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THE USES AND LIMITS OF ECONOMIC MODELS AS A CLIMATE CHANGE POLICY TOOL:

A Summary Report

A workshop sponsored by

The Alliance to Save Energy

and

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I. Introduction

The Alliance to Save Energy initiated this workshop as a means of bringing climate change policy makers and economists together on the eve of the opening negotiating session for a climate change convention. The one and one-half day workshop was attended by 16 analysts who provided presentations on modeling approaches and 40 country delegates and other observers. The strong attendance attests to the need of policy makers to be better able to evaluate the growing literature estimating the potential cost of policy options. Our hope is that this report, to be presented at the conclusion of the negotiations on the framework convention on climate change at the Earth Summit in Brazil, will help policy makers in the U.S. and elsewhere evaluate the costs and benefits of national climate change mitigation policies.

Although it is still unclear how far the convention will go in requiring emissions reductions, many countries are proceeding with detailed plans to reduce domestic carbon dioxide (CO_2)emissions. Our goal in holding the workshop and writing this report is to spark a new level of dialogue between the producers and users of information on the costs and benefits of climate change mitigation policies leading to the development of more cost-effective policy solutions at the national and international levels.

Section II discusses the policy setting and summarizes the main themes and findings which emerged from the workshop discussions. Section III summarizes individual workshop presentations, with additional explanatory information where we hope it will help put the material in the context of the overall workshop. We have done our best to characterize each presentation as accurately as possible. The credit for all presentations summarized here should go to the individual authors; any errors or omissions in summarizing their work are our own. In Section IV we discuss the workshop presentations in terms of their implications for developing climate change mitigation policies.

II. Major Findings

Making Climate Change Policy Choices

Many scientists tell us that, absent efforts to control carbon dioxide and other greenhouse gas (GHG) emissions, the earth's climate will undergo continued warming. The impacts of these environmental changes can be direct -- in the form of lost environmental resources and amenities -- or indirect, through their impact on human activities. Changes in agricultural and fisheries productivity, loss of coastal real estate and the need for new or modified irrigation and water supply systems all affect economic well-being. The potential for a large portion of the earth's population to migrate in response to changing coastal and agricultural conditions imposes another possible source of welfare loss.

The dilemma for policy-makers is enormous. Acting now to reduce carbon dioxide and other greenhouse gas emissions means making substantial changes in the way energy is used, the type of energy used, and in agricultural practices and other aspects of the economy. Failing to begin action now means risking a build-up of GHG concentrations in the atmosphere that cannot be readily reversed, if at all. The problems associated with climate change differ from conventional pollutants in three important ways:

(1)The potential scale of damages are extremely uncertain and hotly disputed. Most analysts appear to believe that over the next several centuries at least the damages are not likely to be catastrophic, but none can rule out the possibility.

(2)Timely policy responses cannot be based on observed localized damages. With conventional air and water emissions, it is often possible to observe damages in one location over a relatively short period of time, craft policy responses designed to reduce those emissions to acceptable levels, and avoid increased emissions elsewhere. There is sufficient inertia in the determinants of the earth's climate, however, that the consequences of today's GHG emissions will not be observable for decades, or even a century to come. And once the damages are observed, it would take many additional decades to halt or reverse the underlying warming trend.

(3)The results are global. It is impossible to learn from our mistakes, and avoid repeating elsewhere, mistakes made in one part of the world as we have been able to do with conventional pollutants.

These future uncertainties must be weighed in some way against the more immediate economic and social benefits and costs of reducing greenhouse gas emissions. This is true whether or not one believes that dollar values can be attached to all or even most of the consequences of action or inaction. Indeed, even as models which estimate the economic costs and benefits of climate change policies improve, economic theory and inquiry will only be able to take us so far down the road of selecting appropriate policies. As one of our speakers, Dr. Jerome Rothenberg, pointed out at the conference, it will ultimately be left to policy makers themselves to supply values for many of the various environmental, social and intergenerational choices thrust upon us by the prospect of changes in the earth's climate. Economic theory and modeling can provide valuable guidance, but not the final answers.

Workshop Themes

All of the workshop sessions dealt with the use of economic modeling for the evaluation of climate change policies. The presentations addressed three main topics: how to compare the costs of benefits of policy options; how to quantify the economic costs of climate change policies; and how to apply economic modeling approaches to developing economies.

Estimating Climate Change Benefits

Costs and benefits can be the flip sides of the same coin when economists speak of the benefits from climate change mitigation costs associated with a changing climate.[1] Unfortunately, there are very few empirical estimates of climate change costs and much of the debate centers on how these damages might best be calculated for comparison with potential costs of mitigation policies. Three presenters addressed the difficulties of identifying the potential physical damages which might, of placing dollar values on these damages (especially damages not associated with market activities), and of calculating the impact of these costs on the economy as a whole. Two types of damages were distinguished: those which directly affect economic activity (and therefore changes in GNP) and those which affect human well-being directly through, for example, changes in environmental amenities.

Most of the discussion on climate change mitigation benefits centered on two essentially normative questions: how to weigh the risks of uncertain future outcomes and how to value the well-being of future generations. Economists cannot answer either of these questions, but economic analysis can help us translate the answers into cost-effective policies. Economists can tell policy members who wish to handle uncertainties in a risk-neutral way, current policy choices on the most likely or average expected outcome. If on the other hand policy members choose to treat uncertainties in a "risk-adverse" way they would base policy more on avoiding the most serious possible outcomes than on responding to the most likely outcome. Economists cannot decide whether a risk-neutral or risk-adverse strategy is better, only help guide the policy choices in that direction.

Because climate change occurs over a period of centuries, the relative weight given to future benefits is critical to determining whether the costs of mitigation to this generation are regarded as "worthwhile." If the costs incurred by this generation are all that matter, the benefits to future generations from avoiding climate change will not justify mitigation policies now. If, on the other hand, a dollar's worth of benefits to a future generation are considered equivalent to a dollar's worth of cost to this generation, mitigation is much more likely to be regarded as worthwhile. In the standard cost-benefit framework, the value of goods and services are discounted in a way which reduces their value slightly for each year of delay in their receipt. The problem is that even very small discount rates can reduce the estimated long-term benefits from mitigation policies essentially to zero, effectively excluding the welfare of future generations from consideration in making policy choices. Several solutions to the question of intergenerational equity were proposed and discussed, ranging from eliminating discounting altogether to using a stock-flow analysis of what each generation receives from the last and passes onto the future.

Estimating Costs

The greatest empirical effort so far has been devoted to estimating the costs of reducing GHG emissions. Despite this effort, estimates of the costs of reducing carbon emissions vary significantly -- from essentially no cost to a several percentage point loss of GNP. This range of estimates not only makes it difficult for policy makers to decide on how to proceed, but may even lead them to think that economic models do not bring useful information to bear on the problem of formulating policy responses. The workshop did not help to narrow the range of cost estimates, but it did indicate ways in which economic modeling can nonetheless provide valuable insights to policy makers.

Perhaps the dominant conclusion which emerged from the workshop is that regardless of the type of model employed, recommended emissions reductions are fairly similar, with energy efficiency improvements and fuel switching dominating short-run changes and the development of new renewable or nuclear power sources the most likely means of achieving

[1] There can be other benefits associated with reducing carbon emissions, such as reductions in local air pollutants. These benefits, however, are typically subtracted from the cost side of the cost-benefit equation rather than included in the benefit analysis.

longer run GHG reductions.[2] All modeling approaches indicate that cost-effectiveness is greatest when the broadest possible range of GHG emissions reduction opportunities are included in the control policy.

Finally, although modelers considered both market based policies such as carbon taxes and regulatory policies such as efficiency standards, both types of policies were structured to help ensure that the least-costly emissions reductions option are realized first. Aggregate macroeconomic models tend to rely on carbon or other taxes to induce emissions reductions. Such taxes encourage any changes in energy use throughout the economy which are less costly than paying the tax. More detailed energy-engineering models tend to be used to analyze regulatory policies, or policies geared towards particular energy sectors, such as the utility sector. In these models, least-cost reductions are provided for by establishing regulatory guidelines based on the cost-effectiveness of different reduction opportunities.

A large portion of the discussion centered on the varying definitions of "cost" used by economists and policy analysts alike. Differences in whether costs are reported in average, marginal, or total terms and whether the cost estimates reflect changes in the energy sector alone or in the economy overall create apparent differences in empirical conclusions. A study which reports a marginal cost of $100 a ton of CO_2 reductions, for instance, might be in full agreement with one which reports average costs on the order of $10 a ton; they have simply decided to report their results differently. Most of the presenters stressed the importance of using cost definitions that include the impact of the policy on the overall economy, rather than just changes in energy markets. Several presenters pointed out that gross national product (GNP) does not measure all of the changes in the overall level of welfare that might result from either climate changes or mitigations policies.

Even after we take account of different definitions of cost, real differences in model results remain. Two factors were identified by most of the presenters as the key to understanding these differences: the basic type of model used and estimates of the costs of future energy sources. Several presenters explained the differences between aggregate macroeconomic models (typically referred to as "top-down" models) and more detailed energy-engineering models (typically referred to as "bottom-up" models). The key advantage of the top-down or econometric approach is its ability to specify a relationship between energy prices and the demand for energy services. The key advantage of the bottom-up or technology-based approach is its ability to base energy requirements on specific opportunities for generating and using energy. The approaches differ most in their implicit view of how energy markets operate. The top-down approach assumes that energy markets generally work efficiently in identifying and exploiting cost-effective energy supply and efficiency opportunities at any given energy price without policy intervention. The bottom-up approach looks at what technologies are technically cost-effective at a given energy price and assumes that any gap between actual and cost-effective use evidence of those technologies results from market failure. In general, the bottom-up approach tends to provide lower cost estimates.

Recognizing that neither approach fully captures reality, several of the presenters stressed the need to incorporate the strengths of both approaches in evaluating climate change policy options. Some advocated side-by-side comparisons of results, or selection of a particular model based on the policy to be analyzed. Others looked for ways to integrate the two approaches into a single model framework.

The second source of differences concerns assumptions of when specific technologies will be available and what they will cost. Even the top-down models tend to have built into them base-case assumptions about the likely price of coal, oil, and natural gas use at different levels of demand, as well as assumptions about how much more costly it would be to replace these fossil fuels with renewable, nuclear, or efficiency options. The less expensive coal

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[2] Although not discussed directly at the workshop, CO_2 offsets such as reforestation, reduce net emissions and climate impacts as well.

(including liquid and gas synthetics) is expected to be in the future, the greater future carbon emissions will be, and the more effort will be required to keep emissions at or below current levels. Likewise, the more expensive non-fossil fuels are relative to fossil fuels, the more costly it will be to the economy to make such a transition. This is true even for those models which recognize the potential for substantial, low-cost efficiency improvements: even with such improvements, the choice of carbon vs. non-carbon fuel sources must be made. Research and development efforts were cited repeatedly by workshop participants as a means of significantly reducing the long-run costs of climate change policies.

Applying Economic Models to Developing Economies

One workshop panel was dedicated to consideration of how the economic modeling approaches described above might apply to developing economies. Developing countries are generally expected to account for a greater share of the world's carbon emissions as their economies grow more rapidly than those of industrialized countries.

Three basic requirements emerged as prerequisites to successful application of economic models to developing economies. First, the model should be able to reflect the significant market failures often found in developing economies such as missing infrastructure links or government policies which set energy prices at well below cost. Second, it should be flexible enough to account for potential development paths which differ significantly from historical development paths in the West. Finally, it should be able to reflect the synergism between emissions reductions efforts worldwide and the resources, including new technologies, available for emissions reductions in developing economies. Presenters found substantial opportunities for cost-effective emissions reductions in several of the countries they had studied, but could not gauge the potential for overcoming country-specific obstacles to exploiting those opportunities.

Finally, there was some discussion of whether limitations on financial resources might limit the potential for growth in energy use and, therefore, in carbon emissions. The extent to which economic growth can be based on increasing fossil fuel based electricity consumption is limited to the availability of capital to construct new power plants. Likewise, for all but oil-producing developing countries, the ability to base development on increasing use of petroleum depends on the availability of cash to import the oil. Given the general shortage of capital and borrowing capacity in developing countries, investments in lower cost energy efficiency improvements and renewable power for remote locations can look like the most promising path towards economic growth. Nonetheless, several presenters cautioned that the economic benefits of using energy more productively often run head-long into the equity and other social concerns which encouraged subsidization of energy prices in the first place. The irony is that additional financial resources are needed in the short run to realize the opportunities for efficiency improvements and renewable energy sources that have the potential to overcome capital constraints in the long term.

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