

EXECUTIVE SUMMARY

The primary purpose of this analysis is to examine costs and benefits of taking action to mitigate the threat of global warming. In particular, we examine costs and benefits of complying with the emissions reduction target for the United States set forth in the Kyoto Protocol on Climate Change, negotiated in December 1997. For reasons discussed at length in this paper, it is our conclusion that, with the flexibility mechanisms included in the treaty, and by pursuing sound domestic policies, the United States can reach its Kyoto target at a relatively modest cost. Moreover, the benefits of mitigating climate change are likely to be substantial.

Before considering the economics of taking action, however, we ought to step back and ask the threshold question -- whether taking action to mitigate global climate change is necessary in the first place.

The Rationale for Taking Action

The great weight of scientific authority suggests that climate change is a serious problem and that prudent steps to mitigate it are in order. In essence, we need to take out an insurance policy with reasonably priced premiums. As long ago as 1992, the National Academy of Sciences, in a study entitled *Policy Implications of Greenhouse Warming*, concluded that "...even given the considerable uncertainties in our knowledge of the relevant phenomena, greenhouse warming poses a potential threat sufficient to merit prompt responses....Investment in mitigation measures acts as insurance protection against the great uncertainties and the possibility of dramatic surprises" (p. 68).

What the science tells us is that greenhouse gases are rapidly building up in the atmosphere as a result of the burning of fossil fuels and deforestation; that the concentration of these gases is 30 percent higher than it was at the beginning of the industrial revolution; and that this concentration is expected to reach almost twice current levels by 2100 -- a level not seen in 50 million years. Theory and computer models suggest that this increased concentration of greenhouse gases could warm the Earth by about 1.8 to 6.3° F by 2100. By way of comparison, the last ice age was only about 9° F colder than today. Moreover, much evidence suggests that warming is already underway. For example, we know from ice cores and other data that we are living in the hottest century since at least 1400, that the nine hottest years since records were first kept in the late 19th century have all occurred since 1987, and that 1997 is the hottest year on record.

Scientists predict a range of likely effects from global warming. For example, the rate of evaporation is expected to increase as the climate warms, leading to increasingly frequent and intense floods and droughts. Sea level is projected to rise 6-37 inches by 2100. A 20-inch rise could inundate about 7,000 square miles of U.S. territory. Warmer temperatures would be expected to increase the risk of mortality from heat stress, aggravate respiratory disease, and increase the range and rates of transmission of some infectious diseases.

Scientific opinion is not unanimous on these points, but most independent climate scientists believe that global climate change poses real risks. A few scientists contest the notion that increasing concentrations of greenhouse gases will warm the planet, while a few others concede that the earth is indeed getting warmer, but argue that this is a good thing -- "a wonderful...gift from the industrial revolution," in the words of one. But these are distinctly minority views. The prevailing view is that the risks of climate change warrant prudent and prompt action. Prompt because to wait for greater scientific certainty could have very large costs. Greenhouse gases are long-lived and the decisions being made by governments and firms in the next decade with respect, for example, to the kinds of power plants to build or the kinds of energy sources to develop, are likely to have significant consequences for our ability to limit the buildup of greenhouse gases.

Consequently, there is a substantial rationale for acting now. Our task is to act in a manner that responds appropriately to the scope of the risk while at the same time being economically sensible.

Domestic Policy

In October 1997, the President announced a domestic program designed to reduce greenhouse gas emissions. In essence, the program contemplated (a) a set of activities that made sense as good energy and environmental policy irrespective of whether an agreement were reached in Kyoto, and (b) a mandatory domestic emissions trading system that would take effect in the 2008-2012 period if an agreement in Kyoto were reached and approved by the U.S. Senate.

The Kyoto Protocol

The Kyoto Protocol, which requires the advice and consent of the Senate, commits industrialized nations to take on binding targets for greenhouse gas emissions, and includes three basic kinds of flexibility provisions that were proposed by the United States. These provisions -- commonly referred to as "when", "what", and "where" flexibility -- have great potential to significantly lower the costs of meeting the Kyoto

targets. “When” flexibility appears in the form of a multi-year commitment period (2008-2012), and allowance for “banking” of emissions reductions. The freedom for countries or companies to delay or accelerate reductions within an agreed upon time frame can help lower costs. “What” flexibility is provided by both the inclusion of all six greenhouse gases -- enabling reductions in emissions of one gas to be used to substitute for increases in emissions of another -- and the coverage of certain “sink” activities, such as afforestation or reforestation, that absorb carbon. Most important, the Protocol incorporates “where” flexibility in the form of international emissions trading and joint implementation among countries that take on binding targets, coupled with a “clean development mechanism” allowing industrial countries or firms to earn credits for projects in the developing world that reduce emissions. These mechanisms can provide opportunities for industrial countries and firms to secure low-cost reductions and for developing countries to achieve sustainable growth.

Developing countries did not take on binding emissions targets at Kyoto, although they did agree to provisions for the Clean Development Mechanism. The President has said that he will not submit the Protocol to the Senate without meaningful participation from key developing countries. While the Clean Development Mechanism provides a down payment on such participation, the Administration is actively seeking greater developing country engagement.

Costs and Benefits of Mitigation

Analyzing the costs and benefits of mitigating climate change is a difficult undertaking for three reasons. First, uncertainties remain about significant details of certain provisions in the Protocol. Second, available models have inherent limitations in their abilities to analyze even short-term costs and benefits. Third, it is extremely difficult to quantify the long-term economic benefits of climate change mitigation. Thus, while we have summarized the literature, we have not calculated a monetary value of these benefits.

Recognizing these difficulties, our conclusion is that the costs for the United States to meet its Kyoto emissions target are likely to be modest if those reductions are undertaken in an efficient manner employing the flexibility measures of emissions trading (both domestic and international), joint implementation, and the Clean Development Mechanism. This would be so even without considering the direct benefits of mitigating climate change or the impact that key additional factors -- such as the President’s domestic climate change proposals, the ancillary benefits of improved air quality, or the inclusion of sinks -- could have on lowering the net costs of mitigation.

Our conclusion concerning the costs of complying with the Kyoto Protocol is not entirely dependent upon, but is fully consistent with, formal model results. For example, given the flexibility measures noted above, with key developing countries participating in trading, and *excluding* both the benefits of mitigating climate change and the key additional factors just noted, estimates derived using Battelle's Second Generation Model (SGM) suggest that the resource costs of attaining the Kyoto targets for emission reductions might amount to \$7-12 billion per year in 2008 to 2012, or just 0.1 percent of projected GDP. The same model predicts that emission permits in 2010 would cost between \$14 and \$23 per ton of carbon equivalent -- which would translate into an increase of about 4 to 6¢ per gallon of gasoline. The increase in energy prices would raise the average household's energy bill in 2010 by between \$70 and \$110 per year -- a relatively small amount compared to typical energy price changes. Moreover, this increase would be substantially offset by the decline in electricity prices resulting from the Administration's electricity restructuring proposal.

These numbers are instructive. They demonstrate the importance of flexibility measures like emissions trading and the potential for meeting our Kyoto target at a relatively modest cost. However, it is just as important to understand what these numbers do *not* say. They do not tell us about either (a) the economic *benefits* of mitigating climate change or (b) the potential for any other domestic policy measures (aside from emissions trading) to reduce costs further and/or to increase the percentage of greenhouse gas reductions we can accomplish at home. The reason is that the SGM model we used to generate these numbers does *not*, by its terms, account for either of these factors.

Benefits of mitigating climate change. There are substantial long-term benefits of mitigating global climate change. Monetary estimates of damages from the environmental, health, and economic impacts of global warming during the next century range in the tens of billions of dollars per year. One noted economist, William Cline, has estimated that a doubling of pre-industrial concentrations of greenhouse gases would cost the U.S. economy about 1.1% of GDP annually -- some \$89 billion a year in today's terms. Moreover, these estimates do not reflect the potential costs of so-called "non-linearities" -- the risk that global warming will lead not to gradual and predictable problems, but to relatively abrupt, unforeseen, and potentially catastrophic consequences. Although we do not think the benefits of mitigating climate change are, at this stage, quantifiable with adequate precision, they are nonetheless likely to be real and large in the long run.

There are also ancillary benefits of reducing greenhouse gas emissions -- in particular, the corresponding reductions in conventional air pollutants like sulfur dioxide or nitrogen oxides. These benefits alone could produce savings equal to about a quarter of the costs of meeting our Kyoto target.

The impact of policies not included in illustrative analysis. Following on the President's October 1997 policy announcement, the Administration is pursuing a number of domestic initiatives that will help reduce greenhouse gas emissions. These initiatives -- all of which are consistent with our commitments under the 1992 Framework Convention on Climate Change, which the Senate approved that same year -- could reduce costs and/or increase the amount of reductions accomplished through domestic action. First, the Administration's \$6.3 billion budget proposal to promote energy efficiency and renewable energy should help increase the rate of technology development and diffusion. Many of the components of this initiative reflect recommendations made in an October 1997 report by the President's Committee of Advisors on Science and Technology (PCAST), which concluded that "the inadequacy of current energy R&D is especially acute in relation to the challenge of responding prudently and cost-effectively to the risk of global climatic change...." (PCAST 1997, p. i).

Second, the Administration's electricity restructuring proposal is estimated to reduce greenhouse gas emissions in the United States by about 25 to 40 million metric tons per year. Competition would provide a direct profit incentive for generators to produce more electricity with less fuel and improve energy efficiency. Several specific provisions in the Administration's proposal would yield further emissions reductions.

Third, the Administration is conducting industry consultations aimed at promoting voluntary agreements with major energy-intensive industries, energy providers, and others to yield further emissions reductions. One such agreement, the Partnership for Advancing Technology in Housing (PATH), announced in May, established goals for voluntary improvements in home energy use that would reduce emissions in 2010 by about 24 million metric tons of greenhouse gas emissions.

Fourth, the Administration is pursuing an active program to reduce emissions produced by the federal government, the nation's largest consumer of energy.

As noted above, models like SGM, while well equipped to assess policies such as a tradable permit program, do not assess policies like these. To the extent that policies like these boost the rate at which energy efficiency improves, the United States could lower the cost of mitigation and increase the amount of reductions made domestically.

Finally, our illustrative analysis, based on the SGM model, did not account for the effects of carbon sinks in reducing net greenhouse gas emissions. Opportunities to reduce net emissions through carbon sinks could further reduce the costs of achieving the Kyoto target and increase domestic reductions.

Conclusion

The current state of the science provides a powerful rationale to take prompt, prudent action to mitigate climate change. The agreement negotiated in Kyoto includes flexibility mechanisms that will allow the United States to meet its Kyoto target at a modest cost. Additional factors not included in the modeling effort -- such as the President's domestic climate change policies, the inclusion of sinks and the ancillary benefit of improving air quality -- could lower costs even further and increase the percentage of reductions made through domestic action. The benefits of mitigating long-term impacts of global climate change, while not precise enough to quantify at this stage, are likely to be very important. In short, this is an insurance policy we should buy and it is one we can buy for reasonably priced premiums.