prepared for American Coalition for Clean Coal Electricity, June 25, 2012

Environmental and Economic Impacts of the 2012 Integrated Resource Plan, prepared for Nevada Power Company, June 2012.

Evaluation of Incentives in International Sectoral Crediting Mechanisms, prepared for Enel S.p.A., October 2011.

Environmental and Economic Impacts of the First Amendment Supplemental Filing to the 2009 Integrated Resource Plan, prepared for Nevada Power Company, October 2011.

Environmental Costs and Economic Impacts of the Second Amendment to the 2009 Integrated Resource Plan, prepared for Nevada Power Company, August 2011.

Environmental Costs and Economic Impacts of the 2010 Integrated Resource Plan, prepared for Sierra Pacific Power Company, July 2010.

Environmental Costs and Economic Impacts of the 2009 Integrated Resource Plan, prepared for Nevada Power Company, February 2010.

Follow-up letter to US Environmental Protection Agency Clarifying Key Conclusions from Review of EPA's Approach to Aggregating Emissions Across Time in Proposed Revisions of Renewable Fuel Standards, prepared on behalf of Growth Energy, January 2010.

Review of EPA's Approach to Aggregating Emissions across Time in Proposed Revisions of Renewable Fuel Standards, prepared for Growth Energy for submission to U.S. EPA, Docket ID No. EPA-HQ-OAR-2005-0161, September 2009.

Differentiation among Batches of Conventional Biofuels based on Greenhouse Gas Emissions, prepared for Growth Energy, September 2009.

Impacts of Waxman-Markey Bill on US Refiners: Preliminary Estimates, prepared for major industrial sector, July 2009.

Effects of Waxman-Markey on Natural Gas and Electricity Businesses: Phase 1, prepared for a Midwest utility, July 2009.

Environmental Costs and Economic Benefits of Electric Utility Resource Selection, prepared for Nevada Power Company, March 2009.

Impacts of the California Greenhouse Gas Emission Standards on Motor Vehicle Sales, prepared for the Alliance of Automobile Manufacturers, April 2009.

Accounting for Differences in the Timing of Emissions in Calculating Carbon Intensity for the California Low Carbon Fuels Standard, prepared for the Renewable Fuels Association, April 2009.

Environmental Costs and Economic Benefits of Electric Utility Resource Selection, prepared for Nevada Power Company, March 2009.

Evaluation of Alternative Benchmarked Sector-Level Allocation Formulas, prepared for a major U.S. industrial trade group, October 2008.

Impacts of Climate Change Policies Using the NERA Carbon Financial Impacts Model (Phase 2 Study), prepared for a major U.S. industrial manufacturer, June 2008.

Effects of the Regional Greenhouse Gas Initiative on Regional Electricity Markets, prepared for AES and Dynegy, June 2008.

Environmental Costs and Economic Benefits of Electric Utility Resource Selection, prepared for Nevada Power Company, May 2008.

Impacts of Potential Climate Change Policy using the NERA Carbon Financial Impacts Model, prepared for a major U.S. trade association, April 2008.

Market Conditions and the Pass-Through of Compliance Costs in a Carbon Emission Cap-and-Trade Program, prepared for Conoco Phillips, January 2008.

Evaluation of the Financial Impacts of Alternative Climate Change Cap-and-Trade Programs using the NERA Carbon Financial Impacts Model, prepared for a major U.S. industrial manufacturer, December 2007.

Evaluation of the Financial Impacts of Alternative Climate Change Cap-and-Trade Programs using the NERA Carbon Financial Impacts Model, prepared for a major U.S. energy company, November 2007.

Evaluation of the Financial Impacts of Alternative Climate Change Cap-and-Trade Programs using the NERA Carbon Financial Impacts Model, prepared for a major U.S. industrial manufacturer, October 2007.

Evaluation of the Financial Impacts of Alternative Climate Change Cap-and-Trade Programs using the NERA Carbon Financial Impacts Model, prepared for a major U.S. energy company, September 2007.

Environmental Costs and Economic Benefits of Electric Utility Resource Selection, prepared for Sierra Pacific Power Company, June 2007.

Evaluation of the Financial Impacts of Alternative Climate Change Cap-and-Trade Programs using the NERA Carbon Financial Impacts Model, prepared for a major U.S. energy company, March 2007.

Effectiveness of the California Light Duty Vehicle Regulations As Compared to Federal Regulations, in collaboration with Sierra Research, Inc. and Air Improvement Resource, Inc., prepared for the Alliance of Automobile Manufacturers, June 2007.

Financial Impacts of Potential Mandatory CO₂ Cap-and-Trade Programs using the NERA Carbon Financial Impacts Model, prepared for a major U.S. trade association, January 2007.

Modeling the Fleet Population Effects of the Rhode Island Proposal to Reduce Greenhouse Gas Emissions from Motor Vehicles, prepared for the Alliance of Automobile Manufacturers, November 2005.

Review of Potential Expansion of the UK Phase II National Allocation Plan to the Petrochemical Sector, prepared for UK Department for the Environment, Food and Rural Affairs (DEFRA) and Department of Trade and Industry (DTI), November 2005.

The Impacts of CO₂ Prices on European Electricity Prices, prepared for Electricité de France (EDF), October 2005.

Modeling the Fleet Population Effects of the Massachusetts Proposal to Reduce Greenhouse Gas Emissions from Motor Vehicles, prepared for the Alliance of Automobile Manufacturers, October 2005.

Modeling the Fleet Population Effects of the Maine Proposal to Reduce Greenhouse Gas Emissions from Motor Vehicles, prepared for the Alliance of Automobile Manufacturers, October 2005.

Modeling the Fleet Population Effects of the New Jersey Proposal to Reduce Greenhouse Gas Emissions from Motor Vehicles, prepared for the Alliance of Automobile Manufacturers, September 2005.

Modeling the Fleet Population Effects of the Connecticut Proposal to Reduce Greenhouse Gas Emissions from Motor Vehicles, prepared for the Alliance of Automobile Manufacturers, September 2005.

Modeling the Fleet Population Effects of the Vermont Proposal to Reduce Greenhouse Gas Emissions from Motor Vehicles, prepared for the Alliance of Automobile Manufacturers, August 2005.

Modeling the Fleet Population Effects of the New York State Proposal to Reduce Greenhouse Gas Emissions from Motor Vehicles, prepared for the Alliance of Automobile Manufacturers, July 2005.

Initial Review of Potential Expansion of the UK Phase 2 NAP to Additional CO₂ Sources, prepared for the Department for the Environment, Food and Rural Affairs, May 2005.

Environmental and Economic Impacts of the ARB Staff Proposal to Control Greenhouse Gas Emissions from Motor Vehicles, prepared for the Alliance of Automobile Manufacturers, September 2004. Submitted to the California Air Resources Board.

Reviews of Studies Evaluating the Impacts of Motor Vehicle Greenhouse Gas Emissions Regulations in California, for the Alliance of Automobile Manufacturers, September 2004. Submitted to California Air Resources Board.

TXU Activities Regarding Actual and Potential US Air Emissions and Climate Change Policies, prepared for TXU Corporation, September 2004.

Strategies for Chubu Electric Power Co., Ltd., to Take Advantage of Opportunities Under Greenhouse Gas Emissions Trading Programs, in collaboration with Japan NUS Co., Lt, for Chubu Electric Power Co., Ltd, January 2004.

Impacts of ZEV Sales Mandate on California Motor Vehicle Emissions: Responses to Comments of Air Resource Board Staff and Related Documents Provided as Part of the 15-Day Notice (with Sierra Research, Inc.), prepared for the Alliance of Automobile Manufacturers, November 2001.

KEPCO's Role in a Greenhouse Gas Emissions Trading Program, prepared for Kansai Electric Power Company, February 2001.

International Carbon Emissions Trading Practices: Review of Recent Literature, prepared for Chubu Electric Power Company, February 2001.

The Timing of Plant Replacement and the Cost-Effectiveness of CO₂ Reductions from Two Canadian Utilities, prepared for Ontario Hydro and TransAlta Corporation, July 1996.

B. Air Quality

Environmental Costs and Economic Impacts of the Emissions Reduction and Capacity Replacement Plan, prepared for NV Energy Inc., May 2014.

Cost-Effectiveness Analysis of Alternative Woodstove New Source Performance Standards, prepared for Hearth, Patio and Barbecue Association, May 2014.

Assessment of EPA Economic Analyses for Proposed Wood Heater New Source Performance Standards, prepared for Hearth, Patio and Barbecue Association, May 2014.

Cost-Effectiveness Analysis of Alternative Hydronic Heater New Source Performance Standards, prepared for Hearth, Patio and Barbecue Association, May 2014.

Economic Implications of Recent and Anticipated EPA Regulations Affecting the Electricity Sector, prepared for American Coalition for Clean Coal Electricity, October 2012.

Environmental and Economic Impacts of the First Amendment Supplemental Filing to the 2009 Integrated Resource Plan, prepared for Nevada Power Company, October 2011.

Potential Impacts of EPA Air, Coal Combustion Residuals, and Cooling Water Regulations, prepared for the American Coalition for Clean Coal Electricity, September 2011.

Environmental Costs and Economic Impacts of the Second Amendment to the 2009 Integrated Resource Plan, prepared for Nevada Power Company, August 2011.

Environmental Costs and Economic Impacts of the 2010 Integrated Resource Plan, prepared for Sierra Pacific Power Company, July 2010.

Environmental Costs and Economic Impacts of the 2009 Integrated Resource Plan, prepared for Nevada Power Company, February 2010.

Economic Analysis of Proposed U.S. EPA Biocide Data Requirements, prepared for The American Chemistry Council, March 2009.

Evaluation of Potential Attainment Costs and Economic Impacts under a Potential Revised EPA 8-Hour Ozone Standard, prepared for the National Association of Manufacturers, January 2008.

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Before the Minnesota Public Utilities Commission, *Considerations in the Development of Externality Values for Greenhouse Gas Emissions*, surrebuttal testimony prepared on behalf of Northern States Power Company In the Matter of the Establishment of Environmental Cost Values, Docket No. E-999/CI-93-583, April 1995.

Before the Minnesota Public Utilities Commission, *Considerations in the Development of Externality Values*, rebuttal testimony prepared on behalf of Northern States Power Company In the Matter of the Establishment of Environmental Cost Values, Docket No. E-999/CI-93-583, March 1995.

Before the Public Service Commission of Nevada, *Environmental Externality Cost Values*, prepared testimony on behalf of Nevada Power Company, Docket No. 94-7001, February 1995.

Before the Minnesota Public Utilities Commission, *Considerations in the Development of Externality Values*, direct testimony on behalf of Northern States Power Company In the Matter of the Establishment of Environmental Cost Values, Docket No. E-999/CI-93-583, November 1994.

Before the Public Utilities Commission of the State of California, *External Benefits from Increasing Electric Vehicles in the Southern California Edison Service Territory*, testimony prepared on behalf of Southern California Edison Company In the Matter of the Order Instituting Investigation and Order Instituting Rulemaking to Develop Rules, Procedures, and Policies Governing Utility Involvement in the Market for Low-Emissions Vehicles, October 1993.

Before the Public Utilities Commission of the State of California, *External Benefits from Increasing Electric Vehicles in the Pacific Gas & Electric Service Territory*, testimony prepared on behalf of Pacific Gas & Electric Company In the Matter of the Order Instituting Investigation and Order Instituting Rulemaking to Develop Rules, Procedures, and Policies Governing Utility Involvement in the Market for Low-Emissions Vehicles, October 1993.

Before the Public Utilities Commission of the State of California, *External Benefits from Increasing Electric Vehicles in the San Diego Gas & Electric Service Territory*, testimony prepared on behalf of San Diego Gas & Electric Company In the Matter of the Order Instituting Investigation and Order Instituting Rulemaking to Develop Rules, Procedures, and Policies Governing Utility Involvement in the Market for Low-Emissions Vehicles, October 1993.

Affidavit on the Economic Impacts of Chicago Area Airports on the Chicago Regional Economy, prepared on behalf of The City of Chicago in the *People of the State of Illinois et al. v. The City of Chicago et al.*, in the Circuit Court for the Eighteenth Judicial Circuit, DuPage County, Wheaton, Illinois, December 1992.

Before the Public Utilities Commission of the State of California, *Air Quality Issues and Disaggregation of LEV Benefits by Rate Class*, rebuttal testimony prepared on behalf of Southern California Edison Company in the Matter of the Order Instituting Investigation and Order Instituting Rulemaking to Develop Rules, Procedures, and Policies Governing Utility Involvement in the Market for Low-Emissions Vehicles, Docket Nos. I.91-10-029 and R.91-10-028, August 1992.

Before the California Energy Commission ER-92 Hearing on Valuing Air Quality Impacts of Energy Resources, *Revised Damage-Based Values for Residual Emissions Valuation*, (with M. B. Deming), testimony prepared on behalf of Southern California Edison Company, Sacramento, California, May 1992.

Before the State of California Energy Resources Conservation and Development Commission, *Valuing Air Quality Impacts of Alternative Energy Resources*, testimony prepared on behalf of Southern California Edison Company, Docket No. 90-ER-2, March 1992.

Before the California Energy Commission ER-92, *Group I Hearing Issues: Air Quality*, (with Southern California Edison), *1992 Electricity Report*, testimony prepared on behalf of Southern California Edison Company, Docket No. 90-ER-92, submitted by Southern California Edison, November 1991.

Affidavit on Landing Fees at Logan International Airport, prepared on behalf of the defendant in *New England Legal Foundation, et al. v. Massachusetts Port Authority and National Business Aircraft Association, Inc., et al.*, United States District Court, District of Massachusetts, June 1988. (Also submitted to the U.S. Department of Transportation.)

Defendant's Expert Witness Disclosure on Summary of Damages Claimed by the State of Michigan for Fish Killed by the Luddington Pumped Storage Plant, prepared on behalf of Consumers Power Company and The Detroit Edison Company in *Frank J. Kelley, ex rel Michigan Natural Resources Commission; Michigan Department of Natural Resources; and Gordon Guyer, Director of the Michigan Department of Natural Resources v. Consumers Power Company and The Detroit Edison Company*, Case No. 86-57075-CE in the Circuit Court for the County of Ingham, June 1988.

IV. Presentations

A. Climate Change

"Offsets in Potential EPA GHG Tradable Performance Standard for Existing Power Plants: Preliminary Assessment," Presentation to the Electric Power Research Institute Environment & Renewable Program Advisory Meeting, Kansas City, Missouri, September 24, 2013.

"The Interactions of Complementary Policies with a GHG Cap-and-Trade Program: The Case of Europe," presentation at the EPRI-IETA Joint Symposium, San Francisco, April 16, 2013.

“Incentives for International Sectoral Crediting Mechanisms,” presented at the Workshop on New Market Mechanisms organized by the International Emissions Trading Association and Enel S.p.A., Brussels, October 13, 2011.

“The Copenhagen Conference: International Climate Policy and Implications for US Policy,” presented at the Fenway Colleges Climate Change Teach-In, Washington, DC, February 25, 2010.

“U.S. Greenhouse Gas Cap-and-Trade Programs and Cost Containment,” presented at the EUEC 2010 Energy & Environment Conference, AZ, Phoenix, February 1, 2010.

“Financial Implications of a US Cap-and-Trade Program for Sectors and Companies,” presented at 2nd Annual Carbon Trading Summit, New York City, January 13, 2010.

“Lessons Learned from the European Union Emissions Trading Scheme,” presented to California State Senate Select Committee on Climate Change and AB 32 Implementation, Sacramento, CA, January 7, 2010.

“Greenhouse Gas Emissions Cap-and-Trade Program: Key Design Elements,” presented at the IETA Fall 2009 Symposium, Washington, DC, November 3, 2009.

“Compliance Flexibility in Domestic Greenhouse Gas Cap-and-Trade Programs,” presented to the 9th Annual Workshop on Greenhouse Gas Emissions Trading sponsored by the Electric Power Research Institute, the International Energy Agency, and the International Emissions Trading Association, Paris, September 14, 2009.

“Allocation Decisions in the European Union Emissions Trading Scheme,” presented to the California Economic and Allocation Advisory Committee, July 1, 2009.

“Economic Analysis of Waxman-Markey Climate Bill (ACES),” presented as part of Environmental Markets Association Webinar, June 4, 2009.

“Climate Policy Risks for Electric Utilities: Economic Modeling to Assist Utilities in Responding to Climate Change Programs,” presented at the Utility Rate Case Conference organized by Law Seminars International, Las Vegas, NV, February 6, 2009.

“Cost-Containment in a U.S. Greenhouse Gas Cap-and-Trade Program,” presented at the EEI Fall 2008 Legal Conference, Boston, October 30, 2008.

“Climate Change and Electricity Prices: What Should Electricity Companies Do,” presented at the EUCI Conference on Electricity, Chicago, September 30, 2008.

“The EU Energy and Climate Package: Interactions between EU Policies and Targets and Implications for CO₂ Price Uncertainty,” presented at the IEA/IETA/EPRI 8th Annual Workshop on Greenhouse Gas Emissions Trading, Paris, September 23, 2008.

“European Union Emissions Trading Scheme: Overview and Implications for the U.S.,” presented at the Second Carbon Trading Summit, New York, NY, June 24, 2008.

“Carbon Emissions Trading and Allocation: Complexities of Policy Choices,” presented at the IETA/AIGN Workshop, Canberra, Australia, March 5, 2008.

“Climate Change: What Every Company Should Do to Get Ready for a Mandatory Emissions Trading Program,” presented at NERA Economic Consulting Workshop, Sydney, Australia, March 4, 2008.

“Workshop on Carbon Emissions Trading: EU and US Experience and Implications for IP/Australia,” presented before International Power, Melbourne, Australia, March 3, 2008.

“Design Elements for Potential Canadian GHG Cap-and-Trade Program,” presented at the Cap and Trade Working Group Retreat, Toronto, Ontario, January 31, 2008.

“Allocation in the EU ETS: What Have We Learned?” presented at the MIT workshop on EU ETS, Washington, DC, January 24, 2008.

“Emissions Trading: Background, Prior Programs and Implications for a U.S. Carbon Cap-and-Trade Program,” presented at ALI-ABA Course on Clean Air: Law, Policy and Practice, Washington, DC, November 9, 2007.

“Overview of the European Union Emissions Trading Scheme for Carbon Dioxide,” presented at EEI’s 2007 Fall Legal Conference, Napa, California, October 4, 2007.

“Evaluating the Financial Impacts of Potential Carbon Cap-and-Trade Programs on Electricity Companies: What Every Electricity Company Should Do to Get Ready for Mandatory Climate Change Policy,” presented at the Carbon Constraint Conference, Chicago, September 13, 2007.

“EU ETS Allocation Options: Reconciling Complexities and Simplicity/Transparency,” presented before the IETA-CEPS Climate Change Conference, Brussels, Belgium, June 26, 2007.

“Overview of Allocation Methodologies and Principles,” presented before the European Climate Change Programme working group on emissions trading, Brussels, Belgium, May 21, 2007.

“Allocation Choices for a Carbon Trading Program,” presented at the Carbon Expo, Cologne, Germany, May 3, 2007.

“Allocation Choices and International Considerations,” presented to Senate staff members, Washington, DC, February 2, 2007.

“Carbon Financial Analyses for Electricity Companies,” presented at the Electric Utilities Environmental Conference, Tucson, Arizona, January 23, 2007.

“Carbon Emissions and State Electric Utility Regulation,” presented at the Electric Utilities Environmental Conference, Tucson, Arizona, January 22, 2007.

“European Union Emissions Trading Scheme for Carbon Dioxide: Lessons and Implications,” presented at North America and The Carbon Markets Conference hosted by Point Carbon and Pew Center on Global Climate Change, Washington, DC, January 18, 2007.

“Policy Design Side By Side: What Elements Matter,” presented at North America and the Carbon Markets Conference hosted by Point Carbon and Pew Center on Global Climate Change, Washington, DC, January 17, 2007.

“European Union,” presented at North America and the Carbon Markets Conference hosted by Point Carbon and Pew Center on Global Climate Change, Washington, DC, January 17, 2007.

“Carbon Markets, Linking, and Cost Containment,” presented at the IEA/IETA/EPRI 6th Annual Emissions Trading Workshop, Paris, France, September 27, 2006.

“Auctioning Experience in Other Sectors and Implications for Designing a Carbon Auction,” presented at the IETA Workshop on Allocation Methodologies, Paris, France, September 25, 2006.

“European Carbon Markets and Implications for a US Carbon Constrained Future,” presented at Preparing for a Carbon Constrained Future Conference hosted by Electric Utility Consultants, Inc., Arlington, Virginia, June 28, 2006.

“Overview of the European Union Emissions Trading Scheme,” presented to staff of the Senate Committee on Energy and Natural Resources, Washington, DC, June 16, 2006.

“Policies to Address Potential EU ETS Impacts on Power Prices and Industrial Competitiveness,” presented at the CEPS/IETA Climate Change Conference, Brussels, Belgium, May 30, 2006.

“Learning from Experience: First Year of the European CO₂ Emissions Trading Scheme,” presented to New Prospects for Climate Change Regulation Panel organized by Harvard Law School, March 10, 2006.

“Carbon Policies and Electric Utility Rate Cases,” presented at the Managing the Modern Utility Rate Case Conference organized by Law Seminars International, Las Vegas, NV, February 14, 2006.

“Beyond Cost: Carbon Markets, Electricity Prices and ‘Windfall Profits,’” presented to Electric Utilities Environmental Conference, Tucson, AZ, January 23, 2006.

“European CO₂ Emissions Trading Scheme: First Year Accomplishments and Implications,” presented at an International Emissions Trading Association side event at the 11th Conference of the Parties to the Kyoto Protocol, Montreal, December 5, 2005.

“Allocation Choices for a U.S. Carbon Dioxide Emissions Trading Scheme,” presented to National Commission on Energy Policy, Workshop on Allowance Allocation, Washington, DC, September 30, 2005.

“Carbon Markets, Electricity Prices and Windfall Profits: Emerging Information on the European Union Emissions Trading Scheme” presented to IEA-IETA-EPRI Emissions Trading Workshop, Paris, September 27, 2005.

“U.S. State-level Climate Regimes: Lessons from the U.S. and Europe, presented to Fourth Annual Green Trading Summit, New York, NY, May 2, 2005.

“Overview of Allocation Choices: Alternatives and Implications,” presented to Stakeholder Workshop, Regional Greenhouse Gas Initiative, Boston, MA, October 14, 2004.

“Emissions Trading: Concepts, Experience, Lessons, and Implications Greenhouse Gas Programs,” presented to Iberdrola, Cambridge, MA, March 25, 2004.

“How CEPCO Can Gain from CO₂ Trading,” presented to Chubu Electric Power Co., Inc., Nagoya, Japan, November 25, 2003.

“The Rise of Emissions Trading in Air Quality and Climate Change Policy,” presented to EPRI Environmental Sector Council, San Antonio, Texas, September 12, 2003.

“Greenhouse Gas Emissions Trading and Firm Risk Management Behavior”, presented to the ARPEL-IPIECA Workshop, A Practical Approach to Identifying Emission Reduction Opportunities: Examples under the Kyoto Mechanisms in Latin America and the Caribbean, San Jose, Costa Rica, December 3, 2002.

“Initial Allocations in Various Systems of Emissions Trading” presented to the Exploring New Approaches in Regulating Industrial Installations (ENAP) Workshop on Emissions Trading for NO_x and SO_x in Europe, The Hague, Netherlands, November 22, 2002.

“Overview of Alternative Allocations for European GHG Trading Program,” presented to IEA-EPRI-IETA Workshop on Greenhouse Gas Emissions Trading, Paris, September 17, 2002.

“Evaluation of Alternative Allocations for European GHG Trading Program,” presented to IEA-EPRI-IETA Expert Meeting: Allocation of GHG Objectives, Paris, September 16, 2002.

“Greenhouse Gas Emission Trading Programs,” presented to Chubu Electric Company, Cambridge, MA, July 16, 2002.

“Evaluation of Alternative Allocations for European GHG Trading Program,” presented to Chubu Electric Company, Cambridge, MA, July 16, 2002.

“Corporate Strategies and Practices for GHG Emission Reduction,” presented to Chubu Electric Company, Cambridge, MA, July 15, 2002.

“Emission Trading: Concepts, Experience, and Lessons from Non-Greenhouse Gas Programs,” presented to Chubu Electric Company, Cambridge, MA, July 15, 2002.

“Prospects for the EU Greenhouse Gas Trading Program,” presented to EPRI Global Climate Change Research Seminar, Washington, DC, June 4, 2002.

“Evaluation of Alternative Allocations for European GHG Trading Program,” presented to European Commission, Brussels, Belgium, November 13, 2001.

“Evaluation of Alternative Allocations for European GHG Trading Program,” presented to ENVECO, Brussels, Belgium, November 13, 2001.

“CO₂ Permit Allocations: Evaluation of Alternatives for the EC,” presented to the European Commission, Brussels, Belgium, March 5, 2001.

“Setting Baselines for Greenhouse Gas Trading: Lessons from Experience,” presented to United Nations Framework Convention on Climate Change, Bonn, Germany, June 10, 2000.

“Setting Baselines for Greenhouse Gas Programs: Lessons from Experience,” presented at the EPRI Global Climate Change Research Seminar, Washington, DC, May 18, 2000.

“Emissions Trading and Developing Countries: Implications of U.S. Experience and World Bank Role,” presented at World Bank – Energy Week 2000, Washington, DC, April 13, 2000.

“Domestic GHG Trading: Assessing Impacts on Electric Utilities,” presented to Electric Power Research Institute, Washington, DC, February 17, 2000.

“Energy-Environmental Policy Integration & Coordination (E-EPIC), U.S. Economic Growth & Health,” presented to Electric Power Research Institute, Washington, DC, May 13, 1999.

“Priorities for the Development of GHG Trading Programs: Implications of the United States Experience,” presented to the EPRI Global Climate Change Area Meeting, San Diego, California, January 26, 1999.

“Priorities for the Development of GHG Trading Programs: Implications of the United States Experience,” presented to the Air & Waste Management Association Specialty Conference on Global Climate Change, Washington, DC, October 14, 1998.

“International Greenhouse Gas Trading,” presented to the American Council for Capital Formation, Washington, DC, September 23, 1998.

“International Greenhouse Gas Emission Trading: Promise and Performance,” presented to the EPRI Global Climate Change Research Seminar, Washington, DC, May 27, 1998.

“International Greenhouse Gas Trading: A ‘Silver Bullet’ Train?” presented to Sidebar Meeting, United Nations Framework Convention on Climate Change, Bonn, Germany, October 23, 1997.

“International Greenhouse Gas Trading,” presented to the American Council for Capital Formation Conference on Global Warming, Washington, DC, September 24, 1997.

“International Greenhouse Gas Trading,” presented to the National Association of Manufacturers, Washington, DC, September 17, 1997.

“International Greenhouse Gas Trading,” presented to the American Automobile Manufacturers Association, Washington, DC, May 1, 1997.

“Emission Trading: Alternative Approaches, Experience and Implications for CO₂,” prepared for the AAMA Climate Change Task Force, Washington, DC, September 27, 1996.

“Treatment of Greenhouse Gas Emissions in Electric Utility Resource Planning,” prepared for the Third Conference on External Costs, *Internalization of Social Costs of Energy Conservation and Transportation in the United States and Europe for a Sustainable Development*, Ladenburg, Germany, May 29, 1995.

“Distributive Impacts of Economic Instruments for Greenhouse Gas Abatement,” presented at the Air & Waste Management Association International Specialty Conference *Global Climate Change: Science, Policy and Mitigation Studies*, Phoenix, Arizona, April 6, 1994.

“New Approaches for Controlling Global Warming,” presented to the Conference on Global Warming, Vermont Law School, South Royalton, Vermont, February 16, 1990.

B. Air Quality

“A Carbon Dioxide Standard for Existing Power Plants: Impacts of the NRDC Proposal”, prepared for the American Coalition for Clean Coal Electricity, March 2014.

“Cost-Effectiveness of Alternative Wood Stove New Source Performance Standards,”(with Andrew Foss), presentation to the U.S. Environmental Protection Agency, Raleigh, NC, February 28, 2013.

“Potential Impacts of EPA Air, Coal Combustion Residuals, and Cooling Water Regulations,” presented to the U.S. Environmental Protection Agency, November 21, 2011.

“Potential Impacts of EPA Air, Coal Combustion Residuals, and Cooling Water Regulations,” presented to the U.S. Office of Management and Budget, November 8, 2011.

“Potential Impacts of EPA Air, Coal Combustion Residuals, and Cooling Water Regulations,” presented to the U.S. Treasury Department, October 26, 2011.

“Potential Impacts of EPA Air, Coal Combustion Residuals, and Cooling Water Regulations,” presented to the White House Office of Public Engagement, October 25, 2011.

“Economic Effects of State Restrictions on Interstate Mercury Trading,” presented at the Electric Utilities Environmental Conference, Tucson, Arizona, January 22, 2007.

“Using Emissions Trading to Regulate Mercury Emissions in Montana,” presented at a Public Hearing, Billings, Montana, June 1, 2006.

“Developing an Emissions Trading Program for Regional Haze,” presented to Midwest RPO Regional Air Quality Workshop, Chicago, IL, June 28, 2005.

“Developing an Emissions Trading Program for Regional Haze,” presented to the Visibility Improvement State and Tribal Association of the Southeast (VISTAS), via conference call from Boston, MA, June 1, 2005.

“Economic and Environmental Analyses of CARB Tier 3 Non-Handheld Exhaust Emission Regulations,” presented to the California Air Resources Board staff in Sacramento, CA via videoconference from Boston, MA, September 18, 2003.

“Market Based Instruments and Shipping Emissions,” presented to conference sponsored by DG Environment, Brussels, September 5, 2003.

“Economic and Environmental Analyses of CARB Tier 3 Non-Handheld Emission Regulations: Status Report and Preliminary Results”, presented to Outdoor Power Equipment Institute and Engine Manufacturers Association (OPEI & EMA), Washington, DC, August 26, 2003.

“Ex Post Evaluation of the RECLAIM Emissions Trading Program for the Los Angeles Air Basin”, presented to OECD Workshop on Ex Post Evaluation of Tradable Permits: Methodological and Policy Issues, Paris, January 21, 2003.

“Emissions and Cost-Effectiveness of the Pull-Ahead Requirements for Heavy Heavy-Duty Diesel Engines,” presented to U.S. Office of Management and Budget, Washington, DC, July 24, 2002.

“Economic Analysis of Alternative EPA Snowmobile Regulations,” presented to U.S. Environmental Protection Agency Office of Mobile Sources, Ann Arbor, Michigan, May 1, 2002.

“Impacts of ZEV Sales Mandate on California Fleet Emissions,” presented to the California Air Resource Board, Sacramento, CA, September 7, 2000.

“Economic Assessment of the Cost-Effectiveness of Alternative MACT Standards for the Metal Coil Surface Coating Industry,” presentation to the U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, August 2, 2000.

“Economics and Environmental Regulation: Opportunities and Obstacles,” presented to Crowell & Moring, LLP, Washington, DC, March 22, 2000.

“RECLAIM: A Comprehensive Approach to Air Quality Regulation,” presented to Edison Electric Institute, Washington, DC, March 6, 2000.

“Economic Assessment of the Cost-Effectiveness of Alternative Phase 2 Regulations for Handheld Engines,” presented to the U.S. Environmental Protection Agency and Office of Management and Budget, Washington, DC, February 14, 2000.

“Economic Assessment of the Cost-Effectiveness of Alternative Phase 2 Regulations for Handheld Engines,” presented to the U.S. Environmental Protection Agency, Office of Mobile Sources, Washington, DC, October 12, 1999.

“Economic Assessment of the Cost-Effectiveness of Alternative Phase 2 Regulations for Handheld Engines,” presented to the U.S. Environmental Protection Agency, Office of Mobile Sources, Ann Arbor, Michigan, October 8, 1999.

“Costs & Benefits of Fish Protection Alternatives at the Salem Generating Facility,” presented to the New Jersey Department Environmental Protection, Trenton, New Jersey, May 4, 1999.

“Economic Impacts of ARB Staff Proposed Marine Emission Standards,” presented to the California Air Resources Board Hearing, Sacramento, California, December 10, 1998.

“Cost-Benefit Analysis of MACT Standards for Boat Manufacturing,” presented to the National Marine Manufacturers Association, Tampa, Florida, October 15, 1998.

“Economic Analyses of Alternative California Standards for Exhaust Emissions from Marine Engines,” presented to California Air Resources Board, Sacramento, California, October 9, 1998.

“Tradable Permits for Air Pollution Control: The United States Experience,” presented to the Organization for Economic Cooperation and Development Workshop on Domestic Tradable Permit Systems for Environmental Management, Paris, September 24, 1998.

“NO_x Trading Program to Implement EPA’s SIP Call,” presented to Indiana Department of Environmental Management, Indianapolis, Indiana, May 4, 1998.

“Economic Analysis of Alternative EPA Standards for Large CI Non-Road Engines: Draft NERA Results,” presented to the Engine Manufacturers Association and the Equipment Manufacturers Institute, Chicago, Illinois, September 4, 1997.

“Cost-Effectiveness of ARB Small Off-Road Engine Regulations: Preliminary Results,” presented to the California Air Resources Board, Sacramento, California, May 2, 1997.

“RECLAIM: Turning Theory Into Practice for Emissions Trading in the Los Angeles Air Basin,” presented to the NERA Seminar on Tradable Permits, London, United Kingdom, April 11, 1997.

“RECLAIM: Turning Theory Into Practice for Emissions Trading in the Los Angeles Basin,” presented to the *International Workshop on Tradable Permits, Tradable Quotas and Joint Implementation*, University of Sussex, Brighton, United Kingdom, April 9, 1997.

“Economic Analyses of Alternative ARB Regulatory Requirements for Small SI Non-Handheld Engines,” presented to the California Air Resources Board staff, El Monte, California, February 4, 1997.

“Cost-Effectiveness of Alternative Emission Control Technologies for Small Utility Engines,” presented to California Air Resources Board staff, El Monte, California, December 18, 1996.

“Emission Regulations for Non-Road Engines,” presentation to the U.S. Environmental Protection Agency, Ann Arbor, Michigan, July 17, 1996.

“Valuation of Externalities: Methods and Examples,” presented to the PSP&ED Advisory Group of the Hawaiian Electric Company, Honolulu, Hawaii, April 3, 1996.

“Valuation of Externalities: Experience and Methods,” presented to the Hawaiian Electric Company Externalities Advisory Group, Honolulu, Hawaii, January 31, 1996.

“Emission Regulations for Small Utility Engines,” presented to Small Non-Road Engine Regulatory Negotiations, Ann Arbor, Michigan, December 13, 1995.

“Economic Evaluation of Alternative Regulations of Exhaust Emissions from Small Utility Engines,” presented to U.S. Environmental Protection Agency, Ann Arbor, Michigan, November 28, 1995.

“Emission Regulations for Small Utility Engines,” presented to California Air Resources Board staff, El Monte, California, October 3, 1995.

“Briggs & Stratton/NERA Phase 2 Economic Study,” presented to U.S. Environmental Protection Agency, Ann Arbor, Michigan, September 22, 1995.

“RECLAIM: Turning Theory Into Practice for Emissions Trading in the Los Angeles Basin,” presented to the Stanford Law School Environmental Markets Seminar, Stanford, California, March 8, 1995.

“Emission Trading for NO_x: Experience with RECLAIM,” presented to Edison Electric Institute, Washington, DC, May 26, 1994.

“Emission Trading for NO_x: The RECLAIM Experience,” presented to Edison Electric Institute, May 13, 1994.

“Projecting the Price of RECLAIM Trading Credits for NO_x,” presented at a California Energy Commission Workshop, Sacramento, California, February 4, 1994.

Comments on “Presumptive Pigouvian Tax: Complementing Regulation to Mimic an Emissions Fee,” presented to the Conference on Market Approaches to Environmental Protection, Stanford University, Palo Alto, California, December 3, 1993.

“Economic Effects of Regulatory Requirements to Protect Grand Canyon Visibility,” presented to the Grand Canyon Visibility Transport Commission, Salt Lake City, Utah, October 21, 1993.

“Evolving Role of Externalities in Utility Activities,” presented to the Electric Power Research Institute Energy Analysis Task Force, Nashville, Tennessee, September 29, 1993.

“External Costs of Electricity Generation in Southern Nevada,” presented on behalf of Nevada Power Company, at a workshop sponsored by the Nevada Public Service Commission, Las Vegas, Nevada, May 19, 1993.

“Environmental Externalities,” presented to Central and Southwest Corporation, Dallas, Texas, May 4, 1993.

“Creating Markets for Environmental Protection: Overview of Experience with Tradable Permit Systems,” presented at The Claremont Institute

Conference *Environmental Protection Through Market Incentives: A Strategy for the Future*, Los Angeles, California, January 20-21, 1993.

“Tradable Permits and Social Costing: The California Experience,” presented at the American Economic Association and Allied Social Science Association Meetings, Anaheim, California, January 6, 1993.

“The Distributive Impacts of Economic Instruments for Environmental Policy,” presented to the OECD Group on Economic and Environmental Policy Integration, Paris, November 19, 1992.

“Emissions Trading: A Better Way to Incorporate Environmental Costs in Electric Utilities Resource Planning,” presented at the Pace University

Center for Environmental Legal Studies Conference on *Incorporation of Social Costs of Energy in Resource Acquisition Decisions*, Racine, Wisconsin, September 8-11, 1992.

“Banking and Trading of Air Emission Reduction Credits,” presented to the State of Connecticut Office of Policy and Management Meeting on Emissions Trading, Hartford, Connecticut, July 22, 1992.

“The Distributive Effects of Economic Instruments for Environmental Policy,” presented to the OECD Group on Economic and Environmental Coordination, Paris, June 18, 1992.

“A Marketable Permits Program for the Los Angeles Air Basin,” prepared for MIT Center for Energy and Environmental Policy Research *1992 New Developments Workshop*, Cambridge, Massachusetts, April 30, 1992.

“The Road From Theory to Practice: Developing a Marketable Permits Program for the Los Angeles Air Basin,” seminar presented to the MIT Center for Energy and Environmental Policy Research, Cambridge, Massachusetts, March 11, 1992.

“Southern California Edison Damage-Based Values for Residual Emissions Valuation,” presented to the California Energy Commission ER 92 Committee Workshop on Air Emission Damage Functions, Sacramento, California, January 29, 1992.

“Turning Theory Into Practice: Developing a Marketable Permits Program for the Los Angeles Basin,” prepared for Project 88 -- Round II Seminar, John F. Kennedy School of Government, Harvard University, Cambridge, Massachusetts, December 11, 1991.

“Workshop on Economic Instruments,” prepared for Imperial Oil Ltd., Toronto, Canada, October 1-2, 1991.

“Market-Based Approaches to Air Quality Improvement,” presented to the Board of Directors of the California Council for Environmental and Economic Balance, San Diego, California, July 1991.

“Environment and Equity,” presented to the Board of Directors of the California Council for Environmental and Economic Balance, San Diego, California, July 1991.

“Contribution of Economists to Environmental Policy: Comments on the Gruenspect-Lave Critical Review,” presented to the Air and Waste Management Association, Vancouver, British Columbia, June 19, 1991.

“Airports and Economic Development,” presented to the Southeast Chicago Development Commission, Chicago, Illinois, May 24, 1991.

“Environmental Economics in the 1990s,” presented to the OECD Group of Economic Experts, Paris, May 16, 1991.

“The Clean Air Act: How to Make the Mandate Worth the Effort,” presented to the Workshop on Emerging Environmental Policies and Business, North Carolina State University, Raleigh, North Carolina, April 18, 1991.

“Market-Based Approaches to Managing Air Emissions in California’s South Coast Basin,” presented to Workshop on Market Incentives, South Coast Air Quality Management District, El Monte, California, January 29, 1991.

“Market-Based Approaches to Managing Air Emissions in California’s South Coast Basin,” presented to the Steering/Advisory Committee on Market Incentives, South Coast Air Quality Management District, Los Angeles, California, December 11, 1990.

“How Environmental Policies Influence Natural Gas Markets,” presented to the Conference on Emerging Competition in California Gas Markets, sponsored by the California Energy Commission, San Diego, California, November 9, 1990.

“Air Quality and Electric Vehicles,” presented to the Electric Vehicle Symposium, sponsored by the Western Energy Supply and Transmission Associates, Ontario, California, November 8, 1990.

“Incorporating Environmental Impacts in Public Utility Commission Regulation,” presented to the Energy Research Group, Washington, DC, November 6, 1990.

“The Promise and Performance of the Acid Rain Allowance Program,” presented to the Conference on the New Acid Rain Legislation: Capitalizing on a Market-Based Approach, sponsored by Public Utilities Reports, Inc., Washington, DC, October 24, 1990.

“What Environmental Legislation Means for Crude Oil Marketers: A U.S. Overview,” prepared for the Oxford College of Petroleum Studies, Long Beach, California, presented October 1, 1990.

“Market-Based Approaches for Environmental Improvement,” presented to the Eleventh Annual Antitrust and Trade Regulation Seminar, sponsored by National Economic Research Associates, Santa Fe, New Mexico, July 5-7, 1990.

“Using Market-Based Approaches in the Energy Sector,” presented to the OECD Economic Incentives Working Group, Paris, June 19-20, 1990.

“Emissions Trading: Concepts and Experience,” prepared for The Canadian Electrical Association and presented at the *Workshop on Tradable Permits*, Toronto, Canada, June 13, 1990.

“Prototypical Trading Policy: Stationary Sources of NO_x,” prepared for NO_x/VOC Task Force and presented at the *Workshop on Flexible Mechanisms*, Montreal, Canada, June 6-7, 1990.

“Emissions Trading: An Overview of Concepts and Experience,” prepared for NO_x/VOC Task Force and presented at the *Workshop on Flexible Mechanisms*, Montreal, Canada, June 6-7, 1990.

“Market-Based Approaches for Environmental Improvement,” presented to the Board of Directors, The Conference Board of Canada, Edmonton, Canada, May 30, 1990.

“Market-Based Approaches for Environmental Protection: Lessons from the U.S. Experience,” presented to the Advisory Board, Research Program on Business and the Environment, The Conference Board of Canada, Toronto, Canada, April 24, 1990.

“Ozone and Economics,” presented to the Air and Waste Management Association, Los Angeles, California, March 20, 1990.

“Clear Thinking on Clear Air: Agenda for the 1990’s,” paper and panel discussion presented at the American Enterprise Institute’s Thirteenth Annual Policy Conference, Washington, DC, December 4, 1989.

“The Acid Rain Allowance Program,” presented to the Energy Research Group, Washington, DC, November 3, 1989.

C. Water Quality

“Benefit-Cost Analysis in Section 316(b) BTA Determinations: The Road Ahead,” presented at the American Fisheries Society Symposium, Seattle, Washington, September 6, 2011.

“Cost-Benefit Analysis for Fish Impingement and Entrainment Reduction at Pickering Nuclear Generating Station,” presented to Canadian Nuclear Safety Commission, Ottawa, Canada, October 29, 2009.

“Cost-Benefit Analysis for Fish Impingement and Entrainment Reduction at Pickering Nuclear Generating Station,” presented at Ontario Power Generation Inc. Stakeholder Workshop, Ontario, Canada, September 29, 2009

Uncertainty in §316(b) Compliance Demonstration: Case Study Including Monte Carlo Analysis,” presented at the UWAG/EPRI Conference on Technologies and Techniques for §316(b) Compliance, Atlanta, Georgia, September 7, 2006.

“Electricity System Impacts of Nuclear Shutdown Alternatives,” presented to New York City Council, New York, NY, May 7, 2002.

“Electricity System Impacts of Nuclear Shutdown Alternatives,” presented to Westchester County Board of Legislators Committee on Environment and Health, Westchester, New York, April 29, 2002.

“An Economic Approach to 316(b) BTA Determination,” presented to the UWAG 316(b) Technical Workshop for the Environmental Protection Agency, Annapolis, Maryland, January 25, 2001.

“Methodology for Cost-Benefit Assessment of Fish Protection Alternatives for the Mercer Facility,” presentation to the Mercer 316(b) Permit Team, Newark, New Jersey, August 8, 2000.

“Roadmap for Costs & Benefits of Fish Protection Alternatives for the Salem Facility,” presented to the Monitoring Advisory Committee, Mt. Laurel, New Jersey, December 9, 1999.

“Natural Resource Damage Assessments: Economic Techniques,” presented to PSE&G, Newark, New Jersey, December 9, 1997.

“Use of Economic Analysis in Environmental Impact Statements and Other Regulatory Proceedings,” presented to Hudson River Utilities, New York, New York, November 19, 1997.

“Combining Science and Economics: The Case of Superfund,” presented to ENVIRON, Princeton, New Jersey, May 16, 1995.

“Social Costing: Policy Overview,” presented to the British Columbia Utilities Commission Social Costing Workshop, Vancouver, British Columbia, March 29, 1995.

D. Economic Impact

“Cumulative Energy Market Impacts of Various Environmental Regulations,” presented at Law Seminars International, Utility Rate Case Issues and Strategies 2013, Las Vegas, Nevada, February 21, 2013.

“Financial Implications of a US Cap-and-Trade Program for Sectors and Companies,” presented at 2nd Annual Carbon Trading Summit, New York City, January 13, 2010.

“Evaluating the Impact of Future E.U. Chemical Policy on the French Economy,” presented to REMI Northeast Policy Analysis and Users’ Conference, Boston, MA, January 31, 2006.

“Background on NERA Study ‘Socioeconomic Effects of the Niagara Power Project and Local NYPA Presence’,” presented to Niagara Power Project Relicensing Stakeholder Meeting, Niagara Falls, NY, November 13, 2003.

“Economic Benefits to the Chicago Region from the Whitecap Energy System,” presented to the Illinois Department of Natural Resources, Springfield, Illinois, January 30, 2001.

“Fueling Electricity Growth for a Growing Economy,” presented to Edison Electric Institute, Palm Springs, California, January 13, 2000.

“Economic Impact Analyses with REMI: Two Case Studies,” presented to the REMI Seminar, Miami, Florida, October 6, 1997.

“Impacts on the Hawaii Economy of Alternative Resource Plans for Oahu,” presented to the Hawaiian Electric Company IRP Advisory Group, Honolulu, Hawaii, July 24, 1997.

“Economic and Environmental Effects in Maine of the Maritimes & Northeast Pipeline Project,” presented to the Maine Economic Development Council, Rockland, Maine, February 12, 1997.

“Economic and Environmental Effects of the Maritimes & Northeast Pipeline Project,” presented to a media conference and Editorial Boards of the *Bangor Daily News*, the *Portland Press Herald*, and the *Kennebec Journal*, Bangor and Augusta, Maine, November 21, 1996.

“Assessing the Economic Impacts of Alternative HECO Resource Plans,” presented to the PSP&ED Advisory Group of the Hawaiian Electric Company, Honolulu, Hawaii, July 3, 1996.

“The Lake Calumet Airport and Chicago’s Economic Future,” presented to the Lake Calumet Airport Advisory Committee, Chicago, Illinois, July 2, 1991.

“Socioeconomic Impacts of Proposed Rule 431.2,” prepared for Southern California Edison and presented to the South Coast Air Quality Management District, Los Angeles, California, May 4, 1990.

“An Economist Looks at the Federal Regulation of Biotechnology,” presented to the Conference on Emerging Issues in Biotechnology, sponsored by Boston University Law School, Boston, Massachusetts, March 2, 1990.

Noah Kaufman
Senior Consultant
NERA Economic Consulting
11th Floor, 200 Clarendon Street
Boston, Massachusetts 02116
Tel: 617-927-4586 Fax: 617-927-4501
Mobile: 914-450-8654
Noah.Kaufman@NERA.com
www.nera.com

NOAH KAUFMAN

Senior Consultant

Noah Kaufman is a Senior Consultant in the NERA Environment Group. At NERA, he works on projects related to the economics of environmental and energy policies in the fields of climate change, air quality, water quality, and other environmental, health, and safety areas. He also has experience evaluating the impacts to the economy and to the electricity grid of infrastructure investments and energy policies.

Dr. Kaufman has published peer-reviewed journal articles on the topics of the social cost of carbon dioxide emissions, accounting for risk aversion in environmental policy evaluations and effective incentives to support purchases of green consumer products and utility energy-efficiency programs. He wrote his doctoral dissertation on the economics of climate change.

He holds a Ph.D. in Economics with a concentration in Environment and Public Economics from the University of Texas at Austin. He received his BS in economics, cum laude, from Duke University.

Education

Ph.D. in Economics, 2011; M.S. in Economics, 2009
THE UNIVERSITY OF TEXAS AT AUSTIN, Austin, Texas

B.S., Economics, *cum laude*, 2004
DUKE UNIVERSITY, Durham, North Carolina

Professional Experience

NATIONAL ECONOMIC RESEARCH ASSOCIATES, INC.
2014 - *Senior Consultant*
2011 - 2014 *Consultant*
2006 - 2007 *Analyst*

RESOURCES FOR THE FUTURE
2008, 2009 *Research Analyst*

UNIVERSITY OF TEXAS AT AUSTIN
2007-2011 *Teacher's Assistant, Environmental and Resource Economics; Microeconomics*

Noah Kaufman

KEEFE BRUYETTE & WOODS, INC.
2004-2006 *Analyst, Corporate Finance Department*

Peer-Reviewed Journal Publications

“Why is Risk Aversion Unaccounted for in Environmental Policy Evaluations?” *Climatic Change*: Forthcoming (published online May 2014, DOI: 10.1007/s10584-014-1146-8).

“Overcoming the Barriers to the Market Performance of Green Consumer Goods,” *Resource and Energy Economics*; Volume 36; Issue 2; pages 487-507; May 2014.

“Energy Efficiency Program Evaluations: Opportunities for Learning and Inputs to Incentive Mechanisms” (with Karen Palmer, Senior Fellow, Resources for the Future),” *Energy Efficiency*: Volume 5; Issue 2; pages 243-268; May 2012.

“The Bias of Integrated Assessment Models that Ignore Climate Catastrophes,” *Climatic Change*: Volume 110; Numbers 3-4; pages 575-595; February 2012.

Other Publications

Annual Energy Outlook Projections and the Future of Solar PV Electricity, New York University School of Law Institute for Policy Integrity working paper, April 2014.

Effective Use of Demand Side Resources: The Continued Need for Availability Payments (white paper written with Jonathan Falk and Stephen Buryk), prepared for EnerNOC, October 2013.

Selected Consulting Project Reports

Environmental Costs and Economic Impacts of the Emissions Reduction and Capacity Replacement Plan, prepared for NV Energy, Inc., May 2014.

Economic Impacts of the Underprovision of Government contracts and Jobs to the Inuit People of Nunavut, Canada, prepared for Nunavut Tunngavik, Inc., February 2014.

Economic Analysis of the Effects of Fuel Economy and Fuel Economy Misstatements on the Market Price of Vehicles (not public), January 2015.

Economic Analysis of a Component (Vehicle and Engine) Approach to Phase 2 Greenhouse Gas Emissions Standard for U.S. Commercial Vehicles (not public), January 2014.

Benefits and Costs of Cylindrical Wedgewire Screens and Cooling Towers at IPEC, prepared for Entergy Nuclear Indian Point 2, LLC and Entergy Nuclear Indian Point 3, LLC, December 2013.

“Wholly Disproportionate” *Assessments of Cylindrical Wedgewire Screens and Cooling Towers at IPEC*, prepared for Entergy Nuclear Indian Point 2, LLC and Entergy Nuclear Indian Point 3, LLC, December 2013.

Noah Kaufman

A Carbon Dioxide Standard for Existing Power Plants: Impacts of the NRDC Proposal, prepared for the American Coalition for Clean Coal Electricity, November 2013.

The US Government's Updated Social Cost of Carbon and Implications for Including Greenhouse Gas Emission Benefits in Cost Benefit Assessments, prepared for a large energy company, July 2013 (not public).

Economic Outcomes of a U.S. Carbon Tax, prepared for National Association of Manufacturers, February 2013.

Report on the Socioeconomic Effects to Mid-Atlantic States of the Relicensing of Various Hydroelectricity Facilities, prepared for a large electricity generating company, November 2012 (not public).

Environmental and Economic Impacts of the Second Amendment to the 2010 Integrated Resource Plan, prepared for Sierra Pacific Power, August 2012.

Benefit-Cost Analysis of Alternative Technologies and Operational Measures of Cooling Water System Alternatives at Millstone Power Station, prepared for Dominion, August 2012.

Comments on EPA's Notice of Data Availability for §316(b) Stated Preference Survey, prepared for Utility Water Act Group and Edison Electric Institute, July 2012.

Environmental and Economic Impacts of the 2012 Integrated Resource Plan, prepared for Nevada Power Company, June 2012.

Preliminary Economic Analysis of Cooling Water Intake Alternatives at Merrimack Station, prepared for Public Service of New Hampshire, February 2012.

Report on the Economic Impacts of the Construction and Operation of Gas-to-Liquids Facilities in U.S. and Canada, prepared for a multinational energy corporation, February 2012 (not public).

Environmental and Economic Impacts of the First Amendment Supplemental Filing to the 2009 Integrated Resource Plan, prepared for Nevada Power Company, October 2011.

Comments on Economic Issues Related to EPA's Proposed Regulations for Cooling Water Intake Structures at Existing Facilities, prepared for Utility Water Act Group, August 2011.

Environmental Costs and Economic Impacts of the Second Amendment to the 2009 Integrated Resource Plan, prepared for Nevada Power Company, August 2011.

Other Working Papers and White Papers

Optimal Targeted Abatement Spending to Avoid Climate Catastrophes

The Market Performance of Green Consumer Goods with Uncertain Qualities and Costs

Noah Kaufman

Multilateral Cooperation on the Long-Term Storage of Spent Nuclear Fuel

Bilateral Climate Change Agreements among Heterogeneous Countries

Affiliations

Economics for Equity and the Environment (E3)

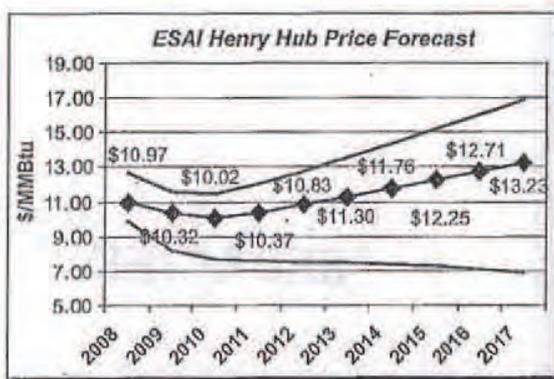
Association of Environmental and Resource Economists (AERE)

Expert referee of manuscripts for the journals Environmental and Resource Economics, Resource and Energy Economics, and Climate Policy.

NATURAL GAS 10-YEAR FORECAST

42

<i>ESAI Long-Term Henry Hub Forecast (\$/MMBtu) - Nominal Dollars</i>										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Base Case	10.97	10.32	10.02	10.37	10.83	11.30	11.76	12.25	12.71	13.23
High Case	12.61	11.55	11.42	12.03	12.78	13.56	14.35	15.18	16.01	16.94
Low Case	9.87	8.21	7.63	7.55	7.52	7.46	7.36	7.25	7.09	6.93

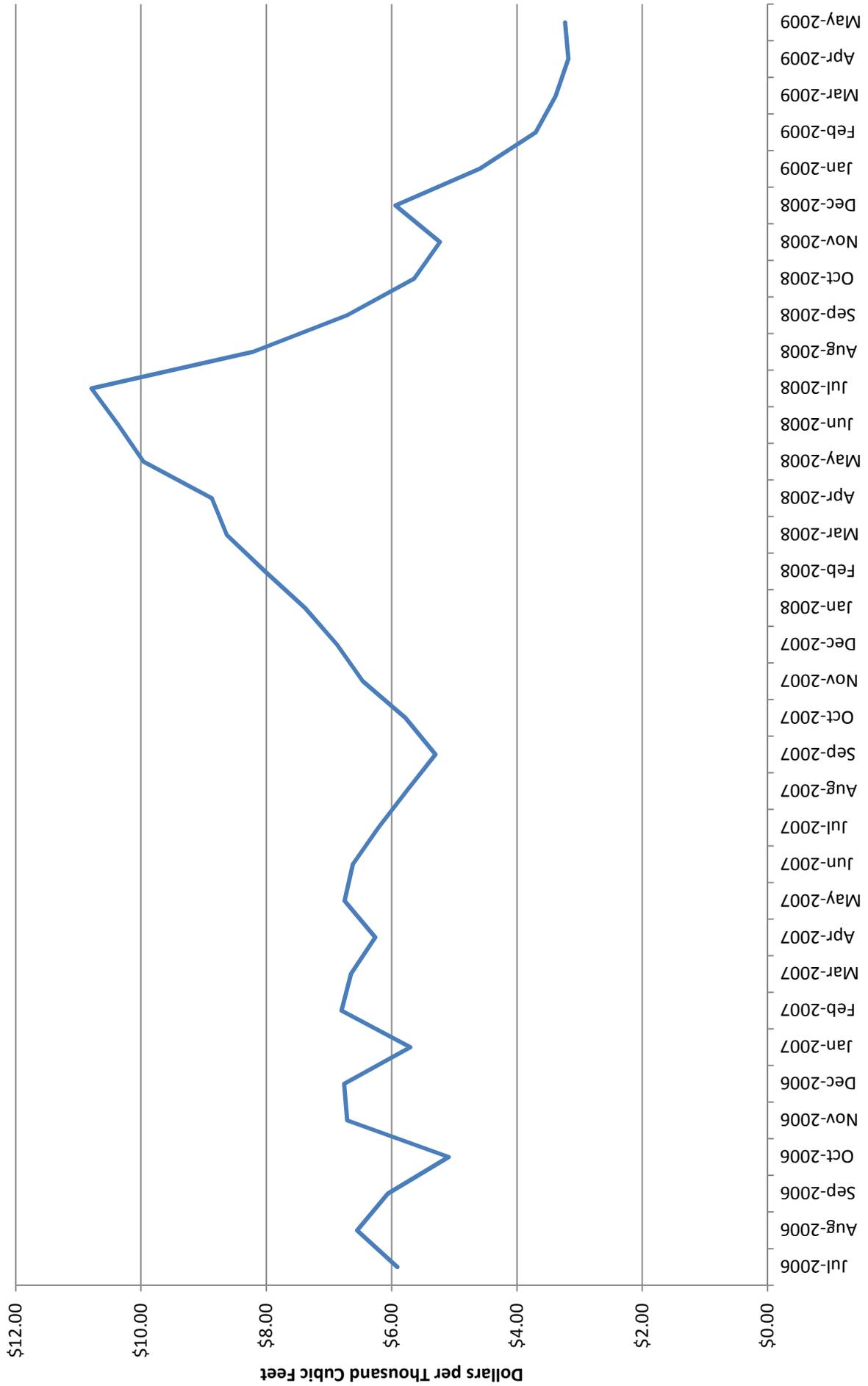


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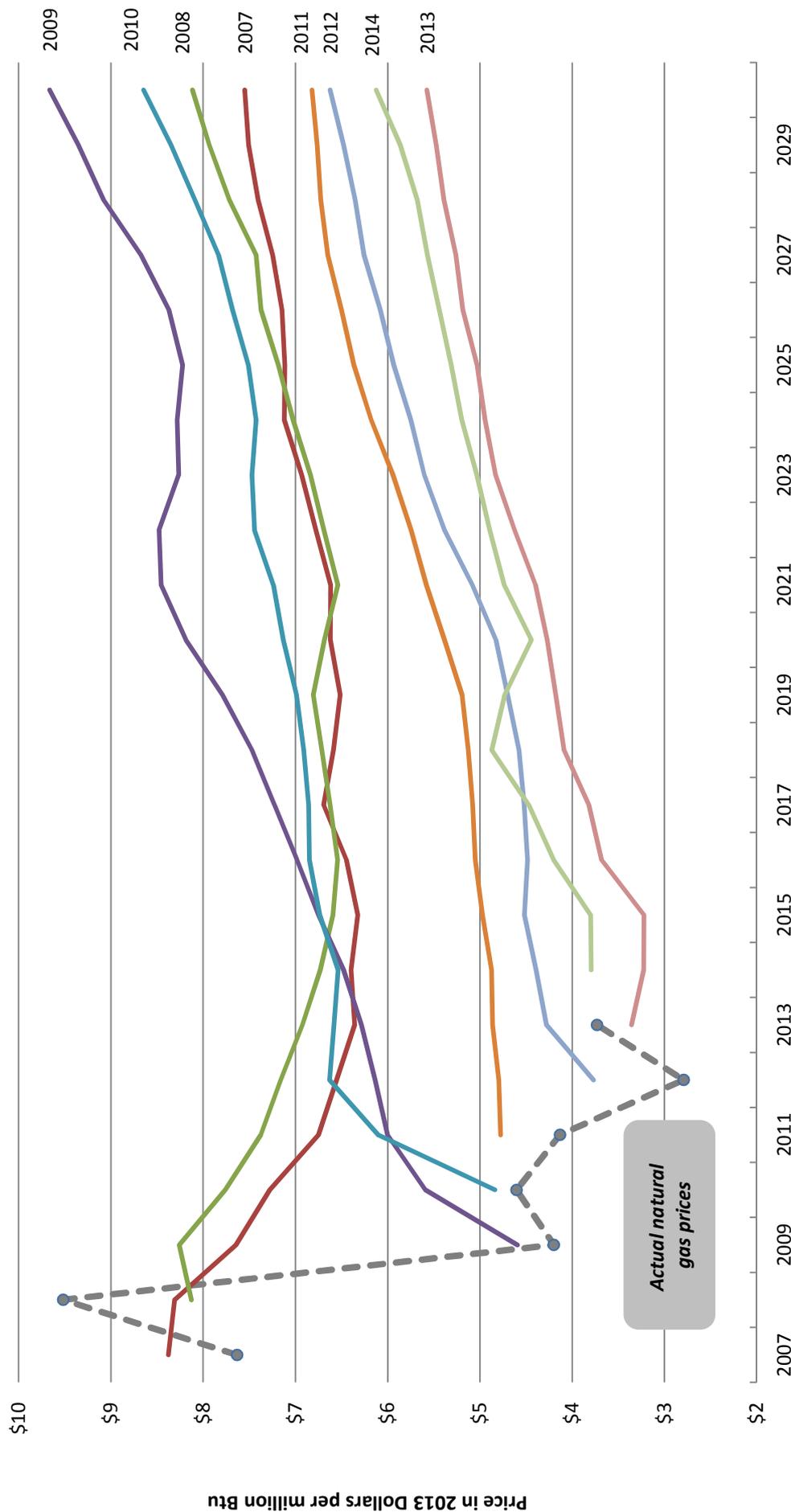
REDACTED

Average Monthly U.S. Natural Gas Wellhead Prices



Source: U.S. Energy Information Administration (<http://www.eia.gov/dnav/ng/hist/n9190us3m.htm>)

U.S. EIA Natural Gas Price Forecasts, 2007-2014



Note: Values reflect average annual Henry Hub Natural Gas Spot Prices, adjusted to 2013 Dollars using U.S. Department of Commerce's "GDP Implicit Price Deflator"
 Source: Projections from EIA Annual Energy Outlooks 2007-2014; Actual prices from EIA U.S. Henry Hub Natural Gas Spot Price Series (2014)

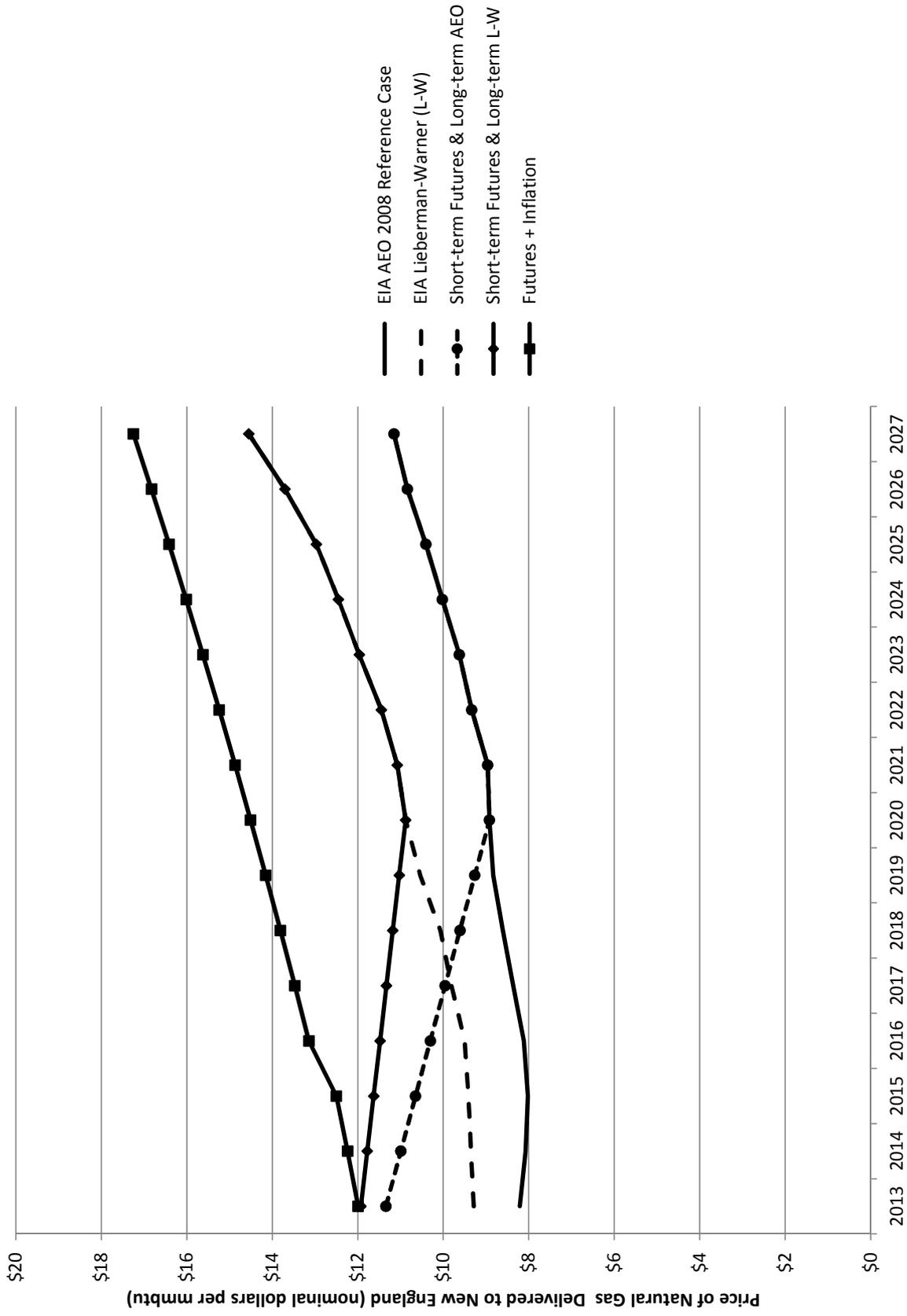
Scenarios for NERA Scrubber Analysis

Scenario	Electricity and Natural Gas Prices ¹		Environmental Costs ³	Natural Gas Plant Costs ⁴	Sources for Natural Gas, Electricity and CO ₂ Emissions Price Data
	Short-term ²	Long-term			
Mid-2008 Analysis Date:					
1	EIA Forecasts	EIA Forecasts	High	\$800 / kW	Natural gas, electricity and CO ₂ prices per EIA modeling of L-W cap-and-trade program. ⁵
2	EIA Forecasts	EIA Forecasts	High	\$1500 / kW	
3	EIA Forecasts	EIA Forecasts	Low	\$800 / kW	Natural gas and electricity prices per EIA AEO 2008 Reference Case ⁶ ; CO ₂ prices (i.e. RGGI) from futures market as of November 2008 ⁷ .
4	EIA Forecasts	EIA Forecasts	Low	\$1500 / kW	
5	Futures	EIA Forecasts	High	\$800 / kW	Short-term natural gas and electricity prices per June 2008 futures markets ⁸ ; long-term natural gas, electricity and all CO ₂ prices per EIA modeling of L-W cap-and-trade program.
6	Futures	EIA Forecasts	High	\$1500 / kW	
7	Futures	EIA Forecasts	Low	\$800 / kW	Short-term natural gas and electricity prices per June 2008 futures markets; CO ₂ prices (i.e. RGGI) from futures market as of November 2008.
8	Futures	EIA Forecasts	Low	\$1500 / kW	
9	Futures	Futures / Inflation	High	\$800 / kW	Natural gas and electricity prices per June 2008 futures markets and assumed rate of inflation after longest contract; CO ₂ prices per EIA modeling of L-W cap-and-trade program.
10	Futures	Futures / Inflation	High	\$1500 / kW	
11	Futures	Futures / Inflation	Low	\$800 / kW	Natural gas and electricity prices per June 2008 futures markets and assumed rate of inflation after longest available contract; CO ₂ prices (i.e. RGGI) per November 2008 futures and assumed rate of inflation after longest available contract.
12	Futures	Futures / Inflation	Low	\$1500 / kW	
Early-2009 Analysis Date:					
1	EIA Forecasts	EIA Forecasts	High	\$800 / kW	Natural gas, electricity and CO ₂ prices per EIA modeling of W-M cap-and-trade program. ⁹
2	EIA Forecasts	EIA Forecasts	High	\$1500 / kW	
3	EIA Forecasts	EIA Forecasts	Low	\$800 / kW	Natural gas and electricity prices per EIA AEO 2009 Reference Case ¹⁰ ; CO ₂ prices (i.e. RGGI) from futures market as of March 2009.
4	EIA Forecasts	EIA Forecasts	Low	\$1500 / kW	
5	Futures	EIA Forecasts	High	\$800 / kW	Short-term natural gas and electricity prices per March 2009 futures market; long-term natural gas, electricity and all CO ₂ prices per EIA modeling of W-M cap-and-trade program.
6	Futures	EIA Forecasts	High	\$1500 / kW	
7	Futures	EIA Forecasts	Low	\$800 / kW	Short-term natural gas, electricity, and all CO ₂ prices (i.e. RGGI) per March 2009 futures markets.
8	Futures	EIA Forecasts	Low	\$1500 / kW	
9	Futures	Futures / Inflation	High	\$800 / kW	Natural gas and electricity prices per March 2009 futures markets and assumed rate of inflation after longest contract; CO ₂ prices per EIA modeling of W-M cap-and-trade program.
10	Futures	Futures / Inflation	High	\$1500 / kW	
11	Futures	Futures / Inflation	Low	\$800 / kW	Natural gas, electricity and CO ₂ prices (i.e. RGGI) per March 2009 futures markets and assumed rate of inflation after longest contract.
12	Futures	Futures / Inflation	Low	\$1500 / kW	

Notes:

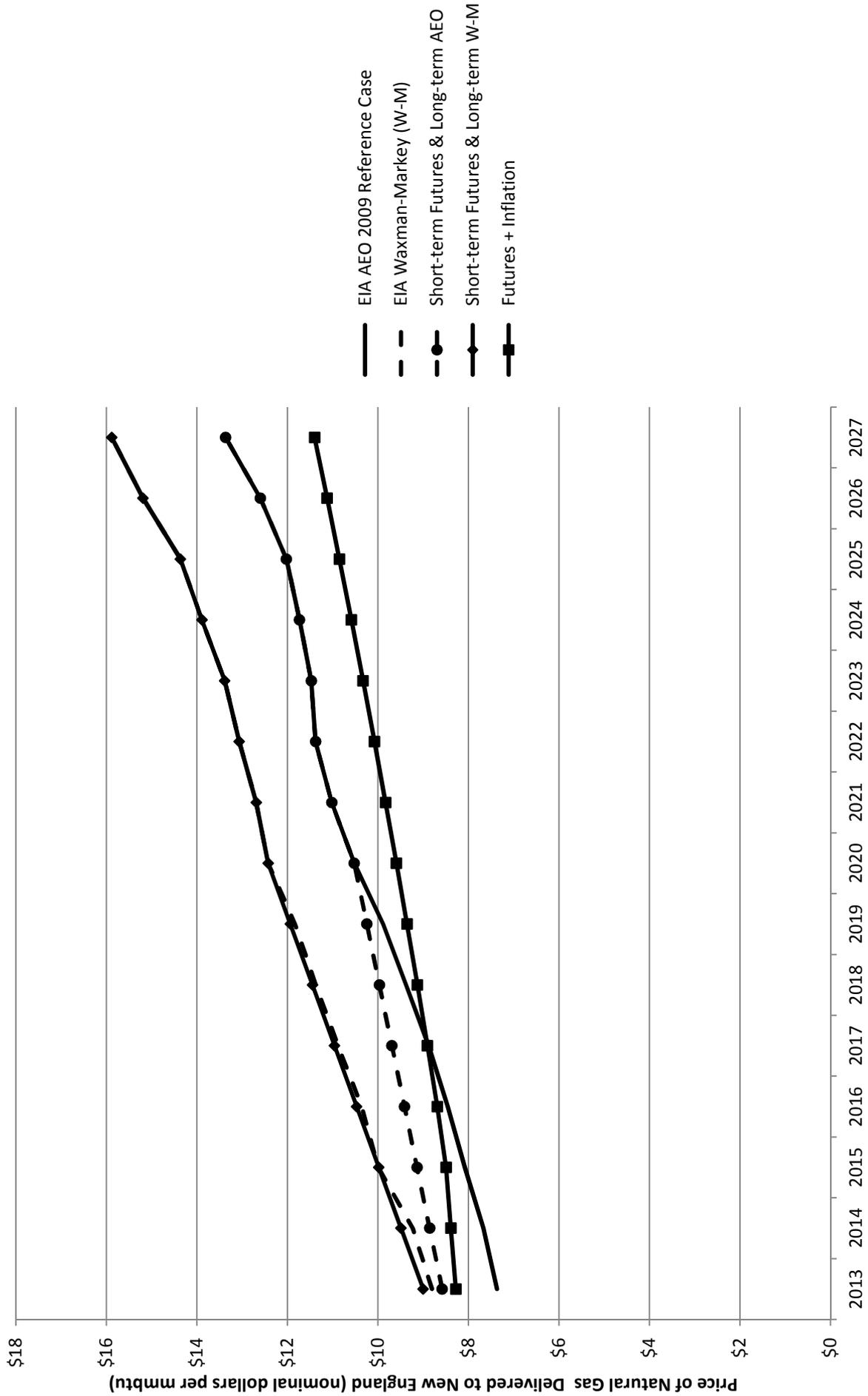
- Prices of wholesale electricity in New Hampshire and natural gas delivered to New England.
- Short-term prices are for two years from the Analysis Date (longer futures contracts are often unavailable or highly illiquid).
- Environmental costs differ across scenarios ("High" and "Low") based on the prices of CO₂ emissions and the costs of regulation under Section 316(b) of the Clean Water Act.
- In June 2008, the Federal Energy Regulatory Commission estimated that new combined-cycle natural gas plants would cost between roughly \$800 and \$1500 / kW.
- L-W refers to the "Leiberman-Warner Bill," an economy-wide CO₂ cap-and-trade program modeled by EIA in April 2008.
- The EIA Annual Energy Outlook 2008 was published in June 2008.
- CO₂ allowance prices from NYMEX futures for RGGI first available in November 2008.
- Prices from 12 and 24-month NYMEX futures contracts for the ISONE energy market (adjusted to New Hampshire) and Henry Hub; capacity market and gas transportation adds per PSNH.
- W-M refers to the "Waxman-Markey Bill," an economy-wide CO₂ cap-and-trade program proposed in early-2009 and modeled by EIA in August 2009.
- EIA published an updated AEO 2009 Reference Case in April 2009 to reflect provisions of the Stimulus Act and recent changes in the economic outlook.

Natural Gas Price Forecasts as of Mid-2008



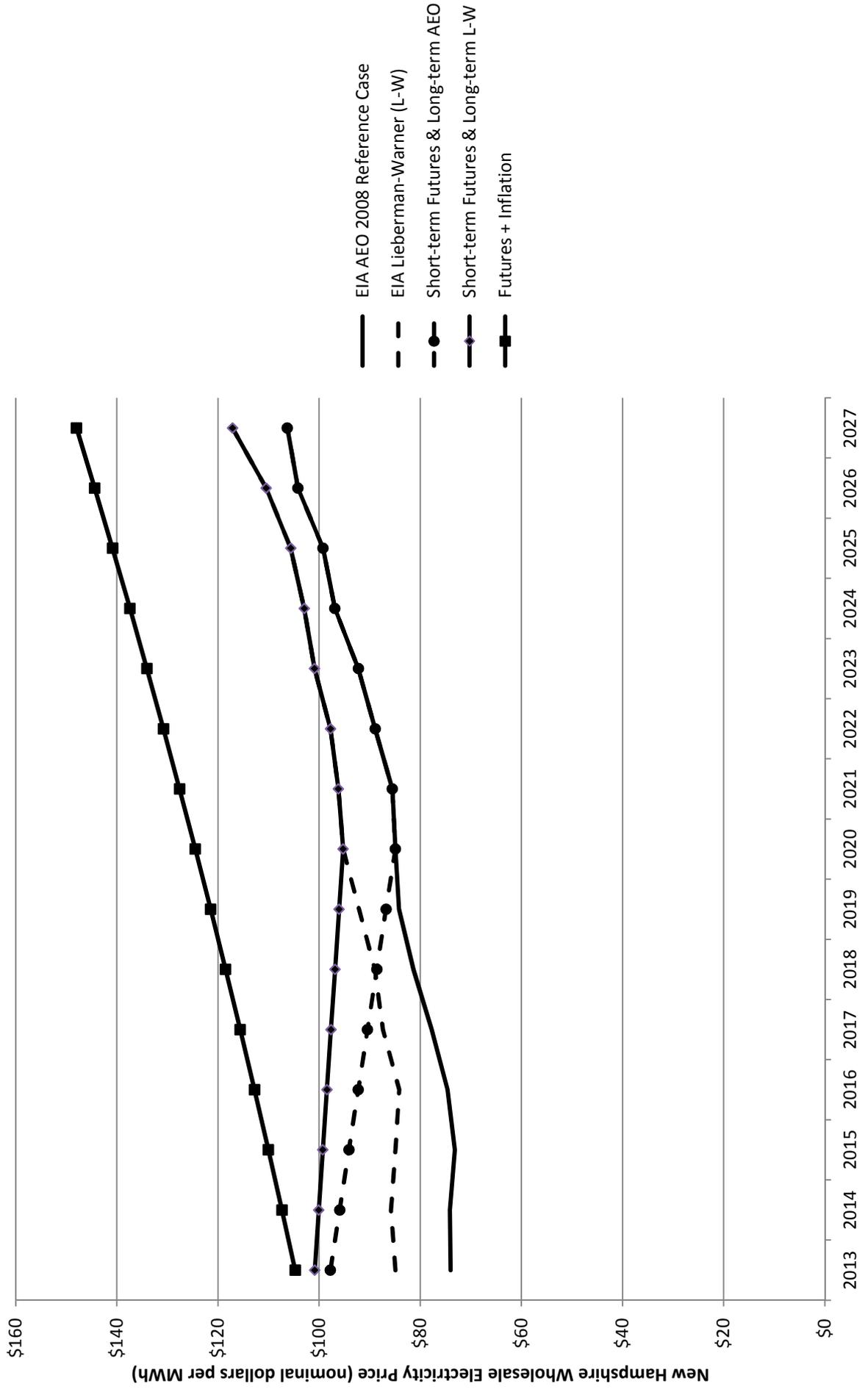
Prices based on modeling of U.S. EIA and NYMEX futures market contracts of Henry Hub Prices; transportation adders provided by PSNH.

Natural Gas Price Forecasts as of Early-2009



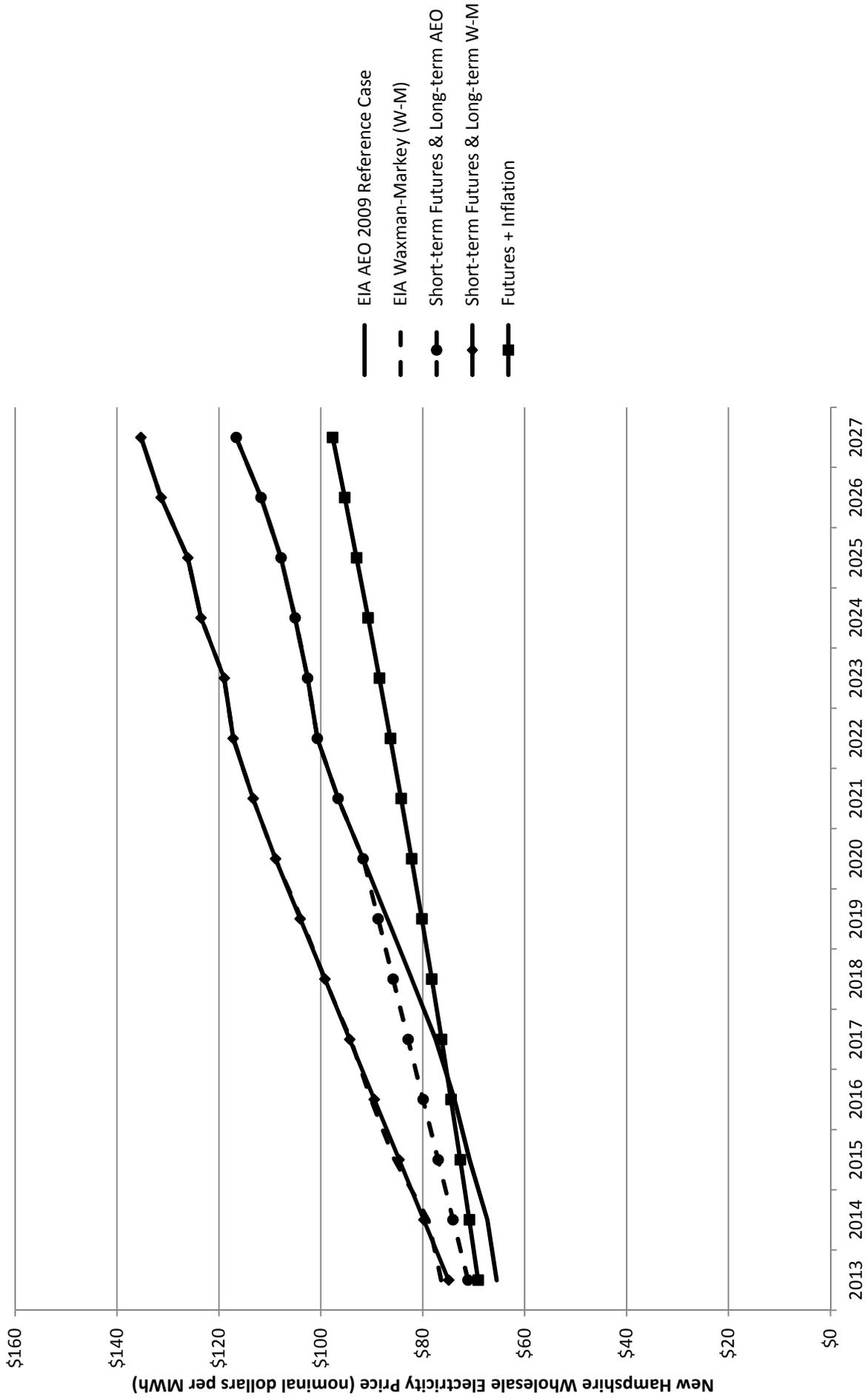
Prices based on modeling of U.S. EIA and NYMEX futures market contracts of Henry Hub Prices; transportation adders provided by PSNH.

Wholesale Electricity Price Forecasts as of Mid-2008



Prices based on modeling by U.S. EIA and NYMEX futures market contracts.

Wholesale Electricity Price Forecasts as of Early-2009



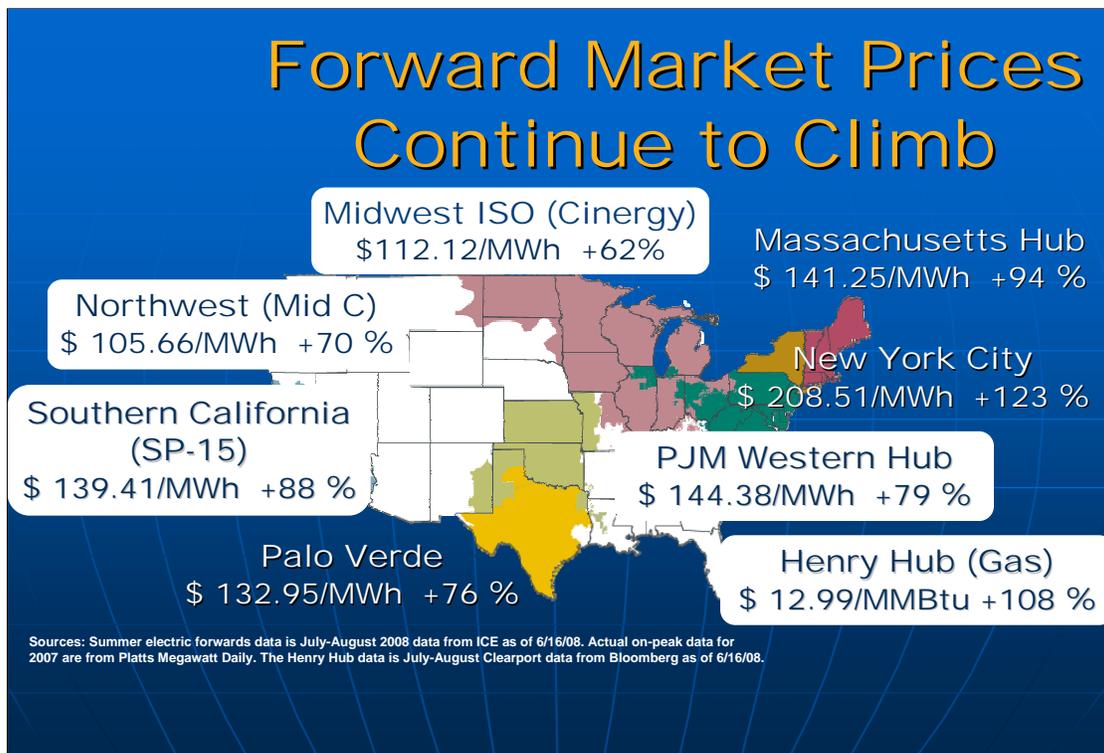
Prices based on modeling by U.S. EIA and NYMEX futures market contracts.



Increasing Costs in Electric Markets

- **Item No.: A-3**
- **June 19, 2008**

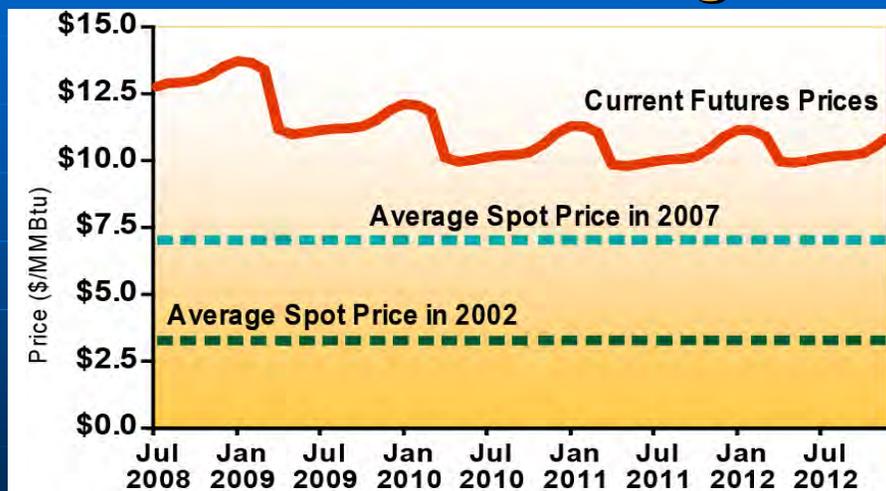
Mr. Chairman and Commissioners, good morning. I am here to present the Office of Enforcement's assessment of likely electricity costs in coming years. This presentation will be posted on the Commission's Web site today.



At last month's meeting, we reported that forward market prices for electric power are much higher than the prices we actually experienced last year. This trend is universal around the country. The slide shows the increases in forward prices for July and August as of this week. They have risen further during the last month as natural gas prices have continued to rise.

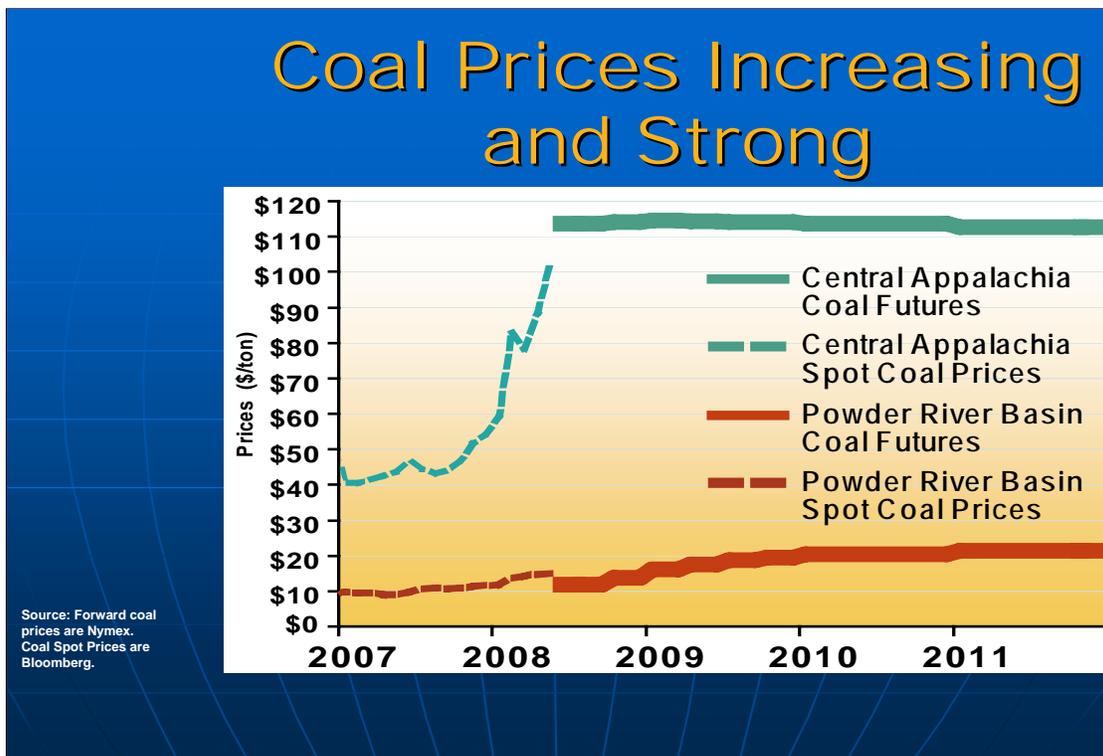
There is little reason to believe that this summer is unusual. Rather, it may be the beginning of significantly higher power prices that will last for years. The purpose of this presentation is to explain why that is so. The two major factors pushing the costs of electric generation higher are increased fuel costs and increased cost for new construction. These factors affect all parts of the country. That is, higher future prices are likely to affect all regions.

Forward Gas Prices Remain Strong



Source: Forward gas prices are Nymex. Annual average spot gas prices are Platts.

The primary reason for the electric power price increases this year is high fuel prices. All current market indications suggest that they will remain high. Let's look at natural gas, which often determines prices because it is so frequently on the margin. The slide shows futures prices for the next few years. The futures prices are somewhat lower for 2009 than for 2008. Even so, they are a good deal higher for all years than the prices people actually paid last year, and they are much higher than the prices many of us remember from earlier in the decade. The implication is that markets anticipate continuing high prices, even though they know that the United States has seen a significant increase in domestic natural gas production over the last year and a half. The anticipation of further high prices makes more sense when one considers the likely increase in gas demand for generation and the global nature of competition for LNG.



Natural gas is not the only important fuel in setting electric power prices. Coal still powers half of all power produced in the U.S. In some markets – the Midwest and the Southeast, for example – coal is often on the margin and plays a major role in setting average prices over time. The slide shows that the price of one key form of coal – Central Appalachian coal - has risen rapidly over the last year. Forward markets show continuing high prices for Central Appalachian coal for the next three years. This reflects, in part, the growing global market for coal and the relatively weak US dollar. Coal imports are becoming more costly and coal exports more profitable, both of which contribute to higher prices in the United States.

I should mention that other coal prices behave somewhat differently from Central Appalachian coal. For example, a majority of the overall cost for Powder River Basin coal comes from transportation rates and can be more difficult to see. Nonetheless, the implication of the prices we can see is that electric power prices are likely to increase even where coal is on the margin. This may take place somewhat differently from the way natural gas price increases flow through into power prices. Generally, companies buy coal under fairly long term contracts, so there may be a lag before the higher prices show their full effects. But the effects are coming.

Net Natural Gas Generation by Region (TWh)

Region	2000	2007	Difference
Northeast	66.3	103.9	37.6
RFC	41.0	64.5	23.5
SERC	86.9	150.5	63.6
FRCC	42.0	96.7	54.7
ERCOT	155.9	163.3	7.4
Midwest	44.2	62.8	18.5
WECC-Rockies and SW	28.1	77.6	49.5
WECC-CA and NW	115.4	129.7	14.4

Source: Derived from Energy Velocity (differences due to rounding).

While both natural gas and coal prices have increased rapidly, natural gas is increasingly important in every region of the country. The slide shows that even in regions where coal has historically dominated – most noticeably in SERC– natural gas usage has grown substantially since 2000, up 63.6 TWh in 2007, more than in any other region. Noticeable increases also occurred in FRCC, which has flexibility to burn either gas or oil at many facilities, and also in the Rockies and Southwest where demand continues to grow considerably.

NERC Net Load Projections through 2016

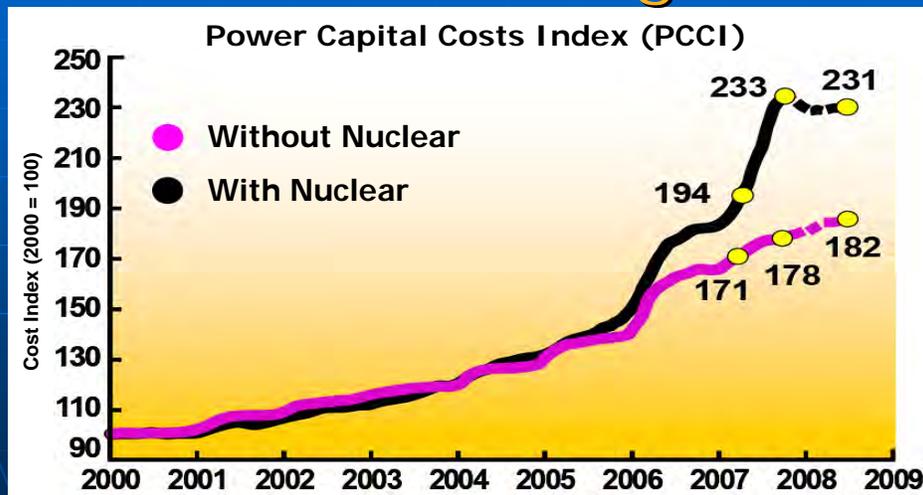
Region	Total Difference (GW)	Percent Change
Northeast	9.7	17
RFC	23.2	13
SERC	28.2	14
FRCC	7.1	15
ERCOT	14.7	24
Midwest	17.2	21
WECC-Rockies and SW	7.6	25
WECC-CA and NW	10.9	10
Total	108.8	14

Source: Derived from NERC 2007 Long Term Reliability Assessment, Oct. 2007 and NERC data request, June 2008.

The second major factor that will put upward pressure on electric power prices is the increasing cost of new construction. This effect is particularly important because the country is entering a period when we will need to make substantial new investments, especially in generation.

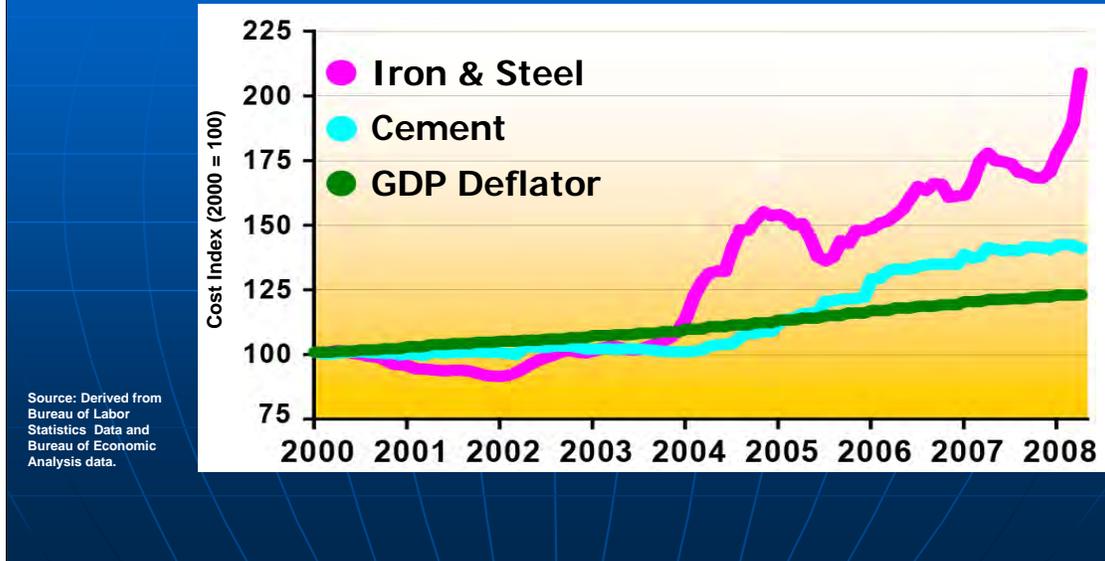
Natural gas fueled most of the last great wave of generation investment, which occurred between 1995 and 2004. In recent years, demand in most regions has gradually caught up with the capacity built around 2000. Looking forward, demand will continue to grow, and the need for new capacity will become ever more acute and ever more widespread. The slide shows NERC’s expectation of peak net load growth in different regions for the next 10 years. We at the Commission are not in the business of forecasting, so I would just say this: There are legitimate reasons to be unsure about exactly how much new generation the country will need in the coming years. For one thing, higher prices will themselves discourage some power demand. Nonetheless, a significant level of demand increase seems virtually inevitable. So will be the need to build more capacity.

Capital Costs Increasing

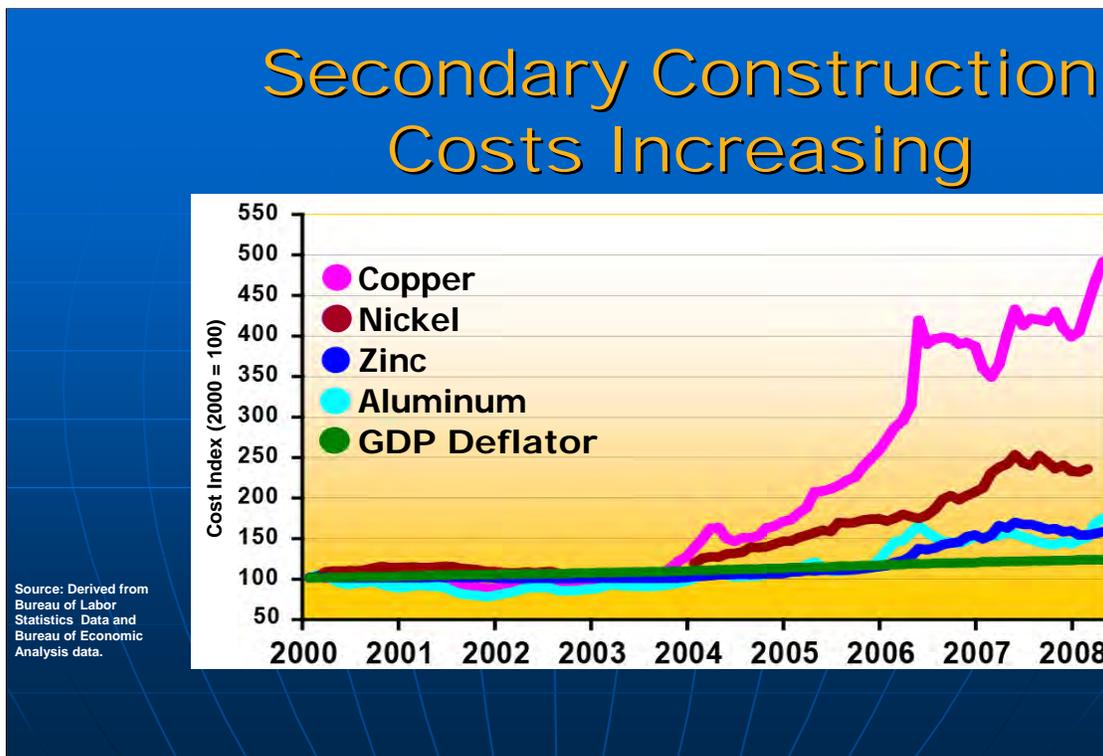


The need for new generation is important because new construction is becoming more expensive – quite aside from fuel price increases. Cambridge Energy Research Associates – CERA – produces an index of costs for the main inputs that go into building new generating plants. The slide shows how that index has almost doubled since 2003. The increase in nuclear plant inputs has risen even faster. Much of this cost increase results from rising global demand for basic materials. Part of it also comes from shortages of people to do key engineering and construction jobs. In any case, the implication is that, we will pay more, not less, for the next round of construction.

Primary Construction Costs Increasing

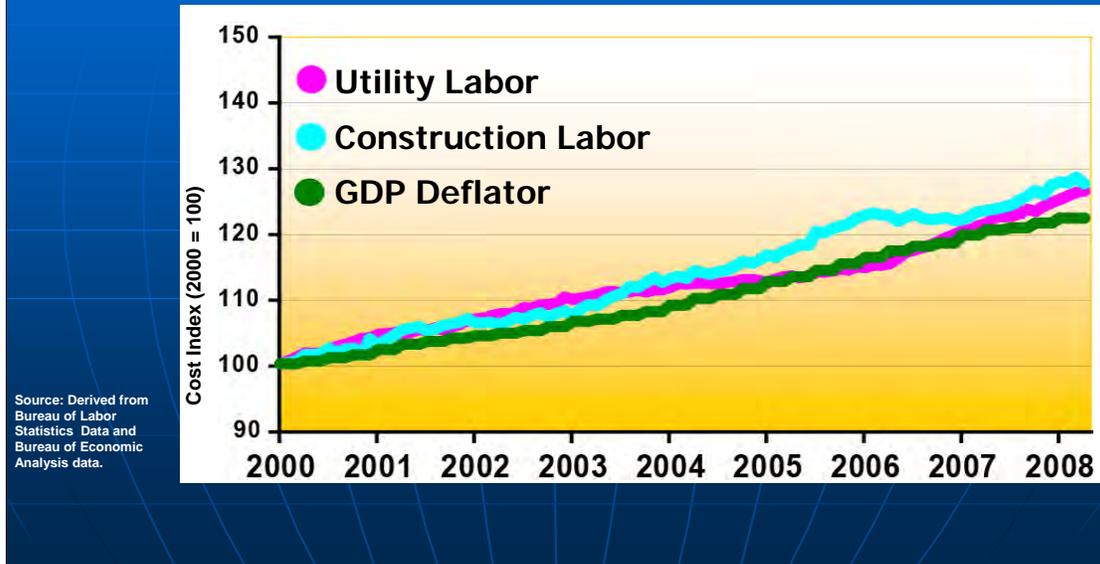


Let's look at some of the reasons that CERA's index is rising so rapidly. The slide shows two of the primary construction materials for electric generating plants – concrete is on the blue line and iron and steel on the red line. As you can see, the prices of both have been rising recently – especially steel, which is now more than twice as expensive as it was four years ago. Rising costs for iron and steel will also affect fuel prices for the power industry. For example, natural gas wells and pipelines both use substantial amounts of steel, so natural gas costs will also reflect rising iron and steel prices.



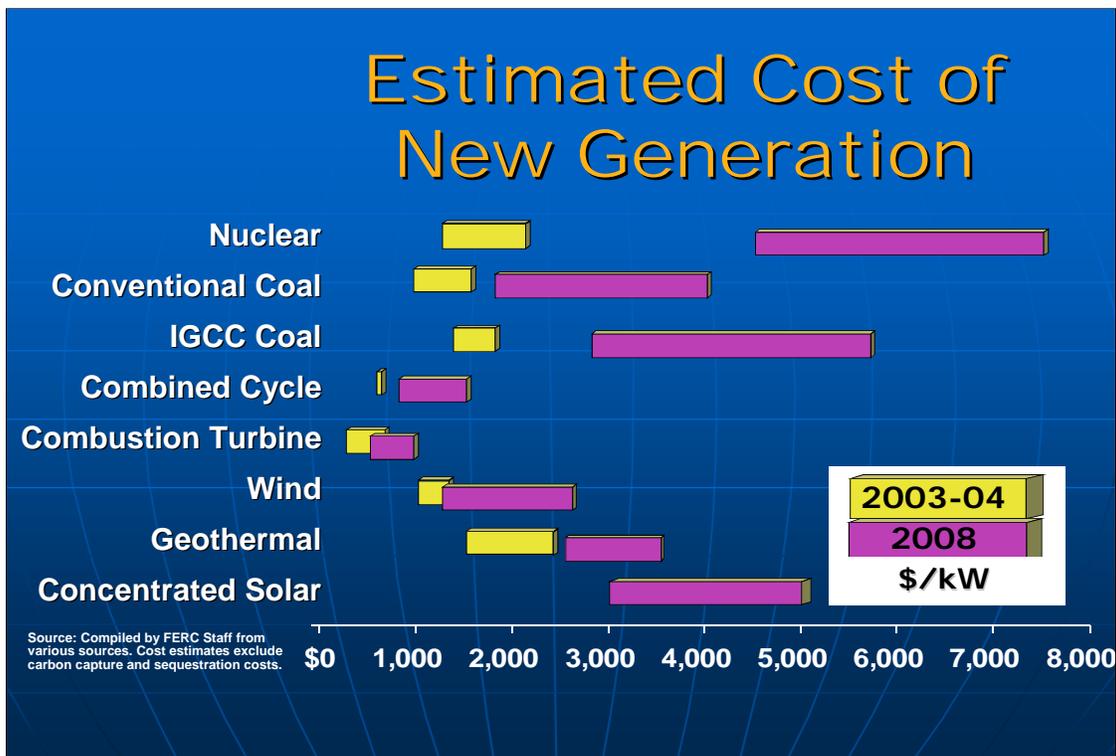
Of course, new generating plants require many other basic commodities. The slide shows the pricing for four key metals that go into generators. As you can see, all of these metals are increasing in price. The one that stands out is copper, up more than five times over the past four years. Indeed, copper is now so valuable there are reports of copper thieves cutting live cables to steal the metal.

Labor Costs Increasing



Labor costs are also increasing. Perhaps the most frequently cited labor shortage is that for nuclear engineers. It has been a full generation since the nation built its last nuclear plant. Most of the engineers who worked on those plants are near retirement – and many have moved on to other occupations. In fact, the labor shortages are more widespread than just nuclear engineers. The slide shows that there has been about a 27% nominal change in average hourly earnings for both construction labor generally and for non-construction utility labor since 2000, outpacing inflation by over 4% for the same period.

In practice, the American labor market is quite responsive to market forces, so short-term labor shortages tend to be self-correcting over the mid-term. Still, there is no quick way to force several years of education into six months, or decades of experience into a year or two.



What do all these cost increases mean for the cost of building a new generating plant?

No one knows precisely. It's difficult to get consistent and trustworthy numbers about plant costs, both because they are commercially sensitive and because the assumptions behind them vary greatly. The numbers reflected on the slide come from a variety of sources and include different assumptions about, for example, location or exactly what facilities are included in the estimate. To take one example: Two recent nuclear procurements in South Carolina and Georgia produced cost estimates of \$5,100 and \$6,400 per kW, respectively, for the same technology. We have been told that most of the difference may be due to different uses of Allowances for Funds Used during Construction – AFUDC.

Despite the difficulties in being precise, the slide represents a good general indication of how capital costs have been changing. If anything, the cost estimates may be lower than the final costs of projects, if input costs continue to rise.

It's also important to remember that these cost estimates cover only capital costs. They do not include fuel costs, which as we've seen earlier will be a large factor for both natural gas and coal-fired plants. To the extent that plants do not have major fuel costs - they may be more competitive over their life cycles than would be suggested just looking at the capital costs. That would affect renewables and, to a degree, nuclear plants.

Similarly, these estimates generally do not include a full accounting of major risk factors, especially those affecting coal and nuclear plants. Both of these technologies have long lead times. That increases the chance that market conditions will change before they are complete and adds to the financial risk of building them. Nuclear plants also have risks associated with both decommissioning and waste fuel disposal. And coal plants have risks associated with the future treatment of greenhouse gases. Of course, relatively new technologies like wind and the new approaches to nuclear also have some risks, simply because they do not have the same track record of more mature technologies.

Climate Change Debate Affects the Market

- **Uncertainty about future carbon regime is a key factor**
- **Affects coal most of all**
 - Greater carbon emissions
 - Many plant cancellations
- **At the least, coal builds will be delayed**

Climate change has become an increasingly urgent national issue. The debate over how to address carbon dioxide emissions is lively and has already affected how companies think about investments. Until recently, rising natural gas prices made coal plants attractive. However, the national uncertainty about carbon policy has made investing in coal plants more risky. Without carbon capture or sequestration, coal unit emit about four times as much carbon as natural gas combined cycle units per MWh. Since January 2007, 50 coal plants have been canceled or postponed. Only 26 remain under construction.

Whatever the eventual result of the climate change debate, costs of producing power from both coal and natural gas are likely to increase. Moreover, as long as future climate change policy is unclear, market participants will have a considerable disincentive to invest in coal plants. Even when the issues are resolved, it remains an open question how competitive coal-fired generation will be, and it would take another four to eight years to build new coal-fired capacity.

Natural Gas is Critical in the Mid-term

- Coal and Nuclear – Long lead times
- Renewables – Important but do not fill capacity needs (yet)
- Demand Response and Energy Efficiency – Key ingredients
- Natural Gas – The necessary technology for the immediate future

Over the long run, the nation can meet its increasing need for generation in several ways. But for the next few years, the options are more limited, and natural gas will be crucial.

The lead times for both nuclear and coal units mean that they will not supply a significant amount of new capacity for nearly a decade.

Most people expect renewables to supply an increasing proportion of the nation's power. For the next few years, wind will almost certainly account for a large share of generation investment and will account for a growing share of overall generation. Wind power has no fuel costs, and so will generally operate when available. However, wind is a variable, weather-dependent resource. As a result, it will not make up as strong a share of the Nation's capacity needs over the next few years. Other renewables are becoming more competitive. Geothermal power is already an important resource in the west, and concentrated solar is becoming economically attractive in desert areas like the Southwest. But these sources are likely to remain relatively small in the national picture over the next few years.

Both demand response and energy efficiency will be important – I'll talk more about them on the next slide – but they are unlikely to eliminate the need for new capacity.

Overall, the most likely outcome is that natural gas will continue to be the leading fuel for new capacity over the next half decade. For example, the consulting firm, Wood Mackenzie estimates that in a carbon constrained environment, gas consumption for power will increase by 69 % by 2017. That's in addition to the 55% increase we've seen since 2000.

Potential Responses to High Prices

- **Economic Demand Response**
- **Energy Efficiency/Conservation**
- **Technological Innovation**

Over the years, we have learned repeatedly that people respond to prices. In the case of electric power, this is likely to take several forms.

First, there is likely to be more demand response. In the simplest terms, high prices at peak will lead some customers – both businesses and others – to prefer to save their money rather than use power. In fact, the first round of demand response may be both the cheapest and fastest way to improve capacity margins on many systems. The best cost estimates for the first rounds of demand response suggest that it should be available for about \$165/kW, far less than any generation side options. The results of ISO-NE's first Forward Capacity Market auction last year corroborates the economic importance of demand response - 7.4 % of the accepted bids were for demand response. However, there are impediments that limit the full use of demand response. For example, most customers do not have the option to respond directly to real-time prices. As a result, they are unlikely to reduce peak consumption as much as they might prefer to if they could take advantage of the price.

Second, customers are likely to be more energy efficient. While few customers see real-time prices, most get an average price over a month. As a result, high prices give them considerable incentive to reduce their overall consumption of power – though no more at peak than at other times. That is, energy efficiency is essentially a substitute for baseload capacity, while demand response is a substitute for peaking capacity. Energy efficiency is also likely to be economically important. Cost estimates show that the first round of energy efficiency may be available for about 3 cents/kWh. At

Continued on next page

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current prices, supplying that same kWh from a combined cycle gas plant would cost 9 cents just for the fuel. Adding to the likelihood of greater energy efficiency is that many states have adopted fairly strong energy efficiency standards.

Third, innovators see higher prices as an opportunity. By the nature of things, it's hard to predict what innovations will succeed. The electric industry has a number of technologies that might take off – including concentrating solar power, hydrokinetic power, and vehicle to grid technologies. In addition, distributed generation is becoming more important, and may continue to do so for both cost and emissions reasons. In other newly competitive industries, such as telecoms and natural gas, innovations have produced large changes, sometimes quickly. Given continuing high electric prices, the electric power industry may see similar results.



Increasing Costs in Electric Markets

- **Item No.: A-3**
- **June 19, 2008**

That concludes our presentation. We welcome comments and questions.

**Present Value of Cost Savings of Scrubber Project versus Alternatives
(2013-2027, millions of nominal dollars)**

Summer 2008			vs Natural Gas Plant			vs Market Purchases		
Short-term Prices =>			EIA Forecast	Futures	Futures	EIA Forecast	Futures	Futures
Long-term Prices =>			EIA Forecast	EIA Forecast	Futures / Inflation	EIA Forecast	EIA Forecast	Futures / Inflation
NG Plant Costs =>	Low	High	(\$164)	\$33	\$388			
	High	High	\$196	\$394	\$748	(\$396)	(\$207)	\$285
	Low	Low	(\$14)	\$210	\$824			
	High	Low	\$347	\$571	\$1,184	(\$32)	\$223	\$882
	NG Plant Costs =>	Environ. Costs =>						

Spring 2009			vs Natural Gas Plant			vs Market Purchases		
Short-term Prices =>			EIA Forecast	Futures	Futures	EIA Forecast	Futures	Futures
Long-term Prices =>			EIA Forecast	EIA Forecast	Futures / Inflation	EIA Forecast	EIA Forecast	Futures / Inflation
NG Plant Costs =>	Low	High	\$55	\$68	(\$297)			
	High	High	\$415	\$428	\$63	(\$144)	(\$149)	(\$642)
	Low	Low	\$202	\$299	\$158			
	High	Low	\$562	\$659	\$519	\$104	\$185	(\$15)
	NG Plant Costs =>	Environ. Costs =>						

Notes:

Positive values indicate the Scrubber Project was the lower-cost alternative.

All figures are present values as of 2013, calculated using a nominal discount rate of 9.61% (based on information provided by PSNH)

Short-term Prices are electricity and fuel prices based on EIA forecasts (with and without a federal CO₂ allowance price in "High" and "Low" env. cost cases, respectively) and two years of futures market prices.

Long-term Prices are electricity and natural gas prices based on U.S. EIA forecasts (differing by env. cost case) and futures market prices for the longest available contract and rising at the rate of inflation thereafter.

Natural Gas Plant Costs: "Low"=\$800/kW; "High"=\$1500/kW; approximate range identified by FERC in 2008.

Environmental Costs: "High" includes CO₂ allowance prices and free allowances from cap-and-trade proposals (and subsequent energy price effects) and costs of 316(b) regulations; "Low" includes RGGI CO₂ prices; both "High" and "Low" cases include minor expected costs associated with other environmental regulations.

Costs of Merrimack Station Scrubber Project Versus Alternatives as of Mid-2008 (1 of 2)

	NERA Scenarios					
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Assumptions						
Short-Term Prices	EIA L/W Bill ¹	EIA L/W Bill ¹	AEO 2008 ²	AEO 2008 ²	Futures ³	Futures ³
Long-Term Prices	EIA L/W Bill	EIA L/W Bill	AEO 2008	AEO 2008	EIA L/W Bill Prices ⁴	EIA L/W Bill Prices ⁴
Environmental Costs	High ⁶	High ⁶	Low ⁷	Low ⁷	High ⁶	High ⁶
Natural Gas Plant Costs ⁸	\$800 / kW	\$1500 / kW	\$800 / kW	\$1500 / kW	\$800 / kW	\$1500 / kW
Capacity Factor ⁹	83%	83%	83%	83%	83%	83%
Net Present Values of Costs of Alternatives from 2013 to 2027 (millions of dollars)						
Scrubber Project Case:						
Non-Fuel O&M ⁹		\$339		\$339		\$339
Additional Environmental O&M ¹⁰		\$115		\$64		\$115
Allowances (net of free allocation) ¹¹		\$666		\$176		\$666
Fuel Expenses ⁹		\$876		\$905		\$876
Property Tax ¹²		\$26		\$26		\$26
Depreciation Expense ¹³		\$316		\$274		\$316
Total Expenses		\$2,339		\$1,783		\$2,339
Return on Rate Base ¹⁴		\$333		\$291		\$333
Total Revenue Requirements		\$2,671		\$2,074		\$2,671
Natural Gas Plant Case:						
Non-Fuel O&M ¹⁵	\$117	\$117	\$117	\$117	\$117	\$117
Allowances (net of free allocation) ¹¹	\$211	\$211	\$49	\$49	\$211	\$211
Fuel and Fuel Related Expenses ¹⁵	\$1,733	\$1,733	\$1,448	\$1,448	\$1,931	\$1,931
Property Tax ¹²	\$75	\$141	\$75	\$141	\$75	\$141
Depreciation Expense ¹³	\$99	\$186	\$99	\$186	\$99	\$186
Total Expenses	\$2,236	\$2,388	\$1,788	\$1,941	\$2,433	\$2,585
Return on Rate Base ¹⁴	\$238	\$446	\$238	\$446	\$238	\$446
Sunk Costs ¹⁶	\$34	\$34	\$34	\$34	\$34	\$34
Total Revenue Requirements	\$2,507	\$2,868	\$2,060	\$2,421	\$2,705	\$3,065
Net Benefits of Scrubber Project: vs. Natural Gas Plant Alternative						
		(\$164)	\$196	(\$14)	\$347	\$33
Market Purchase Case:						
Wholesale Electricity Cost		\$2,241		\$2,008		\$2,430
Sunk Costs ¹⁶		\$34		\$34		\$34
Total Revenue Requirements		\$2,276		\$2,042		\$2,465
Net Benefits of Scrubber Project: vs. Market Purchase Alternative						
		(\$396)		(\$32)		(\$207)

Notes:

Rate of inflation is assumed to be 2.5 percent annually.

Net present values calculated as of January 1, 2013 using a nominal discount rate of 9.61 percent and assuming costs occur at the end of each year.

Scrubber construction costs (\$457 million) and schedule per PSNH.

¹ Prices from April 2008 EIA service report for the Lieberman-Warner Bill, which proposed a CO2 cap-and-trade program (NEMS regional output with 2007 NH vs New England electricity price adjustment).

² Prices from the Reference Case of AEO 2008 published in June 2008; NEMS regional output with NH vs New England electricity adjustment.

³ Prices from NYMEX futures contracts for the ISONE energy market and Henry Hub available in June 2008; capacity market and gas transportation adders per PSNH, electricity prices adjusted to New Hampshire based on ISONE 2007 prices.

⁴ Futures prices used in 2009 and 2010; EIA forecast prices used after 2020; for 2011 through 2019, straight-line method used to extrapolate prices between sources.

⁵ Futures market data used when available; for periods with no futures market data, prices are assumed to increase at the rate of inflation.

⁶ CO2 allowance prices from EIA modeling of the Lieberman-Warner Bill (adjusted for freely distributed allowances); energy prices adjusted to reflect EIA projections; projected cost of cooling water intake structure regulations assuming cooling towers at Merrimack Station (per ENERCON from NERA 2011 study).

⁷ CO2 allowance prices from NYMEX futures for RGGI available in November 2008 (futures prices unavailable in mid-2008).

⁸ Natural gas plant capital cost based on the approximate range of natural gas plant costs cited by FERC in June 2008.

⁹ Average of 2003-2007 historical data (provided by PSNH) for Merrimack Station; fuel and O&M costs assumed to increase at rate of inflation.

¹⁰ Includes costs related to the Scrubber Project (per PSNH) and costs related to cooling water intake structure regulations (per ENERCON from NERA 2011 study).

¹¹ For "High Environmental Cost" scenarios, free allocation of CO2 allowances decrease from roughly 50 to 25 percent of plant emissions between 2013 and 2027, per Lieberman-Warner Bill proposal; SO2 and NOx allowances prices from NYMEX futures contracts available in June 2008.

¹² Projected Merrimack Station property tax payments per PSNH; pollution control equipment is exempt from property tax per New Hampshire law; natural gas plant property tax payments assumed to be 2.53% of plant value (includes local and state tax rates).

¹³ Assumes 15-year straight-line depreciation of all incremental capital costs related to the Scrubber Project; assumes 30-year straight-line depreciation for the natural gas plant (per PSNH).

¹⁴ Assumes a rate of return of 10.87 percent of rate base per PSNH; tax depreciation based on 20-year MACRS schedule for natural gas plant and 15-year straight-line schedule for incremental capital at Merrimack Station.

¹⁵ Operating costs of a combined-cycle natural gas plant are based on information from EIA's Assumptions to the Annual Energy Outlook 2008 report.

¹⁶ Includes costs of cancelling Scrubber Project as of July 1, 2008 (per PSNH), amortized over 2013-2027; excludes any "stranded" costs (non-incremental capital costs) upon retirement of Merrimack Station.

Costs of Merrimack Station Scrubber Project Versus Alternatives as of Mid-2008 (2 of 2)

	NERA Scenarios					
	Scenario 7	Scenario 8	Scenario 9	Scenario 10	Scenario 11	Scenario 12
Assumptions						
Short-Term Prices	Futures ³	Futures ³	Futures ³	Futures ³	Futures ³	Futures ³
Long-Term Prices	AEO 2008 Prices ⁴	AEO 2008 Prices ⁴	Rate of Inflation ⁵			
Environmental Costs	Low ⁷	Low ⁷	High ⁶	High ⁶	Low ⁷	Low ⁷
Natural Gas Plant Costs ⁸	\$800 / kW	\$1500 / kW	\$800 / kW	\$1500 / kW	\$800 / kW	\$1500 / kW
Capacity Factor ⁹	83%	83%	83%	83%	83%	83%
Net Present Values of Costs of Alternatives from 2013 to 2027 (millions of dollars)						
Scrubber Project Case:						
Non-Fuel O&M ⁹		\$339		\$339		\$339
Additional Environmental O&M ¹⁰		\$64		\$115		\$64
Allowances (net of free allocation) ¹¹				\$666		\$176
Fuel Expenses ⁹		\$905		\$876		\$905
Property Tax ¹²		\$26		\$26		\$26
Depreciation Expense ¹³		\$274		\$316		\$274
Total Expenses		\$1,783		\$2,339		\$1,783
Return on Rate Base ¹⁴		\$291		\$333		\$291
Total Revenue Requirements		\$2,074		\$2,671		\$2,074
Natural Gas Plant Case:						
Non-Fuel O&M ¹⁵	\$117	\$117	\$117	\$117	\$117	\$117
Allowances (net of free allocation) ¹¹	\$49	\$49	\$211	\$211	\$49	\$49
Fuel and Fuel Related Expenses ¹⁵	\$1,672	\$1,672	\$2,285	\$2,285	\$2,285	\$2,285
Property Tax ¹²	\$75	\$141	\$75	\$141	\$75	\$141
Depreciation Expense ¹³	\$99	\$186	\$99	\$186	\$99	\$186
Total Expenses	\$2,012	\$2,165	\$2,788	\$2,940	\$2,626	\$2,778
Return on Rate Base ¹⁴	\$238	\$446	\$238	\$446	\$238	\$446
Sunk Costs ¹⁶	\$34	\$34	\$34	\$34	\$34	\$34
Total Revenue Requirements	\$2,284	\$2,645	\$3,059	\$3,420	\$2,898	\$3,258
Net Benefits of Scrubber Project: vs. Natural Gas Plant Alternative						
	\$210	\$571	\$388	\$748	\$824	\$1,184
Market Purchase Case:						
Wholesale Electricity Cost		\$2,263		\$2,922		\$2,922
Sunk Costs ¹⁶		\$34		\$34		\$34
Total Revenue Requirements		\$2,297		\$2,956		\$2,956
Net Benefits of Scrubber Project: vs. Market Purchase Alternative						
		\$223		\$285		\$882

Notes:

Rate of inflation is assumed to be 2.5 percent annually.

Net present values calculated as of January 1, 2013 using a nominal discount rate of 9.61 percent and assuming costs occur at the end of each year.

Scrubber construction costs (\$457 million) and schedule per PSNH.

¹ Prices from April 2008 EIA service report for the Lieberman-Warner Bill, which proposed a CO2 cap-and-trade program (NEMS regional output with 2007 NH vs New England electricity price adjustment).

² Prices from the Reference Case of AEO 2008 published in June 2008; NEMS regional output with NH vs New England electricity adjustment.

³ Prices from NYMEX futures contracts for the ISONE energy market and Henry Hub available in June 2008; capacity market and gas transportation adders per PSNH, electricity prices adjusted to New Hampshire based on ISONE 2007 prices.

⁴ Futures prices used in 2009 and 2010; EIA forecast prices used after 2020; for 2011 through 2019, straight-line method used to extrapolate prices between sources.

⁵ Futures market data used when available; for periods with no futures market data, prices are assumed to increase at the rate of inflation.

⁶ CO2 allowance prices from EIA modeling of the Lieberman-Warner Bill (adjusted for freely distributed allowances); energy prices adjusted to reflect EIA projections; projected cost of cooling water intake structure regulations assuming cooling towers at Merrimack Station (per ENERCON from NERA 2011 study).

⁷ CO2 allowance prices from NYMEX futures for RGGI available in November 2008 (futures prices unavailable in mid-2008).

⁸ Natural gas plant capital cost based on the approximate range of natural gas plant costs cited by FERC in June 2008.

⁹ Average of 2003-2007 historical data (provided by PSNH) for Merrimack Station; fuel and O&M costs assumed to increase at rate of inflation.

¹⁰ Includes costs related to the Scrubber Project (per PSNH) and costs related to cooling water intake structure regulations (per ENERCON from NERA 2011 study).

¹¹ For "High Environmental Cost" scenarios, free allocation of CO2 allowances decrease from roughly 50 to 25 percent of plant emissions between 2013 and 2027, per Lieberman-Warner Bill proposal; SO2 and NOx allowances prices from NYMEX futures contracts available in June 2008.

¹² Projected Merrimack Station property tax payments per PSNH; pollution control equipment is exempt from property tax per New Hampshire law; natural gas plant property tax payments assumed to be 2.53% of plant value (includes local and state tax rates).

¹³ Assumes 15-year straight-line depreciation of all incremental capital costs related to the Scrubber Project; assumes 30-year straight-line depreciation for the natural gas plant (per PSNH).

¹⁴ Assumes a rate of return of 10.87 percent of rate base per PSNH; tax depreciation based on 20-year MACRS schedule for natural gas plant and 15-year straight-line schedule for incremental capital at Merrimack Station.

¹⁵ Operating costs of a combined-cycle natural gas plant are based on information from EIA's Assumptions to the Annual Energy Outlook 2008 report.

¹⁶ Includes costs of cancelling Scrubber Project as of July 1, 2008 (per PSNH), amortized over 2013-2027; excludes any "stranded" costs (non-incremental capital costs) upon retirement of Merrimack Station.

Costs of Merrimack Station Scrubber Project Versus Alternatives as of Early-2009 (1 of 2)

	NERA Scenarios					
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Assumptions						
Short-Term Prices	EIA W/M Bill ¹	EIA W/M Bill ¹	AEO 2009 ²	AEO 2009 ²	Futures ³	Futures ³
Long-Term Prices	EIA W/M Bill ¹	EIA W/M Bill ¹	AEO 2009 ²	AEO 2009 ²	EIA W/M Bill Prices ⁴	EIA W/M Bill Prices ⁴
Environmental Costs	High ⁵	High ⁶	Low ⁷	Low ⁷	High ⁵	High ⁶
Natural Gas Plant Costs ⁸	\$800 / kW	\$1500 / kW	\$800 / kW	\$1500 / kW	\$800 / kW	\$1500 / kW
Capacity Factor ⁹	83%	83%	83%	83%	83%	83%

Net Present Values of Costs of Alternatives from 2013 to 2027 (millions of dollars)

Scrubber Project Case:

Non-Fuel O&M ⁹		\$339		\$339		\$339
Additional Environmental O&M ¹⁰		\$115		\$64		\$115
Allowances (net of free allocation) ¹¹		\$683		\$163		\$683
Fuel Expenses ⁹		\$876		\$905		\$876
Property Tax ¹²		\$26		\$26		\$26
Depreciation Expense ¹³		\$316		\$274		\$316
Total Expenses		\$2,356		\$1,770		\$2,356
Return on Rate Base ¹⁴		\$333		\$291		\$333
Total Revenue Requirements		\$2,689		\$2,061		\$2,689

Natural Gas Plant Case:

Non-Fuel O&M ¹⁵	\$117	\$117	\$117	\$117	\$117	\$117
Allowances (net of free allocation) ¹¹	\$219	\$219	\$47	\$47	\$219	\$219
Fuel Expenses ¹⁵	\$1,878	\$1,878	\$1,569	\$1,569	\$1,891	\$1,891
Property Tax ¹²	\$75	\$141	\$75	\$141	\$75	\$141
Depreciation Expense ¹³	\$99	\$186	\$99	\$186	\$99	\$186
Total Expenses	\$2,388	\$2,540	\$1,908	\$2,060	\$2,401	\$2,553
Return on Rate Base ¹⁴	\$238	\$446	\$238	\$446	\$238	\$446
Sunk Costs ¹⁶	\$117	\$117	\$117	\$117	\$117	\$117
Total Revenue Requirements	\$2,743	\$3,104	\$2,263	\$2,623	\$2,756	\$3,117

Net Benefits of Scrubber Project: vs. Natural Gas Plant Alternative

\$55	\$415	\$202	\$562	\$68	\$428
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Market Purchase Case:

Wholesale Electricity Cost		\$2,427		\$2,047		\$2,422
Sunk Costs ¹⁶		\$117		\$117		\$117
Total Costs		\$2,544		\$2,165		\$2,540

Net Benefits of Scrubber Project: vs. Market Purchase Alternative

(\$144)	\$104	(\$149)
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Notes:

Rate of inflation is assumed to be 2.5 percent annually.

Net present values calculated as of January 1, 2013 using a nominal discount rate of 9.61 percent and assuming costs occur at the end of each year.

Scrubber construction costs (\$457 million) and schedule per PSNH.

¹ Prices from EIA modeling of Waxman-Markey Bill, which proposed (in early-2009) a CO2 cap-and-trade program (NEMS regional output with 2007 NH vs New England electricity price adjustment).

² Prices from the Updated Reference Case of AEO 2009 published in April 2009; NEMS regional output with NH vs New England electricity price adjustment.

³ Prices from NYMEX futures contracts for the ISONE energy market and Henry Hub available in March 2009; capacity market and gas transportation adders per PSNH, electricity prices adjusted to New Hampshire based on ISONE 2007 prices.

⁴ Futures prices used in 2010 and 2011; EIA forecast prices used after 2020; for 2012 through 2019, straight-line method used to extrapolate prices between sources.

⁵ Futures market data used when available; for periods with no futures market data, prices are assumed to increase at the rate of inflation.

⁶ CO2 allowance prices from EIA modeling of the Waxman-Markey Bill, adjusted for freely distributed allowances; energy prices adjusted to reflect EIA projections; projected cost of cooling water intake structure regulations assuming cooling towers at Merrimack Station (per ENERCON from NERA 2011 study).

⁷ CO2 allowance prices from NYMEX futures for RGGI available in March 2009.

⁸ Natural gas plant capital cost based on the approximate range of natural gas plant costs cited by FERC in June 2008.

⁹ Average of 2003-2007 historical data (provided by PSNH) for Merrimack Station; fuel and O&M costs assumed to increase at rate of inflation.

¹⁰ Includes costs related to the Scrubber Project (per PSNH) and costs related to cooling water intake structure regulations (per ENERCON from NERA 2011 study).

¹¹ For "High Environmental Cost" scenarios, free allocation of CO2 allowances decrease from roughly 50 to 25 percent of plant emissions between 2013 and 2027, per Lieberman-Warner Bill proposal; SO2 and NOx allowances prices from NYMEX futures contracts available in March 2009.

¹² Projected Merrimack Station property tax payments per PSNH; pollution control equipment is exempt from property tax per New Hampshire law; natural gas plant property tax payments assumed to be 2.53% of plant value (includes local and state tax rates).

¹³ Assumes 15-year straight-line depreciation of all incremental capital costs related to the Scrubber Project; assumes 30-year straight-line depreciation for the natural gas plant (per PSNH).

¹⁴ Assumes a rate of return of 10.87 percent of rate base per PSNH; tax depreciation based on 20-year MACRS schedule for natural gas plant and 15-year straight-line schedule for incremental capital at Merrimack Station.

¹⁵ Operating costs of a combined-cycle natural gas plant are based on information from EIA's Assumptions to the Annual Energy Outlook 2009 report.

¹⁶ Includes costs of cancelling Scrubber Project as of April 1, 2009 (per PSNH), amortized over 2013-2027; excludes any "stranded" costs (non-incremental capital costs) upon retirement of Merrimack Station.

Costs of Merrimack Station Scrubber Project Versus Alternatives as of Early-2009 (2 of 2)

	NERA Scenarios					
	Scenario 7	Scenario 8	Scenario 9	Scenario 10	Scenario 11	Scenario 12
Assumptions						
Short-Term Prices	Futures ³	Futures ³	Futures ³	Futures ³	Futures ³	Futures ³
Long-Term Prices	AEO 2009 Prices ⁴	AEO 2009 Prices ⁴	Rate of Inflation ⁵			
Environmental Costs	Low ⁷	Low ⁷	High ⁶	High ⁶	Low ⁷	Low ⁷
Natural Gas Plant Costs ⁸	\$800 / kW	\$1500 / kW	\$800 / kW	\$1500 / kW	\$800 / kW	\$1500 / kW
Capacity Factor ⁹	83%	83%	83%	83%	83%	83%
Net Present Values of Costs of Alternatives from 2013 to 2027 (millions of dollars)						
Scrubber Project Case:						
Non-Fuel O&M ⁹		\$339		\$339		\$339
Additional Environmental O&M ¹⁰		\$64		\$115		\$64
Allowances (net of free allocation) ¹¹		\$163		\$683		\$163
Fuel Expenses ⁹		\$905		\$876		\$905
Property Tax ¹²		\$26		\$26		\$26
Depreciation Expense ¹³		\$274		\$316		\$274
Total Expenses		\$1,770		\$2,356		\$1,770
Return on Rate Base ¹⁴		\$291		\$333		\$291
Total Revenue Requirements		\$2,061		\$2,689		\$2,061
Natural Gas Plant Case:						
Non-Fuel O&M ¹⁵	\$117	\$117	\$117	\$117	\$117	\$117
Allowances (net of free allocation) ¹¹	\$47	\$47	\$219	\$219	\$47	\$47
Fuel Expenses ¹⁵	\$1,667	\$1,667	\$1,526	\$1,526	\$1,526	\$1,526
Property Tax ¹²	\$75	\$141	\$75	\$141	\$75	\$141
Depreciation Expense ¹³	\$99	\$186	\$99	\$186	\$99	\$186
Total Expenses	\$2,005	\$2,157	\$2,036	\$2,189	\$1,864	\$2,017
Return on Rate Base ¹⁴	\$238	\$446	\$238	\$446	\$238	\$446
Sunk Costs ¹⁶	\$117	\$117	\$117	\$117	\$117	\$117
Total Revenue Requirements	\$2,360	\$2,720	\$2,391	\$2,752	\$2,220	\$2,580
Net Benefits of Scrubber Project: vs. Natural Gas Plant Alternative						
	\$299	\$659	(\$297)	\$63	\$158	\$519
Market Purchase Case:						
Wholesale Electricity Cost		\$2,129		\$1,929		\$1,929
Sunk Costs ¹⁶		\$117		\$117		\$117
Total Costs		\$2,247		\$2,046		\$2,046
Net Benefits of Scrubber Project: vs. Market Purchase Alternative						
		\$185		(\$642)		(\$15)

Notes:

Rate of inflation is assumed to be 2.5 percent annually.

Net present values calculated as of January 1, 2013 using a nominal discount rate of 9.61 percent and assuming costs occur at the end of each year.

Scrubber construction costs (\$457 million) and schedule per PSNH.

¹ Prices from EIA modeling of Waxman-Markey Bill, which proposed (in early-2009) a CO2 cap-and-trade program (NEMS regional output with 2007 NH vs New England electricity price adjustment).

² Prices from the Updated Reference Case of AEO 2009 published in April 2009; NEMS regional output with NH vs New England electricity price adjustment.

³ Prices from NYMEX futures contracts for the ISONE energy market and Henry Hub available in March 2009; capacity market and gas transportation adders per PSNH, electricity prices adjusted to New Hampshire based on ISONE 2007 prices.

⁴ Futures prices used in 2010 and 2011; EIA forecast prices used after 2020; for 2012 through 2019, straight-line method used to extrapolate prices between sources.

⁵ Futures market data used when available; for periods with no futures market data, prices are assumed to increase at the rate of inflation.

⁶ CO2 allowance prices from EIA modeling of the Waxman-Markey Bill, adjusted for freely distributed allowances; energy prices adjusted to reflect EIA projections; projected cost of cooling water intake structure regulations assuming cooling towers at Merrimack Station (per ENERCON from NERA 2011 study).

⁷ CO2 allowance prices from NYMEX futures for RGGI available in March 2009.

⁸ Natural gas plant capital cost based on the approximate range of natural gas plant costs cited by FERC in June 2008.

⁹ Average of 2003-2007 historical data (provided by PSNH) for Merrimack Station; fuel and O&M costs assumed to increase at rate of inflation.

¹⁰ Includes costs related to the Scrubber Project (per PSNH) and costs related to cooling water intake structure regulations (per ENERCON from NERA 2011 study).

¹¹ For "High Environmental Cost" scenarios, free allocation of CO2 allowances decrease from roughly 50 to 25 percent of plant emissions between 2013 and 2027, per Lieberman-Warner Bill proposal; SO2 and NOx allowances prices from NYMEX futures contracts available in March 2009.

¹² Projected Merrimack Station property tax payments per PSNH; pollution control equipment is exempt from property tax per New Hampshire law; natural gas plant property tax payments assumed to be 2.53% of plant value (includes local and state tax rates).

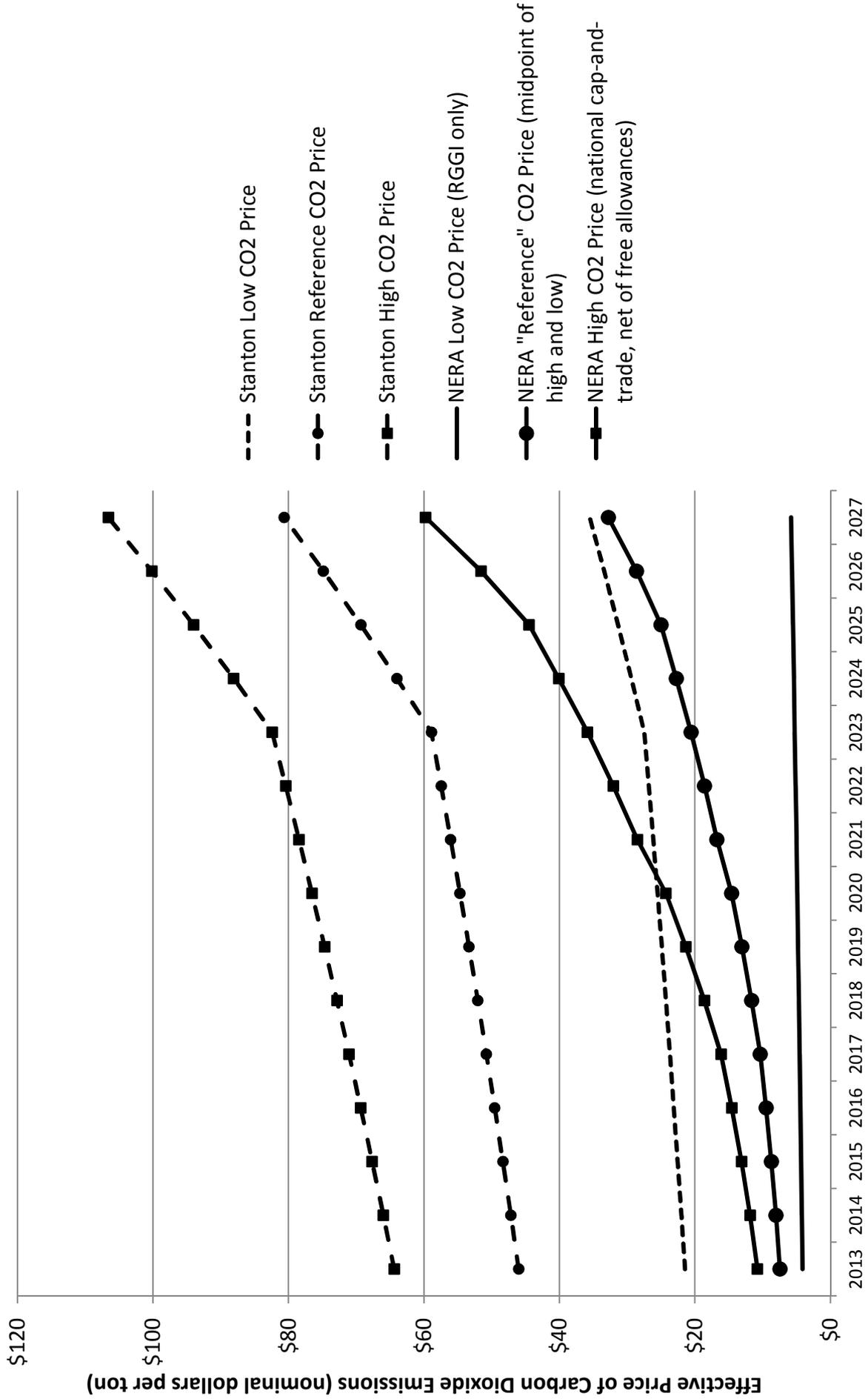
¹³ Assumes 15-year straight-line depreciation of all incremental capital costs related to the Scrubber Project; assumes 30-year straight-line depreciation for the natural gas plant (per PSNH).

¹⁴ Assumes a rate of return of 10.87 percent of rate base per PSNH; tax depreciation based on 20-year MACRS schedule for natural gas plant and 15-year straight-line schedule for incremental capital at Merrimack Station.

¹⁵ Operating costs of a combined-cycle natural gas plant are based on information from EIA's Assumptions to the Annual Energy Outlook 2009 report.

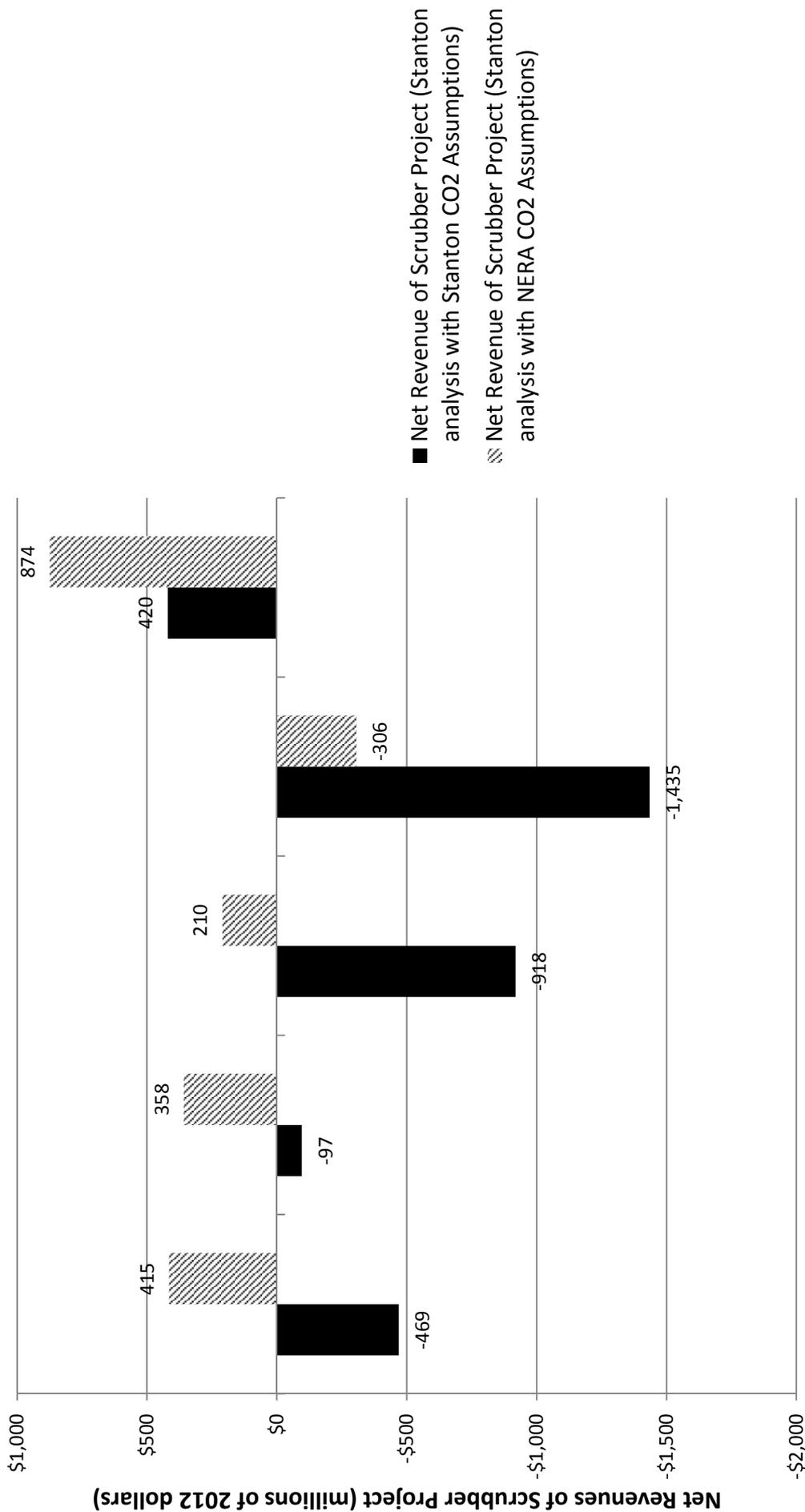
¹⁶ Includes costs of cancelling Scrubber Project as of April 1, 2009 (per PSNH), amortized over 2013-2027; excludes any "stranded" costs (non-incremental capital costs) upon retirement of Merrimack Station.

Comparison of Stanton vs NERA Carbon Dioxide Prices



The NERA High Price is based on EIA modeling of the Waxman-Markey proposal, adjusted to reflect freely distributed allowances; Dr. Stanton's prices are converted to nominal dollars using a 2.5% annual rate of inflation.

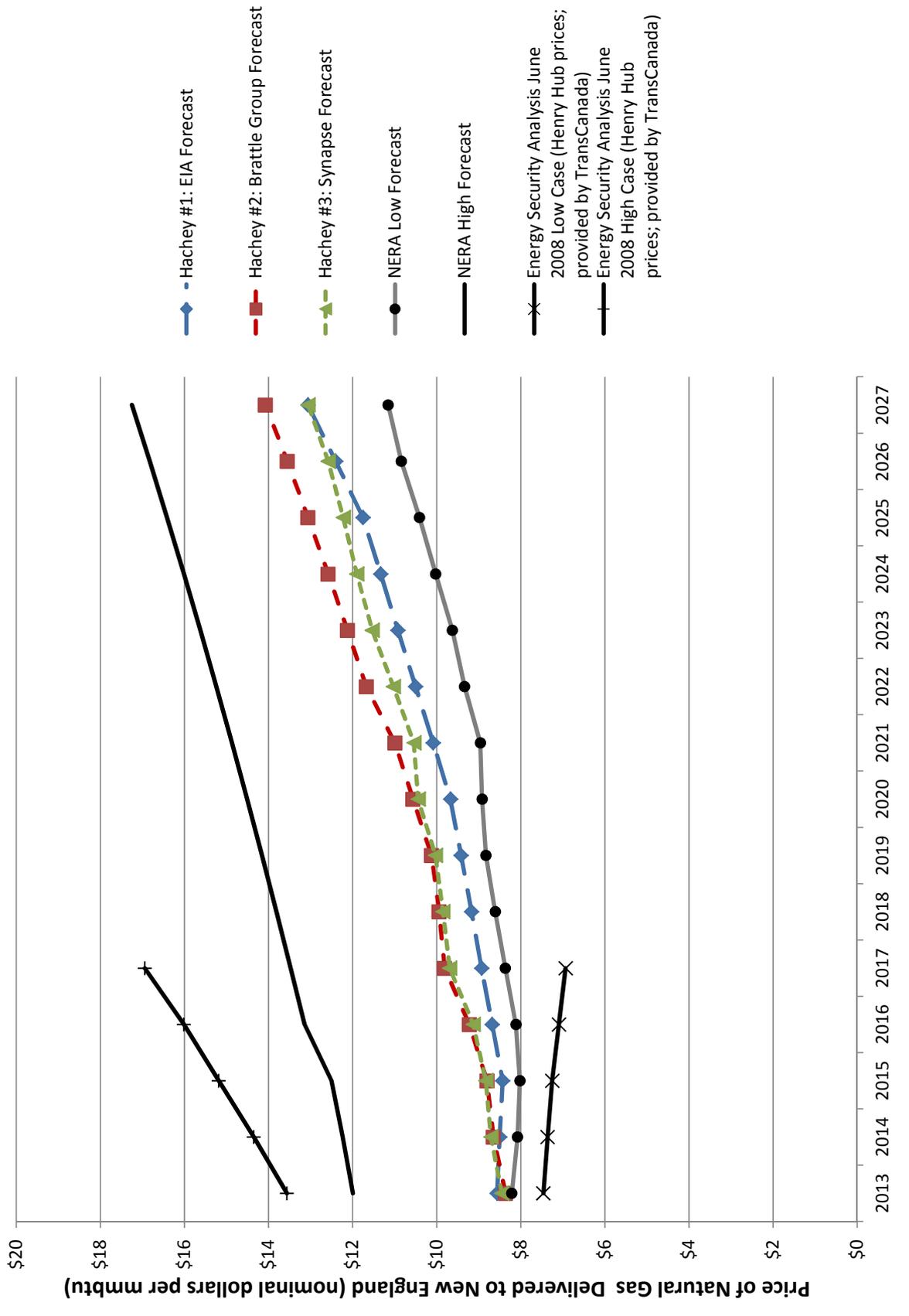
Sensitivity of Stanton Results to Carbon Dioxide Prices



Scenario 1: Reference Case Scenario 2: Low Case, Low Gas Scenario 3: High Case, High Gas Scenario 4: High Case, Low Gas Scenario 5: Low Case, High Gas

Calculations using the spreadsheet model provided by Dr. Stanton as Exhibit 2 to her testimony.

Natural Gas Price Forecasts from Hachey Testimony



NERA Low Forecast for mid-2008 is based on U.S. EIA natural gas price forecasts; NERA High Forecast for mid-2008 is based on futures market prices.