TESTIMONY AT THE HEARINGS ON U.S. CLIMATE CHANGE POLICY

Before the Committee on Energy & Natural Resources
United States Senate

EMF OP 45

John P. Weyant

September 17, 1996

Energy Modeling Forum
Terman Engineering Center
Stanford University
Stanford, California

Testimony of John P. Weyant
Professor of Engineering-Economic Systems
and Operations Research
Stanford University
Stanford, California 94305-4023

At the Hearings on U.S. Climate Change Policy
Before the Committee on Energy and Natural Resources
United States Senate
September 17, 1996

Thank you Mr. Chairman and good morning. My name is John Weyant and I am Professor of Engineering-Economic Systems and Operations Research at Stanford University and have been Director of the Stanford Energy Modeling Forum since 1985. It is an honor and a privilege to be appearing before this committee today and I very much appreciate this opportunity to report on some recent research on the costs of limiting carbon dioxide emissions that you may find of interest in your deliberations about climate change policy. During the past two years, I have been chairing a study by Stanford University's Energy Modeling Forum on "Integrated Assessment of Climate Change." One of the most significant elements of this study has been the work of a study group that has been examining the costs of emission reduction proposals for the post-2000 time frame. An initial report from that subgroup has been submitted with my testimony. In the next few minutes, I will attempt to summarize the major findings of that exercise.

While calling for new commitments on the part of developed countries to limit emissions, the Berlin Mandate does not specify what the commitments should be. Rather it seeks further analysis and assessment to guide and inform the decision making process. The Energy Modeling Forum subgroup addressed a key issue in the analysis and assessment phase -- the design of cost-effective mitigation strategies. The Framework Convention on Climate Change states that "policies and measures to deal with climate change should be cost-effective so as to insure global benefits at the lowest possible costs." Adopting least-cost mitigation strategies will free up valuable resources for further addressing the climate issue or for meeting other societal needs. In our study, we explored ways of promoting this objective. In particular, we focused on the importance of providing for flexibility both in the location and the timing of emission reductions. Let me stress at the outset that the question that we addressed is the question of "how best" to reduce emissions. This is very different from the question of "how much" to reduce emissions. To address the latter requires a careful balancing of the costs of climate change management proposals with what such proposals might buy in terms of reducing the undesirable consequences of global climate change.

The insights from our analysis can perhaps best be communicated by way of an example. Among the scenarios we examined was one that was similar in spirit to the proposal being put forward by the Alliance of Small Island States (AOSIS) and is explicitly included for consideration within the Berlin Mandate. In this scenario, we assume that OECD countries agree to reduce emissions by 20% below 1990 levels by 2010, and to hold them at that level thereafter. We first calculated the costs under the assumption that OECD countries would be required to act independently to meet the proposed targets and timetables. That is, that they would be unable to take advantage of low-cost emission reduction opportunities that may exist in other parts of the world. Rather than rely on a single model, the analysis was based on independent runs of four widely-used energy-economy models. The models were developed by researchers at MIT, Stanford, Pacific Northwest Laboratory and EPRI. The results from the four models are summarized in Figure 1 which is attached to the back of my testimony. Costs are added from today through 2050 and discounted to 1990 at 5% per year.

Because the models differed in terms of key inputs, for example, population, per capita productivity trends, the fossil-fuel resource base, etc., they differ in their cost projections. Nevertheless, they all suggest that the costs of adopting an AOSIS-like proposal will be substantial -- between two and eight trillion dollars.

Not surprisingly, OECD countries would be hardest hit. But the analysis also shows that non-OECD countries would likely incur costs as well, even though the reductions are confined to the OECD. This is because an economic slowdown in the OECD would affect the full range of developing country exports, and hence their economic growth.

We then examined ways that we might achieve the same amount of emission reduction but at a lower cost. In particular, we looked at the benefits of providing what we refer to as "where" and "when" flexibility. In the case of "where flexibility," emissions are reduced by the specified amount, but the reductions may be made where it is cheapest to do so regardless of their geographical location. For example, if emissions can be reduced cost-effectively through energy efficiency programs in developing countries, then these are included in the portfolio of emission reduction measures. In other words, the focus is on identifying the least-cost global solution for meeting each year's emissions targets.

In the case of "when flexibility," we look at the benefits from providing flexibility in the timing of emission reductions. Climate change and its associated impacts are directly related to atmospheric concentrations of carbon dioxide, not to year-by-year emissions. With regard to atmospheric carbon dioxide concentrations, the issue is not so much one of year-by-year emissions, but one of cumulative emissions. Because of the long lifetime of carbon dioxide in the atmosphere, carbon dioxide concentrations are determined by the total amount of carbon dioxide released over an extended period. Accordingly, we looked at a case where a limit was placed on cumulative emissions between now and 2050. This means that a country participating in the agreement could emit more in the early years if it were willing to emit less later on. Flexibility in timing has several distinct advantages. A problem with tight near-term targets is that they require premature retirement of energy-producing and energy-using capital stock, for example, power plants, houses, and autos. As a result they are likely to be particularly costly. One advantage of "when flexibility" is it provides more time for an economical turnover of the existing capital stock.

A second advantage is that it would provide more time to develop low-cost alternatives to carbon-intensive fuels. There has been substantial progress in lowering the costs of carbon-free substitutes (e.g., solar, biomass, energy efficiency) in the past. With a sustained commitment to R&D, there should be further cost reductions in the coming decades. It would make sense to rely more heavily on fossil fuels in the early years when the marginal costs of emissions abatement are highest. With cheaper alternatives in the future, there will be less need for reliance on carbon-intensive fuels.

Figure 2 summarizes the results of the analysis. The figure is based on the average of the model results. The left-most bar shows the case where OECD countries have no flexibility as to where and when the emission reductions must be made. This is by far the most expensive case. Allowing emissions to be reduced where it is cheapest to do so (the middle bar), cuts cost by nearly 70%. The most efficient strategy is one that provides for flexibility both in the location and the timing of emission reductions. Note that when we add "when flexibility" to "where flexibility" costs are halved again.

Figure 3 provides an alternative way to present our results. It shows OECD GDP losses over time averaged across the four models. In the absence of where and when flexibility, GDP losses grow to 2.4% over the next quarter century -- roughly $400 billion in today's economy. The analysis suggests that annual losses can be cut substantially through international cooperation and flexible timing.

It is important to note that whereas the three cases differ markedly in terms of mitigation costs, they are likely to be quite similar in terms of environmental impacts. The reason is that they lead to identical atmospheric concentrations of carbon dioxide in the year 2050 and the concentration paths lie very close together prior to 2050. As a result, the differential impacts on the climate system are likely to be quite small.

In summary, the analysis suggests that mitigation costs can be substantially reduced by providing for flexibility both in the location and timing of emission reductions. With the first, emission reductions are made where it is cheapest to do so. With the second, they take place when it is cheapest to do so. There are formidable obstacles to both strategies, but the potential benefits are huge. Indeed, our calculations suggest that the potential savings to the international community may be of the order of trillions of dollars in unnecessary mitigation costs.

Figure 1. Costs of 20% Cut in OECD Emissions by 2010 (costs through 2050 discounted to 1990 at 5%)

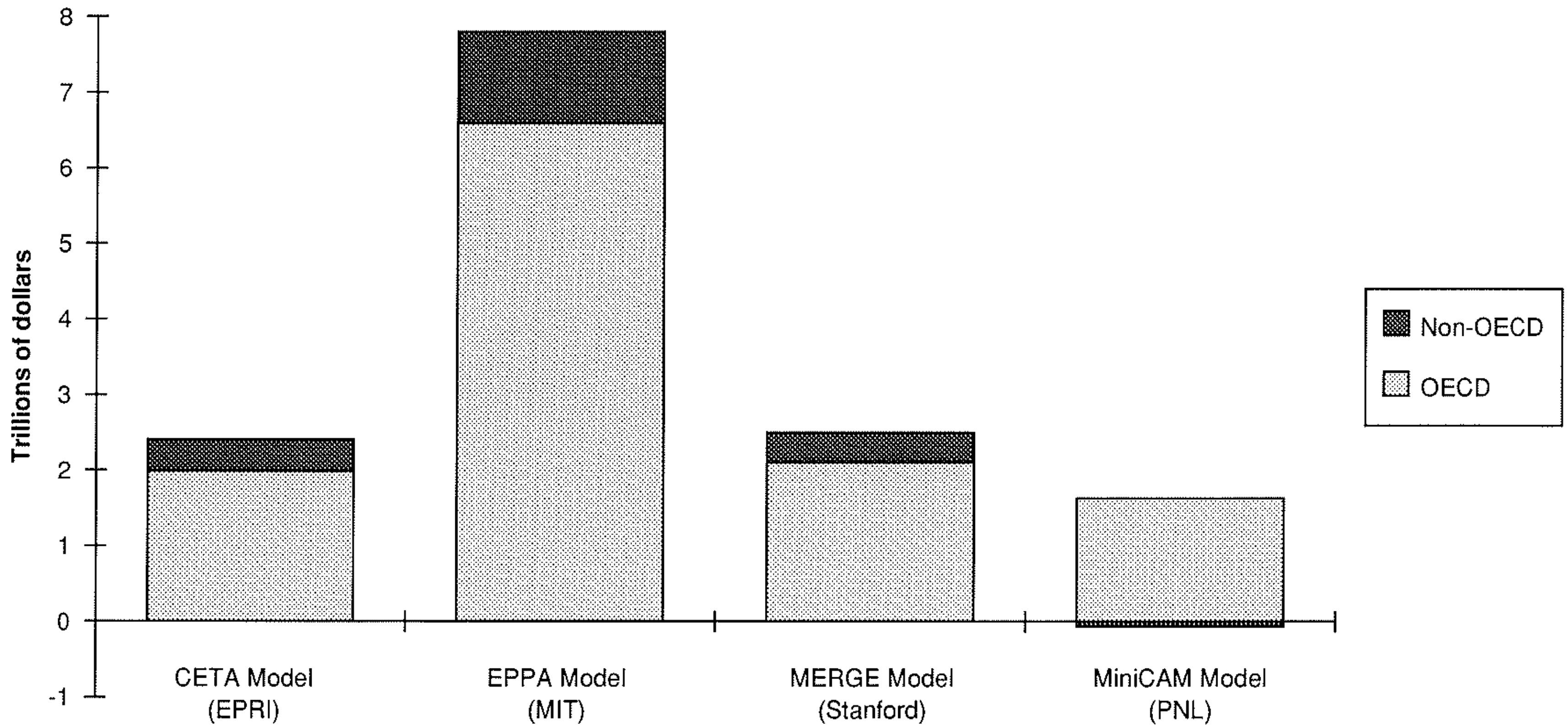

Figure 2. Cost Comparison under Alternative Assumptions about Economic Efficiency (based on average of model results)

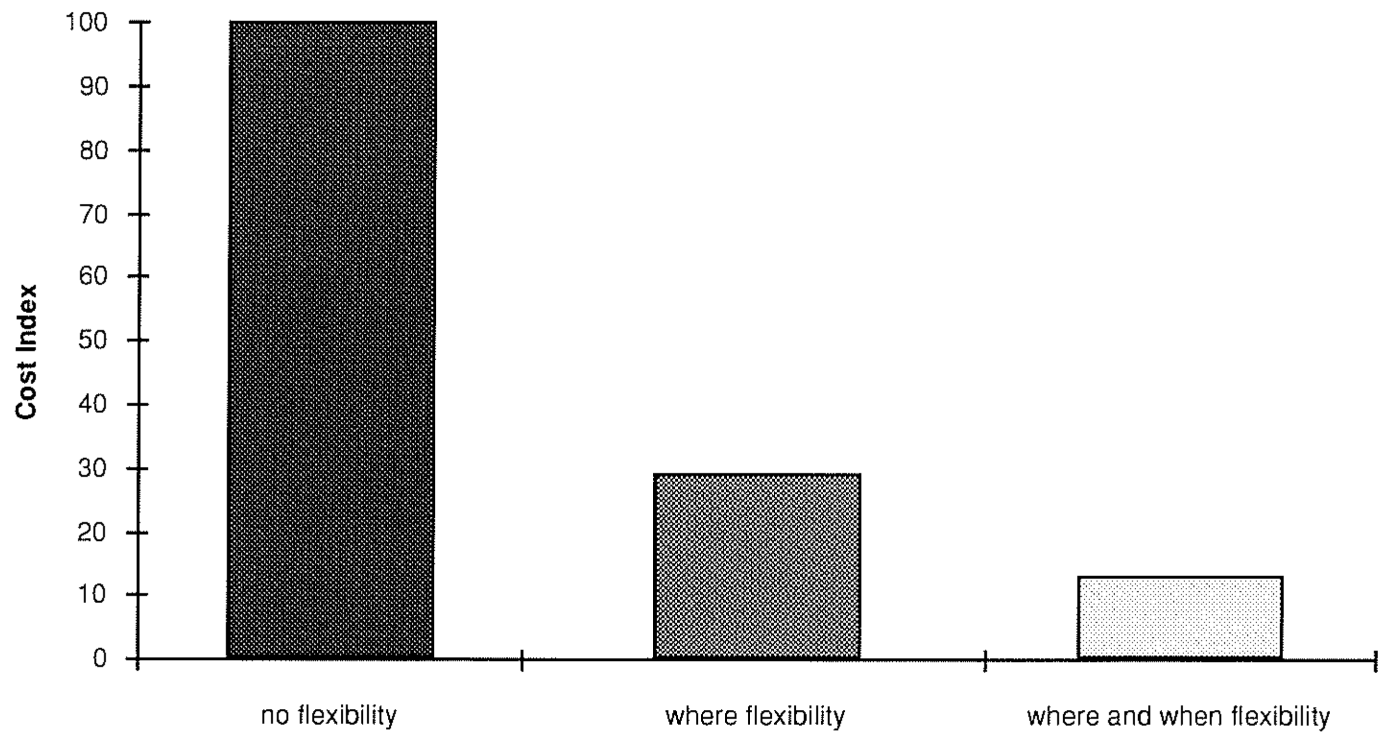

Figure 3. OECD GDP Losses under Alternate Assumptions about Economic Efficiency (based on average of model results)