Prepared Testimony of
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Hearing on Climate Change: Examining the Processes Used to Create Science and Policy
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Mr. Chairman and Members of the Committee:

I am honored by your invitation to testify today. I am an economist by profession and training and am at this moment an independent consultant. I will start with a brief word about my qualifications. My work for the past 20 years has concentrated on economic issues in climate policy. I have published many papers in peer-reviewed journals dealing with design and economic impacts of climate policies, and I was honored by the Association of Environmental and Resource Economists with their 2004 award for a "publication of enduring quality" for my pioneering work on emission trading. I taught environmental economics at the California Institute of Technology and economic theory at Caltech and Stanford University. I was a Principal Lead Author of the IPCC Second Assessment Report's chapter that dealt with the costs of climate change policy and until recently I led the group at Charles River Associates that developed a pioneering set of economic models and used them in studies of virtually every major proposal for national and global climate policy. My testimony today will address the Committee's concerns about the economic analysis of climate policy. Needless to say, these are my own opinions.

I. Summary

Climate change is a global phenomenon driven by global emissions. Concentrations of greenhouse gases in the atmosphere are what matter, not emissions in a single year, and these concentrations change very slowly. Stabilizing global temperatures at any level requires ultimately reducing carbon dioxide emissions from energy use to near zero. To avoid unnecessary economic harm, policies must involve comparable efforts by all countries, mandates for emission reductions must not get out ahead of technology readiness, and effective R&D policy is essential.

Reducing greenhouse gas (GHG) emissions will have a cost. All the comprehensive economic models used to study past proposals have agreed on this point. Model results do differ about the size of these costs, but the differences stem from the models' varied assumptions about future technology and the effectiveness of a global emission trading system. All models also find that the deeper are the emission cuts, the higher is the cost of making them. Some recent studies that make claims to the contrary have recently garnered undue public attention, but the fact remains that regulatory or cap and trade policies will not lead to a net increase in U.S. jobs, nor will they create conditions for a U.S. clean energy industry able to compete more effectively in global markets.

Studies that purport to show that GHG controls will produce these outcomes make a number of common errors. To be sure, if fears about climate change are correct, curbs on GHG emissions will have some benefit. But the harm to the U.S. that can be avoided directly by U.S. action is often greatly exaggerated. Most of the damage from climate change will occur in countries without adequate public health systems and with poor, undernourished and unempowered populations. Four points are crucial to keep in mind. First, if the U.S. were to act without solid assurance of comparable efforts by China, India, and other industrialized countries, its efforts would make almost no difference to global temperature, especially if industrial production and associated emissions are simply exported to other countries. Second, even global action is unlikely to yield U.S. benefits commensurate with the costs it would incur in making steep GHG emission cuts. Third, globally, even with moderate emission reductions, benefits would not be much greater than costs, and, fourth, conflicting economic interests will make international agreements on mandatory limits unstable.

II. Climate economics is driven by three features of climate change

First, climate change is a global phenomenon driven by global emissions. A ton of carbon dioxide put in the air by China causes the same effects on Washington DC as a ton from a power plant in Alexandria. And China has already surpassed the U.S. as the largest emitter of carbon dioxide, and together with other rapidly developing countries will be responsible for the vast majority of emissions over the next century. Their growth is so rapid that even if the U.S. and all other industrial countries ceased all greenhouse gas emissions tomorrow, climate models would still predict global warming to continue unchecked, after a brief pause.

Second, concentrations of greenhouse gases in the atmosphere are what matter, not emissions in a single year, and these concentrations change very slowly. Emissions today are harmless to those in the vicinity of their sources, and matter only because of the consequences of their slow buildup that are predicted by climate models. Most of the carbon dioxide released today will still be in the atmosphere 50 years from now, so that the time scales on which climate policy must operate are very long.

Third, stabilizing global temperatures at any level requires reducing carbon dioxide emissions from energy use to near zero. The smaller the temperature increase society feels is tolerable, the more rapidly this must happen and the lower emissions must go. Achieving near-zero emissions is not possible with today's technology; it requires R&D for and deployment of technologies not known today in every aspect of energy production and use.[1]

These three points have very important implications for the costs and benefits of U.S. climate policy:

1. Reductions in U.S. greenhouse gas emissions, taken by themselves, will not noticeably lessen the impacts of climate change on the United States. The Energy Information Administration projects that the U.S. will contribute about 20% of cumulative global emissions by 2035.[2] But even if the U.S. were to succeed in reducing its emissions to 75% of 2007 levels by 2035, that would make only a 3% difference in cumulative global emissions between now and 2035 and have virtually no effect on temperature increases. The Kerry-Boxer bill that was rejected in the last Congress set the ambitious goals of lowering U.S. emissions to 20% below 2007 levels by 2020 and 50% below by 2035.[3] Even these ambitious targets would lead to only about a 7% reduction in cumulative global emissions over that time period. It is no surprise then that the EPA Administrator herself has admitted that EPA's proposed GHG rule will make virtually no difference to global emissions or impacts on the U.S. Action by the United States cannot possibly be in U.S national interest unless it is part of a larger bargain in which all other major emitters make similar efforts.

2. Achieving reductions in emissions at minimum cost requires Where, When and How

[1] Martin I. Hoffert, , Ken Caldeira, Gregory Benford, David R. Criswell, Christopher Green, Howard Herzog, Atul K. Jain, Haroon S. Kheshgi, Klaus S. Lackner, John S. Lewis, H. Douglas Lightfoot, Wallace Manheimer, John C. Mankins, Michael E. Mauel, L. John Perkins, Michael E. Schlesinger, Tyler Volk, and Tom M. L. Wigley (2002). "Advanced Technology Paths to Global Climate Stability: Energy for a Greenhouse Planet," *Science*, 298(5595): 981-987.
[2] EIA, International Energy Outlook 2010, May 2010, Table A10.
[3] http://www.nicholas.duke.edu/thegreengrok/waxmanmarkey-vs-kerryboxer

flexibility. **Where** flexibility means that on a global and regional scale, emission reductions must occur where they cost least. A system in which the United States adopts costly reductions and China does nothing, in addition to being insufficient to prevent the projected rise in temperature, is an excessively costly way of achieving whatever reductions do occur. **When** flexibility means that targets for reducing emissions must not get ahead of the availability of cost-effective technologies for achieving them. **How** flexibility means that all sources of emissions must be included so that all the lower cost opportunities to reduce emissions are used before more costly ones.

3. Achieving near-zero emissions will require a much more effective program of incentives for R&D into low carbon energy sources and energy efficiency technologies than has ever been seen in U.S. energy R&D. I convened a group of the most distinguished scholars who have studied the economics of R&D at Stanford two years ago. They produced a set of recommendations for R&D policy that would focus government funding on a much more risky program of basic and applied research and leave most development and all demonstration and deployment to the private sector: it would use stable and credible incentives to stimulate private investment in development, demonstration and deployment. It would also avoid any direct funding of the white elephant demonstration projects that led to failure of many past energy R&D activities.[4] This would require the Department of Energy to concentrate its funding on high-risk early-stage R&D and require Congress to eschew the earmarking and micromanagement that has produced so little result for so much wasted money on energy technology

[4] Arrow, Kenneth J., Linda R. Cohen, Paul A. David, Robert W. Hahn, Charles D. Kolstad, Lee L. Lane, W. David Montgomery, Richard R. Nelson, Roger G. Noll, Anne E. Smith (2008). "A Statement on the Appropriate Role for Research and Development in Climate Policy," *The Economists' Voice*, 6(1): Article 6.

development and deployment of costly and immature technologies

III.Common errors that lead to job benefits and deny the existence of costs

I would like now to discuss a number of areas where I believe that there are serious problems with studies of the economic costs and benefits of climate policy. I start with the most questionable studies. These conclude that, by mandating the premature retirement of electric generators and increasing the cost of automobiles and most other goods and services climate policy would create massive numbers of new jobs and stimulate economic growth. I take as an example a series of studies by the Political Economy Research Institute on job benefits of climate policy and other environmental regulations. The most recent of these was based on studies funded by Exelon Corporation and released last month by the Center for American Progress and Ceres.

Telling only half the story about jobs

The PERI study and its like only reach their happy conclusions about economic benefits because they leave out of their calculations all the jobs lost in the rest of the economy because of environmental regulations and the costs they impose. In its calculations of the net jobs created by Clean Air Act regulations that would force retirement of a large number of coal-fired powerplants, PERI did not even include the loss in coal mining jobs that would be caused by lower coal demand. And it completely ignored all the jobs affected in the rest of the economy by higher energy costs and loss in competitive advantage of U.S. industries.

Green jobs studies can make these errors because they do not use a model of the U.S. economy – they simply uses numbers called multipliers that add to the direct jobs involved in producing pollution control and generating equipment an estimate of jobs supplying materials used in that production. If PERI used any comprehensive model of the U.S. economy, it would be forced to account for where the mandatory spending on compliance with carbon limits and other environmental regulations came from..

In previous testimony I described how I used CRA's model of the electric power sector (that supplied the estimates of investment in generation used by PERI), but linked it to CRA's broad model of the entire economy, I found exactly the opposite results from PERI. PERI calculated an increase of 1.5 million jobs from EPA's utility regulations but it ignored what happened to investment outside power generation. EPA's regulations would reduce, not increase, total macroeconomic investment, by increasing the cost burden on new investment. The reduction in investment would be about $150 billion from 2010 – 2015. If these numbers were used with PERI's multipliers the result would be net destruction of over 1 million jobs. I am not espousing either +1.5 million or -1 million jobs as a useful number, my point is that people would have had jobs doing something else if these regulations were not put in place, and it would be doing something that creates more wealth.

Even PERI's calculations of jobs directly associated with compliance are exaggerated because they assume that 100% of the required new equipment will be manufactured in the United States. As I discuss later, there is clear evidence that this is not happening.

The Luddite approach to industrial policy

Studies like PERI explicitly recommend climate and other environmental regulations because they would favor industries that employ more employees per dollar of output and would direct investment away from industries that employ less workers per unit of output. This is nothing more than the Luddite program to save jobs by breaking up productivity-enhancing machines.

More output per worker is the major indicator of technical progress and increasing productivity in the economy. Increasing labor productivity through capital investment and technology improvement is what drives economic growth and undergirds our standard of living. The overall effect of restructuring the economy toward labor intensive industries and processes can only be to lower output per worker and to lower average wages.

Indeed, the logic of the PERI report implies that the greater the unproductive investment caused by a regulation, the greater its beneficial impact on jobs. If that logic were really valid, rather than seeking cost effective regulation we should seek out the highest cost way to achieve environmental goals. The result is absurd because the 'logic' upon which it is based is nonsense.

Believing there is a free lunch in energy efficiency and green energy

There is a long tradition of "bottom-up" studies that do not examine macroeconomic effects or market responses, but conclude based on simple engineering models that greater investment in energy efficiency would produce direct monetary savings in excess of their costs. My experience with these studies goes back to the early 90s when a series of studies by the ACEEE, UCS and OTA produced analysis and conclusions virtually identical to the "McKinsey Curve" that has become so popular in recent years. Despite a series of detailed criticisms by economists, these conclusions are repeated over and over again.[5]

All the studies contradict the basic principle that 'there is no free lunch' unless specific market failures or government interventions distort the incentives that are conveyed by market prices. Unless these market or government failures exist, the free lunch conclusions imply that households and businesses are consistently mistaken in a major way in making choices about

[5] Adam B. Jaffe and R. N. Stavins. "Energy-Efficiency Investments and Public-Policy." The Energy Journal 15. 2 (1994): 43-65. Mark Jaccard and W. David Montgomery "Costs of Reducing Greenhouse Gas Emissions in the USA and Canada." In Energy Policy, Vol. 24, No. 10. pp. 889–898. October/November 1996.

energy use that it is in their own economic interest to get right. And the policy conclusion that energy efficiency standards, technology mandates, or subsidies are the remedy implies that government agencies could do a better job of making those decisions for them.

This has come to be known as the "conservation paradox:" simple engineering studies find that certain energy conservation practices and technologies should on balance save money while observations of actual behavior show that those practices and technologies are not adopted. The technologists' answer is that people are in general wrong or some hidden and unspecified market failure must exist. The economists' answer has been that the engineering studies are missing hidden costs, barriers, or other consequences of adopting more energy efficient vehicles, appliances, structures, and equipment that matter to people.

Considerable research remains to be done on the conservation paradox. Stanford's Energy Modeling Forum is conducting a workshop in which leading bottom up and top down models, including that which I developed at CRA, are participating. An institute at Stanford University headed by Professor James Sweeney is conducting behavioral research. Perhaps the most comprehensive work has been done by my co-author in the IPCC Mark Jaccard at Simon Fraser University in Canada, who finds that upon closer examination the claims of net cost energy savings are almost universally false.

Any claim that a regulation or standard will on balance save money should be regarded with a high degree of skepticism unless accompanied by a well researched and peer reviewed demonstration that the specific action will cure a market failure, and do so without administrative costs great enough to wipe out the gains. As EPA and Congress move more and more into regulating greenhouse gas emissions through traditional command and control regulations and technology mandates and subsidies, this becomes a critical element of sensible policymaking. And the gutting of the agencies that provided critical review of regulatory analysis, such as the OIRA at OMB and OPA at EPA, has just about eliminated that review in the Executive Branch.[6]

Claiming that climate policy will promote a new clean energy industry in the U.S.

Costly greenhouse gas regulations are not likely to create industries producing clean energy equipment for export or domestic use. The experience of the past decade has proven that environmental standards or clean energy mandates will not create industries in the United States that will export clean technology to the rest of the world. To the contrary, the cost of such mandates is borne where they are imposed, but the equipment may well be produced by workers in other countries. For instance, in 2008 U.S. wind turbine imports were $2.5 billion and exports were $22 million; less than half the wind turbines installed in the U.S. in 2007 were manufactured by U.S. companies.[7] China is becoming the world's largest manufacturer of wind equipment,[8] and exporting that technology to the U.S. U.S. solar manufacturers, including some of the technologically advanced, are moving to China to manufacture the solar arrays.[9] German experience has been similar; its huge subsidies for wind energy largely drew electric power from Denmark where the generation capacity had already been installed. And now Vestas (Denmark's largest wind producer) recently closed all or most of its Danish manufacturing, despite the large EU demand for such technologies.

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[6] Randall Lutter and Richard Belzer, EPA Pats Itself on the Back, Regulation Vol 23, No. 3.

[7] USITC, Wind Turbines: Industry and Trade Summary, Office of Industries, Publication ITS-02.

[8] "With their government-bestowed blessings, Chinese companies have flourished and now control almost half of the $45 billion global market for wind turbines. The biggest of those players are now taking aim at foreign markets, particularly the United States, where General Electric has long been the leader." Keith Bradsher, New York Times, Dec 14, 2010.

[9] Edward L. Glaeser: Why Green Energy Can't Power a Job Engine - NYTimes.com http://economix.blogs.nytimes.com/2011/01/18/why-green-energy-cant-power-a-job-engine/?ref=business

Economic theory and the experience in Europe and the United States with renewable energy policies show the effect is the opposite of stimulus to clean technology industries. Clean energy equipment will be produced where it is least costly to do so, and domestic policies that raise energy costs can shift that comparative advantage against the U.S. Regulations create a demand in the U.S. for that equipment, but leave it open to all to supply that equipment. At the same time, environmental regulations increase the cost of doing business in the U.S. relative to other countries. Thus domestic manufacturers of mandated equipment and its components are put at a cost disadvantage relative to competitors located in countries that do not incur the cost of regulation. The result is to shift the supply chain for pollution control and electric generation equipment offshore toward less regulated regions where companies are better able to compete in producing components for powerplants and pollution controls. The result is that regulation increases demand for pollution control equipment but reduces domestic supply.

Even if the goal of industrial policy were accepted, mandatory reductions on greenhouse gas emissions are the wrong way to go about it. A study by economist Michael Spence that was discussed in the *Washington Post*[10] confirms this point. Spence points out that what he calls the tradable sector – which includes manufacturing – has grown in output but not jobs, while the nontradable sector – principally government and health care – has provided the job growth. He then addresses the challenge of how to create U.S. job growth in the tradable sector – which means policies that improve the productivity of U.S. workers so that growth in output is not accompanied by increased outsourcing. Modeling of greenhouse gas regulations that I will discuss later shows that they increase costs and lower worker productivity, thus leaving U.S. workers even more vulnerable to competition from cheaper foreign suppliers. This is not to say

[10] Steven Pearlstein, Good for gdp not good for workers, Washington Post, March 13, 2001, G-1.

that climate policy should be abandoned, but it does imply that it must be designed carefully and sparingly because it does make the task of spurring job growth and income equality more difficult.

IV. Common errors in discussing climate benefits or avoided damages

The most fundamental error is failing to admit how little is known about the direct causes of damage to human and economic systems that have been attributed to climate change. Climate models predict various geophysical consequences of increasing greenhouse gas emissions – change in global average temperature is the fundamental outcome of interest. Different models produce increasingly inconsistent results when they attempt to predict the regional distribution of temperatures or of other climatic variables such as rainfall. In order to predict effects on agriculture, the range of disease vectors, or other land related effects an even finer scale on which the models produce nothing of value is required, as are many other assumptions about levels of institutional development, public health systems, and on and on. [11] Some changes may be beneficial, such as increased growing seasons and carbon dioxide fertilization in high latitudes, and some are negative, such as drought or storms in tropical areas. But the range of possibilities and whether it adds up to a positive or a negative in any particular region is impossible to predict with confidence. Therefore, any economic evaluation of damages is equally uncertain.

Another, and more intentional distortion, is describing total effects of climate change rather than

[11] See paper by Robert Mendelsohn on impacts of climate change on land-based activities and comment by David Montgomery in forthcoming book published by the Lincoln Land Institute.

damages avoided by actions under consideration. Many times the argument for action starts by describing all the potential damaging consequences of temperature increases above today's level and the costs they would impose, and then uses this image to support a particular action or proposed legislation that cannot avoid more than a fraction of that damage. In analyzing any particular policy the costs of that policy must be compared to the damage it avoids. It is shocking how rarely this fundamental economic principle is violated.

Benefits are also overstated by exaggerating fears of health effects and other damages to the U.S. based on what is only likely to happen in poor countries without adequate public health infrastructure and with populations vulnerable due to poverty and poor diet. Concern about greater prevalence of tropical disease in the United States is the most egregious example, when the U.S. public health system already eliminates that risk through vaccination and vector eradication. It is not because of temperature that malaria stops at the US-Mexican border.

There are a number of other more technical errors that lead to overestimation of damages. The first is ignoring how individuals and businesses will adapt to climate change in order to avoid harm. This error was labeled the "dumb farmer" approach in pioneering work by Robert Mendelsohn of Yale who showed the large reduction in damages when it is assumed that farmers adapt through changing farming practices rather than continuing with practices that are more vulnerable to changes in climate.

Another error is including avoided damages that occur in all the rest of the world in estimates of the social benefits of greenhouse gas reductions in the United States. This approach was adopted by the U.S. government in its guidance for calculating the social cost of carbon for use in cost-benefit within the U.S. government. It leads to choices that have significantly higher costs than the benefits they provide in the United States.

The final error that exaggerates distant benefits relative to near term costs is the use of low discount rates derived from ethical arguments rather than economically meaningful discount rates that represent economic costs of displacing more productive investments with less productive ones.

V. Common errors that lead to underestimating costs

A review of modeling studies of costs of climate regulations reveals four common errors that lead to underestimating costs.

The first I call hiding policy interventions in the baseline. This is particularly a problem because of the incremental approach we have taken to adopting a climate policy. Fuel economy and renewable fuel standards were adopted in ACES. Subsidies for renewable technologies were expanded in the stimulus package. Fuel economy standards have been tightened again under the Obama administration. Each time this happened, the EIA included the new regulations in its reference case and lowered its emission forecast. This means that each time it analyzed the cost of a cap on greenhouse gas emissions – even when it had exactly the same provisions as a previous year's proposal – its costs came down. The prior regulatory programs hidden in the baseline appeared to be providing emission reductions at no cost. It is only by stripping out all explicit climate measures from the baseline – even those put in place in the past – that it is possible to calculate the full cost of committing to mandatory limits on greenhouse gas emissions.

A second common practice is assuming more efficient policies than are actually under consideration. This occurred in the Clinton Administration when the official estimate of the cost of the Kyoto Protocol assumed that all countries would participate in unrestricted emission trading, when under the actual provisions of the Protocol only industrial countries would do so. I observed the same thing in estimates in the cost of the Lieberman-Warner bill, when some of EPA's estimates assumed levels of availability of offsets that were not possible under the provisions of the law, and when estimates by other groups were based on earlier, less stringent legislative proposals. It is necessary to make sure that cost estimates are actually representing the policies on which a decision is to be made. This is going to be a major problem in evaluating EPA's proposed greenhouse gas regulations, because many models are incapable of incorporating the intricacies of those regulations and will simplify them to be no different from a carbon tax or cap and trade program.

This leads to a gross underestimate of the full cost of command and control regulations. The reason in simple terms why command and control regulations cost more than cap and trade is that they are designed by bureaucrats who know next to nothing about the circumstances of individual businesses. Therefore, their orders cannot possibly lead to the same cost-effective solutions that managers would find for their own businesses when facing a price on greenhouse gas emissions. Likewise, no model can incorporate sufficient detail to capture all the costs imposed by imposing uniform mandates or standards on a highly diverse population of households and businesses.

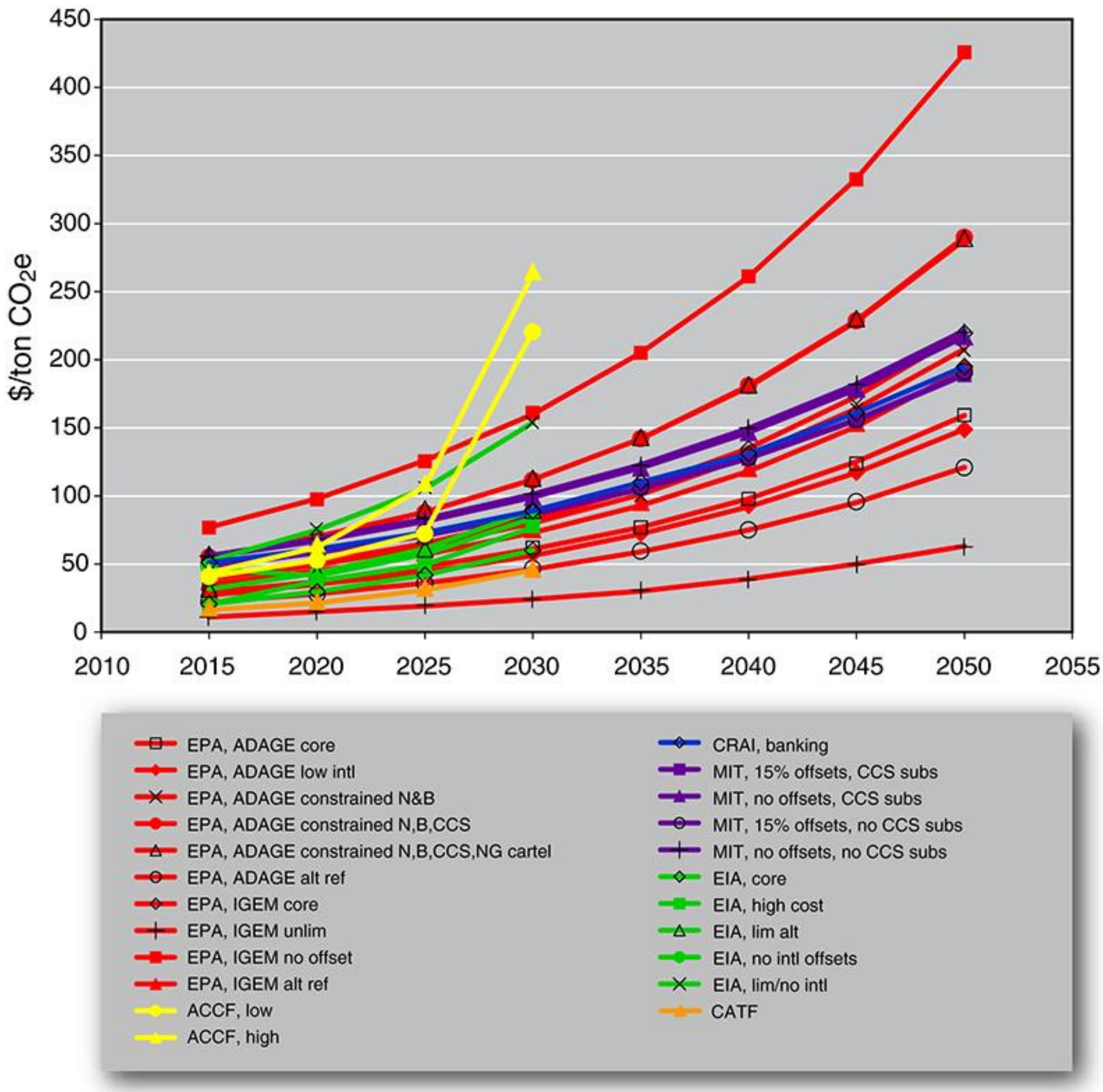
Costs are also underestimated in models that assume unproven "learning curves" for all green technologies (and no others). EPA's recent "Prospective" cost-benefit of Clean Air Act regulations is a case in point. A substantial economics literature has arisen questioning whether the empirical observation that costs of some complex processes or equipment (semiconductors, airframes, for example) to decline as cumulative output increases indicates a causal connection that could be attributed to "learning." Several alternative explanations are equally compelling and have more support in case studies of actual R&D processes. These include the hypothesis that cost reduction comes from a combination of R&D to create new and less costly processes, followed by a limited period of learning; the likelihood that learning is specific to the worker, company or establishment and not able to be transferred to an entire industry, and the fundamental problem that costs may be falling because of general technology improvement over time that cannot be accelerated by producing the item more quickly.[12] Yet many studies of the cost of climate policies assume aggressive "learning curves."

Finally, some studies that reach only a single optimistic conclusion have failed to recognize adequately the uncertainty of future technologies. For example, the low costs found in some studies by the EIA are based on a highly questionable premise of the growth of nuclear generation.

VI. Findings of studies based on broadly accepted models and economic principles

Before turning to global issues, I would like to present some findings from broadly accepted models that have been used to estimate the costs of climate legislation in the United States. I will base these observations on presentations made at workshop held by the Electric Power Research Institute in May 2007 to which authors of all extant studies of the then-pending Lieberman-Warner bill were invited. This included the Energy Information Administration (EIA), the Environmental Protection Agency (EPA), the Congressional Budget Office (CBO), the Massachusetts Institute of Technology (MIT), Charles River Associates (CRA), the American Council for Capital Formation (ACCF) and the Clean Air Task Force (CATF)

[12] William D. Nordhaus, The Perils of the Learning Model For Modeling Endogenous Technological Change. Yale University December 15, 2008



Source: Electric Power Research Institute, EPRI Modeling Workshop May 8, 2008

Although the graph that I have reproduced above[13] of costs per ton of emission reduction appears to show great diversity in estimates of impacts, all the models found that there would be costs to adopting emission controls, and the costs would become larger as deeper cuts are made in

[13] Tom Wilson, Understanding Model Estimates of the Economic Costs of Climate Policy EPRI Modeling Workshop May 8, 2008

emissions.

It is striking that the variation within a single model due to different assumptions is far greater than across the economic models. Looking at 2030, CRA and MIT fall in about the same place on the cost per ton of emission reductions, EPA spans all the results of other models save those from ACCF, and EIA's model NEMS which was used by EIA, ACCF, and CATF spans an even wider range than EPA.

Moreover, the Chair pointed out that "While there are important differences in the modeling approaches and models used, much of the variation in the cost estimates appears to be driven by a handful of key assumptions, several of which are highlighted here:

> Reference case
>
> Most modeling efforts rely on the Energy Information Administration's Annual Energy Outlook (AEO) to develop their reference case. In general, models that use an earlier projection of the baseline (AEO2006 or AEO2007) have to find more emission reductions to achieve the Lieberman-Warner targets and have higher costs - everything else equal - than those using the recent AEO2008 projection ...
>
> Technology Cost and Deployment
>
> In general, scenarios that limit the use of advanced, low and non-emitting electricity generation technologies result in higher costs; those that let them enter freely result in lower costs. Model results presented at this workshop show dramatic variations in renewable, coal with CCS and nuclear capacity additions ...
>
> Emission Offsets

In general, scenarios that allow for compliance using offsets (emission reductions that are made outside of an emissions cap) show a much lower cost than those scenarios without offsets. Most groups do not model offsets in detail, but rather make relatively crude assumptions about their cost and quantity. Several teams did not include any international offsets in their analyses based upon their interpretation of the bill.

Time Horizon

The EIA's NEMS model runs (used by several groups) extend through 2030, but most of the other models run through 2050. Different time horizons can affect compliance behavior (e.g. banking of extra credits), choice of technology deployments, and other aspects of model economics.

Discount Rates

The models use discount rates (which define the time preference for money) ranging from 4 to 7%. This affects the time period in which emissions reductions are viewed to be most attractive from an economic point of view, and leads to differences in total economic cost." [14]

VII. Common errors in dealing with global nature of climate change

I have concentrated on costs of climate policies in the U.S. to the U.S. Let me say a few words about estimates of global costs and benefits of climate policy. Studies that avoid the errors and biases that I have described generally conclude that globally the benefits and the costs of even

14 http://my.epri.com/portal/server.pt?open=512&objID=342&&PageID=223366&mode=2&in_hi_userid=2&cached=true

modest temperature goals would be of roughly of the same magnitude – if they could be achieved with perfect where, when and how flexibility.

But these studies are also overly optimistic, because they ignore two huge obstacles to achieving where, when and how flexibility:

- They ignore the institutional realities that are likely to prevent most countries from adopting the most cost-effective policies to reduce missions within their borders, and
- They ignore clear evidence that no global agreement on mandatory emission reductions is likely to be in the national interest of the countries that must participate for it to be effective.

Excessively costly national policies

Even national governments are complex institutions, and their workings can frustrate the adoption and enforcement of comprehensive emission limits or lead to the use of policies that are needlessly costly. There is good evidence that this will occur in the case of domestic GHG limits. In a recent study, a colleague and I used two examples, the United States and China, to illustrate how the systematic study of institutions and the political economy of choices can expand understanding of current policy choices and likely future progress in countries with very different kinds of political and economic institutions.[15] This analysis suggests several conclusions:

[15] Lee Lane and David Montgomery (2010), "Political Institutions and Greenhouse Gas Controls," AEI Center for Regulatory and Market Studies (Revised August 2010).

- There is a strong, systematic and comprehensible political logic that leads to choice of policies that differ widely from the economist's ideal of a single price on all greenhouse gas emissions
- In the United States, the most cost-effective approaches, a carbon tax and cap and trade, were respectively never on the agenda and defeated in Congress. Instead we appear to be embarking on a piecemeal approach of command and control regulation through the Clean Air Act and technology mandates and subsidies through legislation. This outcome was completely predictable given the history of comprehensive energy legislation and the nature of legislative institutions.
- In China it is likely to be difficult or impossible for the central government to enforce comprehensive and binding limits on greenhouse gas emissions; a related finding is that the outcome of China's adopting a comprehensive cap-and-trade policy is likely to be very different from that predicted by economic models that assume costless enforcement and efficient markets.

Impossibility of a single global commitment to mandatory reductions

Globally, the asymmetric distribution of costs and benefits implies that the national interests of even the most important states that must agree to a global climate regime are inconsistent with any agreement on mandatory emission limits. Most studies of the distribution of damages from climate change conclude that under the most likely scenarios the greatest harm will occur in poor countries located in tropical regions. The United States and Europe will suffer little direct harm in relation to the size of their economies, at least if sensible measures for adaptation are undertaken. Russia is very likely to benefit from warmer temperatures. Yet the distribution of present and future emissions is exactly the opposite. In other word, the countries that would have to undertake the largest emission reductions gain the least benefits. China and India are possible exceptions; they have very large emissions and are also threatened by great potential harm, at least in some regions.

This pattern of costs and benefits is not a formula for a successful agreement in which industrial countries make drastic emission reductions while also covering the cost of emission reductions and adaptation in poor countries. Only a willingness to incur high costs for the benefit of the poor countries of the world could motivate the U.S. to agree to such an outcome, and our current allocation of resources to aid gives no indication of such willingness. China and India might well find an agreement in their national interests, but both are hard bargainers and face their own institutional and political obstacles to carrying out meaningful reductions in emissions. Far from receiving compensation and adaptation assistance, poor countries would have to make payments to the rich in order to make an agreement be in the national interests of the wealthy countries of the world.

VIII. The net result

1. Even on a global scale, costs and avoided damages are quite similar

The global net benefits of even optimal GHG controls appear to be relatively modest. One recent estimate pegged their present discounted value at slightly more than $3 trillion over the next two hundred and fifty years.[16] Compared to the size of the global economy, this is not a very big

[16] William D. Nordhaus, A Question of Balance: Weighing the Options on Global Warming Policies, New Haven: Yale University Press, 2008.

number. Also, controls are certain to be far from optimal,[17] and costs could easily exceed benefits.[18] The rewards of an agreement on controls may, then, be offer only a weak incentive.

2. No global agreement to keep temperature increase to 2 deg C or less will be stable.

The most comprehensive formal analysis of the resulting outcomes that I have seen concludes that

> "Only coalitions including all large emitting regions are found to be technically able to meet a concentration stabilization target below 550 ppm CO_2eq by 2100. Once the free-riding incentives of non-participants are taken into account, only a "grand coalition" including virtually all regions can be successful. This grand coalition is profitable as a whole, implying that all countries can gain from participation provided appropriate transfers are made across them. However, neither the grand coalition nor smaller but still environmentally significant coalitions appear to be stable. This is because the collective welfare surplus from cooperation is not found to be large enough for transfers to offset the free-riding incentives of all countries simultaneously."[19]

[17] Lee Lane and David Montgomery (2008), "Political Institutions and Greenhouse Gas Controls," AEI Center for Regulatory and Market Studies.

[18] Richard S.J. Tol (2009), "An Analysis of Mitigation as a Response to Climate Change," Copenhagen Consensus on Climate.

[19] Valentina Bossetti, Carlo Carraro, Enrica De Cian, Romain Duval, Emanuele Massetti and Massimo Tavoni, "The Incentives To Participate In And The Stability Of International Climate Coalitions: A Game-Theoretic Approach Using The Witch Model, OECD Economics Department Working Papers No.702.