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July 18, 2007

Senator Jack Hart, Chairman
Representative Daniel E. Bosley, Chairman
The Joint Committee on Economic Development and Emerging Technologies
Room 42
State House
Boston, MA 02133

Chairmen Hart and Chairman Bosley:

Thank you very much for accepting my testimony on The Revenue Neutral Carbon Tax Study Bill. My name is Ezra D. Hausman, Ph.D., and I am employed by Synapse Energy Economics[1] of Cambridge, Massachusetts, a research and consulting firm specializing in energy, economic, and environmental topics. I have worked as an analyst, consultant, and expert witness on energy and environmental issues since 1998.

I hold a Bachelor of Arts degree from Wesleyan University, a Master's Degree in Environmental Engineering from Tufts University, a Master's Degree in Applied Physics from Harvard University, and a Doctorate in Earth and Planetary Science from Harvard University. My dissertation at Harvard, entitled "The Reorganization of the Global Carbon Cycle at the Last Glacial Termination", concerned the interaction between rising atmospheric CO_2 levels and climate change at the end of the last glacial period. My C.V. is included as an attachment to this testimony, and can also be found on the Synapse Energy website at http://www.synapse-energy.com/expertise/staff_resumes/resume-hausman.pdf.

I am offering this testimony as both a climate scientist and an expert in the field of energy market regulation and economics. I offer testimony on the science of global climate change; on the history of atmospheric CO_2 levels; on the expected impacts of climate change and the uncertainty in these projections; and on the benefits of a revenue neutral carbon tax as a way to address this issue.

[1] www.synapse-energy.com

Human induced climate change is a grave and increasing threat to the environment and to human societies around the globe. The effects of this process are already observable and documented in the scientific literature, and are consistent with those predicted by computer models of the global climate. These same models predict much more severe effects to come, including sea level rise leading to inundation of coastal areas, dramatic changes in precipitation patterns across the globe, accelerated loss of habitat and species extinctions, and migration of pest species and disease vectors with associated human health impacts. Indeed, we are on a path that, if unchanged, is likely to bring about a climate well outside the range of anything ever experienced by our species, with the potential for severe and irreversible changes that will forever alter our environment, our economies and our way of life.

While some level of climate change is already a fact, computer models tell us that we can avoid or mitigate many dangerous impacts by limiting the further buildup of CO_2 in the atmosphere. Perhaps the most important and cost-effective way to achieve this is by recognizing the cost imposed upon society every time greenhouse gases are released from dormant reservoirs (such as fossil fuels) to the atmosphere. Once this cost is reflected in the price of goods and services that result from these emissions, the forces of innovation and economics can and will act to produce meaningful and lasting reductions and mitigate harm to the climate. A well-designed revenue-neutral carbon tax is one promising way to achieve this effect without imposing an additional tax burden on the citizens of Massachusetts.

THE SCIENCE OF GLOBAL CLIMATE CHANGE

The planet’s climate is a function of how much energy it receives from the sun, how much of that energy it retains, and how that energy is distributed throughout the planet (by wind and ocean currents, evaporation, condensation, and other mechanisms). Solar radiation arrives on earth, mainly in the form of visible light. That radiation is absorbed by the surface of the planet, which in turn radiates heat energy into the lower atmosphere. Some of that heat is trapped in the lower atmosphere by naturally-occurring gases, somewhat analogous to how heat is trapped in a greenhouse by the glass. This gives rise to the natural “greenhouse effect” and the heat-trapping gases are commonly called “greenhouse gases.” The primary greenhouse gas is water vapor; other important greenhouse gases include CO_2, a byproduct of combustion, and methane.

Without the greenhouse effect, the earth would be far too cold to support liquid water, or probably any kind of life. Similarly with too strong of a greenhouse effect, the earth would be considerably warmer and might have no polar ice caps at all. These conditions have occurred in the geologic past, although not within the timeframe of the human species. With an even stronger greenhouse effect the earth could become extremely hot and uninhabitable, like the planet Venus. For all of recorded human history, the greenhouse effect has remained within a fairly narrow range, producing the relative climate stability that has allowed complex human civilizations to form and develop. During periods of geologic history that had different abundances of greenhouse gases such as CO_2, the earth had a very different climate.

Human activities have increased the atmospheric concentration of several greenhouse gases, most notably of CO_2. This increase has come primarily from the burning of fossil fuels (coal, oil, and natural gas), and also from changes in land use such as deforestation, and to a smaller extent from the manufacture of cement. Of the fossil fuels, coal emits the most CO_2 per unit of energy obtained. Today the primary reason for burning coal in the United States is for the generation of electricity.

Because of the continuous and accelerating recovery and combustion of fossil fuels, the background level of CO_2 in the air has increased by roughly one third since preindustrial times. This means that the lower atmosphere does not lose heat to space as efficiently as it otherwise would, so the surface of the earth is generally warming. This is the phenomenon commonly referred to as “global warming.”

Global warming will affect different areas differently, changing the distribution of rainfall, warming many areas but cooling some others, changing the length of growing seasons, and so forth. Paradoxically, some areas are likely to become *cooler* as a response to global warming. To emphasize the range of the planet’s complex response to global warming, scientists have coined the term “global climate change.” I personally prefer to use the term “global climate change” in contexts such as this to emphasize that the impact of the increased atmospheric CO_2 burden will not just be measured in a few warm days, but in disruptions in the characteristics of climate that define our lives and our livelihoods.

Because there has been some confusion about “uncertainty” surrounding the science of global climate change, I would like to take this opportunity to outline those areas of climate change science in which there is unequivocal scientific consensus, versus areas in which there is still some uncertainty. I would say that there is an unequivocal scientific consensus in the following areas:

- The fact that the CO_2 content of the atmosphere is increasing rapidly;
- The fact that this rate of increase, and the resulting abundance of CO_2 in the atmosphere, is unprecedented in at least the past 200,000 years, and probably much longer;
- The fact that the primary source of the recent rapid increase is combustion of fossil fuels by human industrialized societies, i.e., that it is anthropogenic CO_2;
- The fact that the increased abundance of atmospheric CO_2 has a direct radiative forcing effect on climate by altering the heat transfer characteristics of the atmosphere;
- The fact that this change in the heat transfer properties of the atmosphere will have an impact on the climate of the planet;
- The fact that the climate of the earth is currently changing in ways that are consistent with model predictions based on the increased radiative forcing due to the anthropogenic increase in atmospheric CO_2, and that these changes include increased ocean temperatures, increased sea level, loss of arctic permafrost, accelerated loss of mountain and polar glacier mass, and destruction of arctic habitat;
- The fact that these observed changes, taken together, cannot be ascribed to any known natural phenomenon;
- The fact that the magnitude of climate impacts will increase with increasing atmospheric CO_2 content; and
- The fact that once the atmospheric abundance of CO2 has been increased, it can only return to equilibrium levels through natural processes on a timescale of several centuries.

In addition, there is a strong scientific consensus that natural feedbacks in the climate system would, on balance, tend to reinforce warming rather than mitigate it—for example, a warmer world would have more water in the atmosphere, which would tend to make the greenhouse effect stronger. As another feedback example, any melting of the polar ice caps would tend to decrease the efficiency with which the Earth reflect sunlight back to space—the so called *albedo* of the planet—further contributing to warming of the surface.

There is also a strong consensus that one effect of global climate change will be the migration of climate zones, such that human societies and natural ecosystems will find themselves poorly adapted to their local climate. This may be expected to result in disruption and dislocation of ecosystems, migration of pest species and disease vectors, and disruptions in agriculture. Finally, there is general agreement, if not yet consensus, that global climate change will lead to generally more extreme weather patterns across most of the globe, including more intense storms and rainfall events and more extreme dry spells.

INCREASING ATMOSPHERIC CO_2 LEVELS

The U.S. National Oceanic and Atmospheric Administration (NOAA) reported on May 1, 2006, that the average atmospheric carbon dioxide level increased from an average of 376.8 parts per million (ppm, i.e., molecules of CO_2 for every million molecules of air) in 2004 to 378.9 ppm last year. This should be compared with the "preindustrial" level of atmospheric CO_2, which was close to 280 ppm.

To put this in context, I would like to present a few figures from the Intergovernmental Panel on Climate Change (IPCC)[2], the leading international authority on the science and impacts of global climate change. These figures come from the IPCC Working Group I Report from the Third Assessment Report, entitled "Climate Change 2001: The Scientific Basis".[3] These figures present some of the key evidence demonstrating the nature of the modern rise in atmospheric CO_2. However, please note that the scientific evidence goes well beyond the few observations shown here.

The first graph shows the direct, instrumental measurements of CO_2 from Mauna Loa, in Hawaii, taken since the late 1950s. This graph shows both the seasonal variations in CO_2 associated with the growing season in the northern hemisphere, and the year-to-year increase in atmospheric CO_2 during this period:

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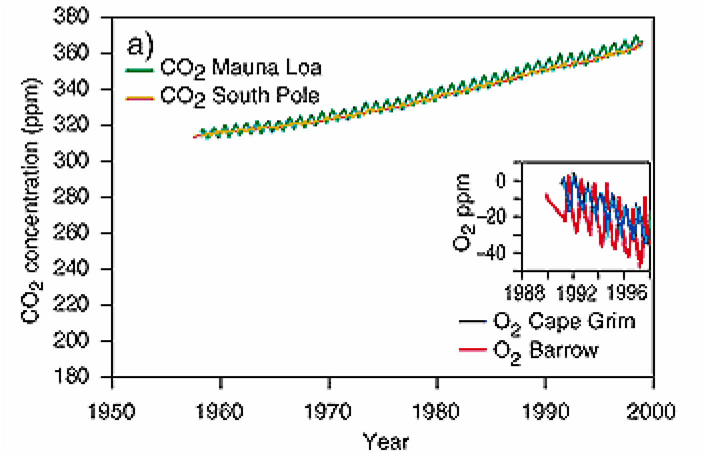
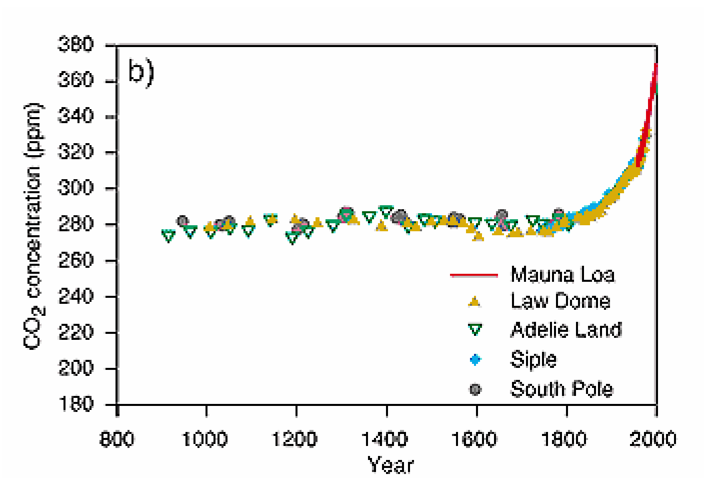
[2] According to the IPCC website, http://www.ipcc.ch/, "The Intergovernmental Panel on Climate Change (IPCC) has been established by WMO [World Meteorological Organization] and UNEP [United Nations Environmental Program] to assess scientific, technical and socio- economic information relevant for the understanding of climate change, its potential impacts and options for adaptation and mitigation.

[3] This report, and all reports from the IPCC Third Assessment Report (TAR), may be found at http://www.grida.no/climate/ipcc_tar/.



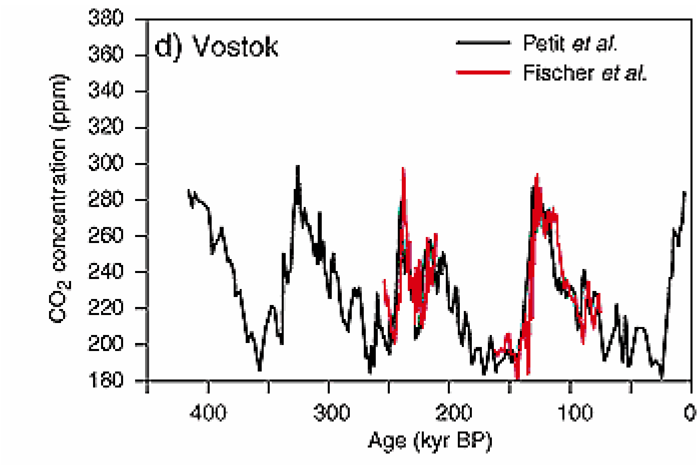
In this period alone, essentially my lifetime, atmospheric CO_2 has risen from under 320 ppm (parts per million, or number of molecules for every million molecules in the atmosphere) to almost 380 ppm, and the rate of increase is itself also increasing. (The inset shows the associated variation in atmospheric oxygen— CO_2 production always takes up oxygen from the atmosphere. While the decrease in abundant atmospheric oxygen is not a concern, these data corroborate and support the CO_2 data.)

This next graph shows the history of atmospheric CO_2 for the last thousand years or so. This is measured in ancient air samples recovered from bubbles trapped in polar ice, in this case from various sites in Antarctica. The vertical scale is the same as in the previous graph, and in fact it also shows the Mauna Loa data for comparison:



These data demonstrate that CO_2 levels have been relatively steady in the atmosphere for over 1,000 years, a time of remarkably quiescent climate by geological standards, during which modern human civilization and culture have flourished around the world. The ice core data match up well with the beginning of the Mauna Loa data, and highlight the extraordinarily steep slope over which CO_2 has risen during the last 50-100 years. On the scale of most geological records, this line would be essentially vertical.

Finally, this last graph shows the variations in atmospheric CO_2 over the last four glacial cycles, also recovered from Antarctic ice cores, in this case a particularly deep core with a long time record known as Vostok. The vertical scale is the same as for the two previous graphs, while the horizontal scale is in thousand years before the present:



Remember that the Mauna Loa data begin just below 320 ppm, and increase rapidly from there. This is already significantly higher than the measured atmospheric abundance for any time in the last 400,000 years, although the variations during this period were considerable. (Some of these slopes appear quite steep too, but the time scale here is much, much longer.) The variations recorded at Vostok were accompanied by enormous changes in climate, including the advances and retreats of glaciers that at times covered much of the North American continent and Eurasia. As a rule over this period, low CO_2 intervals are associated with colder periods and relative glacial advance, while higher CO_2 is associated with the warmer interglacial periods.

We have excellent computer models to predict some of the effects of elevated CO_2 levels, and some of these are reflected in my testimony. Even without these model results, however, it would represent an extraordinary risk to push the climate system where it has never gone in over 400,000 years, and probably in tens of millions of years, when there is such a clear record of the relationship of CO_2 concentrations with climate. This is, in my opinion, a dangerous game to play with the only planet we have.

EXPECTED FUTURE IMPACTS OF CLIMATE CHANGE

The IPCC 2001 report predicts that the average surface temperature of the earth will increase by 1.5 to 5.8 °C by 2100. The range reflects uncertainty about future emission levels and about precisely how the earth and atmospheric dynamics will respond to those emissions. In my opinion, as I will discuss below, this range is conservative.

Temperature changes of 1.5 to 5.8 °C may sound small, but for perspective, the average surface temperature differential between the last ice age and the present was itself only about 5°C. During the last ice age, earth was a profoundly different place, with much of North America covered by an ice sheet a mile or more thick. At the upper range of the IPCC's 2001 warming prediction, earth would experience a warming equivalent to the one that melted that ice sheet. The recovery from the last major glacial period took 5,000 to 18,000 years. The warming we are discussing here will occur within a single century.

Further, the IPCC Reports predict a large number of very serious negative impacts associated with this warming, including:

- Rising sea levels, exposing coastal areas to increased risk of inundation and storm damage;
- Damage to or loss of natural ecosystems, such as prairie wetlands and alpine;
- Migration of habitats, leading to species extinctions and expansion of disease vectors and pests;
- Heat waves leading to higher human morbidity and mortality from heat stress;
- More intense precipitation events resulting in increased floods, mudslides, and soil erosion; and
- Increased summer drying in most continental interiors resulting in more droughts; reduced crop yields, reduced water availability and quality.

In addition, recent research[4] has established a surprisingly clear statistical link between tropical sea surface temperatures and the strength of tropical hurricanes. (I say this clarity is surprising

[4] For example, see K. Emanuel, "Increasing destructiveness of tropical cyclones over the past 30 years", *Nature* 436(4):686-688, August, 2005; also P. J. Webster *et al.*, "Changes in Tropical Cyclone Number, Duration, and Intensity in a Warming Environment", *Science* Vol. 309 No. 5742, September 2005.

because there is a great deal of natural variability in hurricanes, so such a well-defined relationship was not anticipated by, for example, the IPCC reports.) Thus, a temperature increase of the predicted magnitude may be expected to show up as a further increase in the number of very strong hurricanes, along with the associated damage to property and loss of life.

The higher the atmospheric abundance of CO_2 rises, the more severe we can expect these impacts to be; to some extent they are expected even at the lower warming projections. Indeed, there is evidence that the 0.6 °C warming we have experienced to date has already initiated many of these impacts.

Perhaps even more troubling, the scientific evidence shows that these impacts are unlikely to unfold gradually. While computer models are generally unable to predict specific abrupt climate changes, we know from the geologic record that when the planet is changing from one type of climate to another, such as from an ice age to an interglacial, it often changes dramatically in an abrupt, lurching fashion. The well-dated ice core records, show several abrupt and sudden climate swings, during the warming period following the last ice age, of a magnitude that would be extremely disruptive were they to occur today.[5] This is particularly true during warming periods, probably because of the positive feedbacks mentioned earlier such as the self-reinforcing melting of ice caps at high latitudes. Unfortunately, it is extremely difficult to predict at what level of atmospheric CO_2 such abrupt climate events would be likely to occur, or what their nature would be.

There has been a great deal of confusion related to the “uncertainty” associated with these predicted impacts related to global climate change. It is true that the climate system is extremely complicated, even chaotic in its response to perturbations; this is well established based upon ice core records and other geologic evidence. Computer models of the climate are unable to capture this characteristic of the climate well, as they tend to dampen out extreme effects. Thus while there is indeed a great deal of uncertainty in the impact of global warming, this should not be taken as “uncertainty” that the problem exists or that it poses a serious threat—the uncertainty lies in the risk that the climate system may in fact react much more severely than the models predict. In my judgment, climate scientists have been extremely conservative in not over-

[5] See, for example, the 2002 report from the National Academy of Sciences, “Abrupt Climate Change: Inevitable Surprises,” online at *http://www.nap.edu/books/0309074347/html/*.

predicting the impacts of global climate change, largely publishing and publicizing impacts that they feel are virtually certain to occur. This view was reflected in a recent scientific paper led by James Hanson, Director of the NASA Goddard Institute for Space Studies[6]. These authors note that the paleoclimate data are much more consistent with abrupt warming scenarios than gradual ones, and that existing climate models are unable to replicate the ice sheet dynamics that are the likely driver of this behavior. They conclude, "In the absence of realistic models, it is better to rely on information from the Earth's history." (Hansen *et al.,* p. 1937)

Action taken to reduce carbon emissions today, while fully justified to avoid the well-understood and near-certain impacts of climate change, is also essential as insurance against the possibility of much more severe impacts that are more poorly understood.

BENEFITS OF A REVENUE NEUTRAL CARBON TAX

I have focused most of my testimony today on the science and likely impacts of global climate change to emphasize the severity of the problem we face, and the urgency of taking action quickly to avert the worst effects. However, as an expert in energy market economics and electricity market design, I would also like to comment on the merits of a revenue-neutral carbon tax as an instrument for achieving significant reductions in emissions.

As unpopular as they sometimes are, taxes serve two important purposes: they raise money for the public good, and they provide financial incentives and disincentives that drive public behavior. Today there is little direct benefit to individuals for modifying economic behavior in response to the threat posed by climate change, because there is no direct financial disincentive felt by the individual or firm; all of the cost is borne by society as a whole. This is a classic example of the "tragedy of the commons"—the behavior of each individual imposes a net cost on society, but provides a net benefit for the individual. As a result the behavior continues to the detriment of the welfare of society. Taxes can provide a remedy for this situation—they can impose a marginal cost on the individual that reflects the marginal cost on society, so that his or her economic incentives are better aligned with the social good. Note that what is important here

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[6] Hansen, J., Mki. Sato, P. Kharecha, G. Russell, D.W. Lea, and M. Siddall, 2007: Climate change and trace gases. Phil. Trans. Royal. Soc. A, 365, 1925-1954. Available at http://pubs.giss.nasa.gov/docs/2007/2007_Hansen_etal_2.pdf.

is not the total cost which need not be high. What is important is the marginal cost or benefit of behavior to the individual or firm.

There are many, many ways to reduce carbon emissions without materially impacting quality of life in Massachusetts. In study after study, energy efficiency is shown to be the least cost resource for meeting society's energy needs; individuals can carpool or use public transportation to save gas; buildings can be served by better insulation and more efficient lighting. Unfortunately today, most people do not bother making these and similar adjustments, nor do commercial entities invest anywhere near what they could in reducing energy use and greenhouse gas emissions. This is because they do not see the cost of their emissions on society, so they do not make decisions to minimize that cost. A revenue neutral carbon tax is a reasonable response to that situation, providing an incentive to modify behavior in ways that would reduce carbon emissions without imposing a net burden on citizens of the Commonwealth. It would also be a powerful driver for innovation and technology, providing opportunities for Massachusetts businesses to develop the technologies that will run the lower-carbon world of the future.

Of course, climate change is a global problem, and the ultimate solutions to greenhouse gas pollution will involve regulation at the federal level, and ultimately cooperation at the global level. But the solution has to start somewhere, and it has to start soon. Massachusetts can be a leader in literally saving the planet and develop economic opportunities in our state at the same time by developing and implementing visionary carbon policies such as a revenue neutral carbon tax.

Thank you very much for your consideration of this matter.

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SUMMARY

I have worked since 1998 as an electricity market analyst with a focus on market design and market restructuring, as well as pricing of energy, capacity, transmission, losses and other electricity-related services. I have recently performed market analysis, offered expert testimony, let workshops and working groups, made presentations and participated on panels, and provided other support to clients in a number of areas, including:

- Economic analysis, price forcasting, and asset valuation in electricity markets
- Electricity and generating capacity market design
- Economic analysis of environmental and other regulations, including CO_2 regulations, in electricity markets
- Quantification of the economic and environmental benefits of displaced emmissions associated with energy efficiency and renewable energy initiatives
- Modeling and analysis of coordinated hydropower operations and water resource management on reservoir systems
- The role of electricity supply and demand sectors in addressing global climate change
- The role of Liquefied Natural Gas (LNG) imports in the U.S. natural gas and electricity markets
- Regulation and mitigation of greenhouse gas emissions from both the supply and demand sides of the electric sector.

I hold a Ph.D. in atmospheric science from Harvard University, a Master's degree in applied physics from Harvard University, a Master's degree in water resource engineering from Tufts University, and a Bachelor of Arts degree from Wesleyan University.

PROFESSIONAL EXPERIENCE

Synapse Energy Economics Inc., Cambridge, MA. Senior Associate, 2005-present
Conducting research, writing reports, and presenting expert testimony pertaining to consumer, environmental, and public policy implications of electricity industry regulation. Focus of work includes:

- Economic analysis of electricity industry regulation and restructuring
- Efficient pricing of generating and transmission capacity
- Long-term electric power system planning and market design
- Price forecasting and asset valuation
- Impact of air quality and environmental regulations on electricity markets and pricing
- Natural gas and Liquified Natural Gas (LNG) market dynamics

- Energy efficiency and renewable energy programs and policies, including avoided emissions analysis
- Market power and market concentration analysis in electricity markets
- Consumer and environmental protection
- Regulation and mitigation of greenhouse gas emissions.

Charles River Associates (CRA), Cambridge, MA. Senior Associate, 2004-2005
CRA acquired Tabors Caramanis & Associates in October, 2004.

Tabors Caramanis & Associates, Cambridge, MA. Senior Associate, 1998-2004
Modeling and analysis of electricity markets, generation and transmission systems. Projects included:

- Several market transition cost-benefit studies for development of Locational Marginal Price (LMP) based markets in US electricity markets
- Long-term market forecasting studies for valuation of generation and transmission assets,
- Valuation of financial instruments relating to transmission system congestion and losses
- Modeling and analysis of hydrologically and electrically interconnected hydropower system operations
- Natural gas market analysis and price forecasting studies
- Co-developed an innovative approach to hedging financial risk associated with transmission system losses of electricity
- Designed, developed and ran training seminars using a computer-based electricity market simulation game, to help familiarize market participants and students in the operation of LMP-based electricity markets.
- Developed and implemented analytical tools for assessment of market concentration in interconnected electricity markets, based on the "delivered price test" for assessing market accessibility in such a network
- Performed regional market power and market power mitigation studies
- Performed transmission feasibility studies for proposed new generation and transmission projects in various locations in the US
- Provided analytical support for expert testimony in a variety of regulatory and litigation proceedings, including breach of contract, bankruptcy, and antitrust cases, among others.

Global Risk Prediction Network, Inc., Greenland, NH. Vice President, 1997-1998
Developed private sector applications of climate forecast science in partnership with researchers at Columbia University. Specific projects included a statistical assessment of grain yield predictability in several crop regions around the world based on global climate indicators (Principal Investigator); a statistical assessment of road salt demand predictability in the United States based on global climate indicators (Principal Investigator); a preliminary design of a climate and climate forecast information website tailored to the interests of the business community; and the development of client base.

Hub Data, Inc., Cambridge, MA. Financial Software Consultant, 1986-1987, 1993-1997
Responsible for design, implementation and support of analytic and communications modules for bond portfolio management software; and developed software tools such as dynamic data compression technique to facilitate product delivery, Windows interface for securities data products.

Abt Associates, Inc., Cambridge, MA. Environmental Policy Analyst, 1990-1991
Quantitative risk analysis to support federal environmental policy-making. Specific areas of research included risk assessment for federal regulations concerning sewage sludge disposal and pesticide use; statistical alternatives to Most-Exposed-Individual risk assessment paradigm; and research on non-point sources of water pollution.

Massachusetts Water Resources Authority, Charlestown, MA. Analyst, 1988-1990
Applied and evaluated demand forecasting techniques for the Eastern Massachusetts service area. Assessed applicability of various techniques to the system and to regional planning needs; and assessed yield/reliability relationship for the eastern Massachusetts water supply system, based on Monte-Carlo analysis of historical hydrology.

Somerville High School, Somerville, MA. Math Teacher, 1986-1987
Courses included trigonometry, computer programming, and basic math courses.

EDUCATION

Ph.D., Earth and Planetary Sciences. Harvard University, Cambridge, MA, 1997

S.M., Applied Physics. Harvard University, Cambridge, MA, 1993

M.S., Civil Engineering. Tufts University, Medford, MA, 1990

B.A., Wesleyan University, Psychology. Middletown, MA, 1985

FELLOWSHIPS, AWARDS AND AFFILIATIONS

President, Burr Elementary School Parent Teacher Organization, 2005-present

UCAR Visiting Scientist Postdoctoral Fellowship, 1997

Postdoctoral Research Fellowship, Harvard University, 1997

Certificate of Distinction in Teaching, Harvard University, 1997

Graduate Research Fellowship, Harvard University, 1991-1997

Invited Participant, UCAR Global Change Institute, 1993

House Tutor, Leverett House, Harvard University, 1991-1993

Graduate Research Fellowship, Massachusetts Water Resources Authority, 1989-1990

Teaching Fellowships:

> **Harvard University:** *Principles of Measurement and Modeling in Atmospheric Chemistry; Hydrology; Introduction to Environmental Science and Public Policy; The Atmosphere.*
>
> **Wesleyan University:** *Introduction to Computer Programming; Psychological Statistics; Playwriting and Production.*

Professional affiliations

> *Member, American Association for the Advancement of Science*
>
> *Member, American Economic Association*

EXPERT TESTIMONY

Town of Rockingham, VT – 2006/07
Served as expert witness on the value of the Bellows Falls hydroelectric facility

Town of Littleton, NH – 2006/07
Served as expert witness on the value of the Moore hydroelectric facility.

Vermont Public Service Board (Docket No. 7250) 2006-2007.
Prepared report and testimony in support of the application of Deerfield Wind, LLC. For a Certificate of Public Good for a proposed wind power facility.

South Dakota Public Utilities Commission (Case No EL05-22) – June 2006
Minnesota Public Utilities Commission (Docket TR-05-1275) – December 2006
Submitted prefiled and live testimony on the contribution of the proposed Big Stone II coal-fired generator to atmospheric CO_2, global climate change and the environment of South Dakota and Minnesota, respectively.

Arkansas Public Service Commission (Docket No. 06-070-U) – October 2006
Submitted prefiled direct testimony on inclusion of new wind and gas-fired generation resources in utility rate base.

Federal Energy Regulatory Commission (Docket Nos. ER055-1410-000 and EL05-148-000) – May-Sept 2006

- Participant in settlement hearings on proposed capacity market structure (the Reliability Pricing Model, or RPM) on behalf of State Consumer Advocates in Pennsylvania, Ohio and the District of Columbia
- Invited participant on technical conference panel on PJM's proposed Variable Resource Requirement (VRR) curve
- Filed Pre- and post-conference comments and affidavits with FERC
- Participated in numerous training and design conferences at PJM on RPM implementation.

Illinois Pollution Control Board (Docket No. R2006-025) June-Aug 2006
Prefile and live testimony presented on behalf of the Illinois EPA regarding the costs and benefits of proposed mercury emissions rule for Illinois power plants.

Long Island Sound LNG Task Force – January 2006
Presentation of study on the need for and alternatives to the proposed Broadwater LNG storage and regasification facility in Long Island Sound.

Iowa Utilities Board (Docket No. SPU-05-15) – November 2005
Whether Interstate Power and Light's should be permitted to sell the Duane Arnold Energy Center nuclear facility to FPLE Duane Arnold, Inc., a subsidiary of Florida Power and Light.

PUBLICATIONS AND REPORTS

Hausman, E.D., R. Fagan, D. White, K. Takahashi and A. Napoleon. "LMP Electricity Markets: Market Operations, Market Power and Value for Consumers." Prepared and delivered for the American Public Power Association's Electricity Market Reform Initiative (EMRI) symposium, *Assessing Restructured Electricity Markets"* in Washington, DC, February 5, 2007.

Hausman, E.D. and K. Takahashi, "The Proposed Broadwater LNG Import Terminal Response to Draft Environmental Impact Statement and Update of Synapse Analysis" Synapse Energy report on behalf of the Connecticut Fund for the Environment and Save The Sound, January 22, 2007.

Hausman, E.D., K. Takahashi, D. Schlissel and B. Biewald, "The Proposed Broadwater LNG Import Terminal: An Analysis and Assessment of Alternatives" Synapse Energy report on behalf of the Connecticut Fund for the Environment and Save The Sound, March 2, 2006.

Hausman, E.D., P. Peterson, D. White and B. Biewald, "RPM 2006: Windfall Profits for Existing Base Load Units in PJM: An Update of Two Case Studies" Synapse Energy report prepared on behalf of Pennsylvania Office of Consumer Advocate and the Illinois Citizens Utility Board, February, 2006.

Hausman, E.D., K. Takahashi, and B. Biewald, "The Glebe Mountain Wind Energy Project: Assessment of Project Benefits for Vermont and the New England Region" Report prepared on behalf of Glebe Mountain Wind Energy, LLC., February, 2006.

Hausman, E.D., K. Takahashi, and B. Biewald, "The Deerfield Wind Project: Assessment of the Need for Power and the Economic and Environmental Attributes of the Project" Report prepared on behalf of Deerfield Wind, LLC., January, 2006.

Hausman, E.D., P. Peterson, D. White and B. Biewald, "An RPM Case Study: Higher Costs for Consumers, Windfall Profits for Exelon" Synapse Energy report to the Illinois Citizens Utility Board, October, 2005.

Hausman, E.D. and G. Keith, "Calculating Displaced Emissions from Energy Efficiency and Renewable Energy Initiatives" Content for EPA website, 2005 (in prep.)

Rudkevich, A., E.D. Hausman, R.D. Tabors, J. Bagnal and C Kopel, "Loss Hedging Rights: A Final Piece in the LMP Puzzle" *Hawaii International Conference on System Sciences, Hawaii,* January, 2005 *(accepted).*

Hausman, E.D. and R.D. Tabors, "The Role of Demand Underscheduling in the California Energy Crisis" *Hawaii International Conference on System Sciences, Hawaii,* January, 2004.

Hausman, E.D. and M.B. McElroy, The reorganization of the global carbon cycle at the last glacial termination, *Global Biogeochemical Cycles, 13*(2), 371-381, 1999.

Norton, F.L., E.D. Hausman and M.B. McElroy, "Hydrospheric transports, the oxygen isotope record, and tropical sea surface temperatures during the last glacial maximum" *Paleoceanography, 12,* 15-22, 1997.

Hausman, E.D. and M.B. McElroy, "Variations in the oceanic carbon cycle over glacial transitions: a time-dependent box model simulation" presented at the spring meeting of the American Geophysical Union, San Francisco, 1996.

PRESENTATIONS AND WORKSHOPS

***NASUCA 2007 Mid-Year Meeting*:** Invited speaker on the topic, "Protecting Consumers in a Warming World" June 2007.

ASHRAE Workshop on estimating greenhouse gas emissions from buildings in the design phase: Participant expert on estimating displaced emissions associated with energy efficiency in building design. Also hired by ASHRAE to document and produce a report on the workshop. April, 2007.

Center for Climate Strategies: Facilitator and expert analyst on state-level policy options for mitigating greenhouse gas emissions. Serve as facilitator/expert for the Electricity Supply (ES) and Residential, Commercial and Industrial (RCI) Policy Working Groups in the states of Colorado and South Carolina (ongoing).

Assessing Restructured Electricity Markets An American Public Power Association Symposium: Invited speaker on the history and effectiveness of Locational Marginal Pricing (LMP) in northeastern United States electricity markets, February, 2007.

ASPO-USA 2006 National Conference: Invited speaker and panelist on the future role of LNG in the U.S. natural gas market, October, 2006.

Market Design Working Group: Participant in FERC-sponsored settlement process for designing capacity market structure for PJM on behalf of coalition of state utility consumer advocates, July-August 2006.

***NASUCA 2006 Mid-Year Meeting*:** Invited speaker on the topic, "How Can Consumer Advocates Deal with Soaring Energy Prices?" June 2006.

Soundwaters Forum, Stamford, CT: Participated in a debate on the need for proposed Broadwater LNG terminal in Long Island Sound, June 2006.

Energy Modeling Forum: Participant in coordinated academic exercise focused on modeling US and world natural gas markets, December 2004.

Massachusetts Institute of Technology (MIT): Guest lecturer in Technology and Policy Program on electricity market structure, the LMP pricing system and risk hedging with FTRs. 2002-2005.

LMP: The Ultimate Hands-On Seminar. Two-day seminar held at various sites to explore concepts of LMP pricing and congestion risk hedging, including lecture and market simulation exercises. Custom seminars held for FERC staff, ERCOT staff, and various industry groups. 2003-2004.

Learning to Live with Locational Marginal Pricing: Fundamentals and Hands-On Simulation. Day-long seminar including on-line mock electricity market and congestion rights auction, December 2002.

LMP in California. Series of seminars on the introduction of LMP in the California electricity market, including on-line market simulation exercise. 2002.