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United States General Accounting Office
Washington, D.C. 20548

January 30, 2004

The Honorable Ernest F. Hollings
Ranking Minority Member
Committee on Commerce, Science
and Transportation
United States Senate

The Honorable John F. Kerry
Ranking Minority Member
Subcommittee on Oceans, Fisheries
and Coast Guard
Committee on Commerce, Science
and Transportation
United States Senate

Subject: *Climate Change: Analysis of Two Studies of Estimated Costs of Implementing the Kyoto Protocol*

In 1992 the United States ratified the United Nations Framework Convention on Climate Change, which was intended to stabilize the buildup of greenhouse gases in the earth's atmosphere but did not impose binding limits on emissions. In July 1997, when preliminary negotiations on a new climate agreement were under way, the Senate passed a resolution expressing the sense of the Senate that the Clinton administration should not agree to limits on U.S. greenhouse gas emissions if such an agreement did not include economically developing nations or if it could seriously harm the U.S. economy. In December 1997 the United States participated in drafting the Kyoto Protocol, an international agreement to specifically limit greenhouse gas emissions. The Protocol did not impose limits on developing nations' emissions, and its possible effect on the U.S. economy was the subject of numerous studies during that period, including the two studies that are the subject of this report. Although the U.S. government signed the Protocol in 1998, the Clinton administration did not submit it to the Senate for advice and consent, which are necessary for ratification. In March 2001, President Bush announced that he opposed the Protocol.

A participating nation's compliance with the Kyoto Protocol will be determined by first calculating its average emissions of the six covered gases—carbon dioxide, methane, nitrous oxide, and three synthetic gases[1]—for the 5-year period 2008 through 2012. Reductions can then be made for, among other things, the purchase of emissions reductions from certain other nations; this feature, called emissions trading, allows a nation that has reduced its emissions more than the required amount to sell its unused emissions reductions to other nations. In addition, developing

[1]Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

nations can generate emissions reductions for developed countries by participating in certain projects.

Although the United States is not participating in the Kyoto Protocol, climate change remains a topic of congressional and public concern, and there is continuing interest in estimating how reducing greenhouse gas emissions could affect the U.S. economy and quality of life. To make such estimates, economists typically rely on economic models—computerized sets of mathematical equations that represent the economy in a simplified way to project future conditions. Models can vary in terms of size, structure, complexity, and other features. Any such model's results can be significantly affected by changing its assumptions about economic growth, energy prices, and other key variables. For example, the estimated costs of implementing the Kyoto Protocol could be significantly higher or lower, depending on the modelers' assumptions about the future values of such variables. In addition, a model's results can be significantly affected by changing its assumptions about how a policy, like the Protocol, is implemented.

At a July 2002 hearing on the administration's climate initiative, the Chairman of the Council on Environmental Quality (CEQ) testified that implementing the Kyoto Protocol would reduce U.S. economic output by "up to $400 billion" in 2010.[2] This estimate is similar to a $397 billion estimate that appeared in a 1998 report by the Energy Information Administration (EIA), an independent statistical and analytical agency within the U.S. Department of Energy.[3] The EIA estimate differed from another, well-publicized estimate prepared the same year by the Council of Economic Advisers (CEA), which found that the costs of implementing the Protocol could be as little as $7 billion to $12 billion a year in economic output, depending on the extent of international emissions trading allowed and the participation of developing countries.[4] You asked us to identify likely reasons for the differences between the two cited cost estimates ($397 billion from EIA and $7 billion to $12 billion by CEA), based on (1) the economic models used to prepare these estimates and (2) the assumptions incorporated into these models, including economic assumptions and assumptions about how the Protocol would be implemented. You also asked us to determine the basis for the cost estimate cited by the CEQ Chairman.

To address these objectives, we reviewed the CEA and EIA reports, the CEQ testimony, and related literature. We did not perform any independent economic modeling. In addition, we did not attempt to track the continuing international negotiations on the details of the Protocol or to determine whether CEA's and EIA's assumptions about the Protocol's operations turned out to be accurate.

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[2]Statement of James L. Connaughton, Chairman, White House Council on Environmental Quality, on United States Global Climate Change Strategy, before the Senate Committee on Commerce, Science and Transportation, July 11, 2002.

[3]Energy Information Administration, *Impacts of the Kyoto Protocol on U.S. Energy Markets and Economic Activity.* Report No. SR/OIAF/98-03, October 1998.

[4]President's Council of Economic Advisers, *The Kyoto Protocol and the President's Policies to Address Climate Change: Administration Economic Analysis*, July 1998.

Results in Brief

Two likely reasons why the cost estimates differed based on the economic models are that (1) the models focus on different time periods, with different assumptions about how the economy adjusts to new policies, and (2) they measure costs differently. CEA used a type of model that typically focuses on longer time periods and generally assumes that the economy adjusts smoothly to new policies over the longer-term, while EIA used a type of model that typically focuses on a more immediate time period and highlights the near-term costs of economic adjustments (such as unemployment). The different types of models produce different types of cost estimates; EIA's model used a more comprehensive cost measure than CEA's model and was thus able to capture certain costs that CEA's model could not capture.

It was likely that EIA's cited cost estimate would be higher than CEA's estimate because of two assumptions the agencies made about the U.S. economy and about the Protocol's operations. First, the cited EIA estimate assumed that all reductions would be achieved domestically, while the cited CEA estimate allowed for the purchase of emissions reductions from other nations. Second, the economic growth rate assumed by EIA (2.3 percent a year for 1995 through 2010) was higher than the growth rate assumed by CEA (2.1 percent for the same time period). A higher growth rate results in more growth in emissions and would require larger reductions to reach an emissions target.

In testifying that implementing the Kyoto Protocol "would have cost our economy up to $400 billion" in 2010, the CEQ Chairman was relying on the highest of six cost estimates prepared by EIA. This scenario would have required reductions in U.S. greenhouse gas emissions to 7 percent below the 1990 level—the most restrictive of the six EIA estimates. Following the hearing, the Chairman noted that certain provisions in the Kyoto Protocol could require smaller reductions (specifically, to 4 percent below the 1990 level), but he did not cite a cost estimate corresponding to this smaller reduction.

We received written comments on a draft of this report from the Council of Economic Advisers and Council on Environmental Quality, jointly, and from the Energy Information Administration. The Councils characterized our draft as, among other things, "incorrect, incomplete, and lacking in analytical rigor in several significant areas." We strongly disagree with this characterization and do not believe that the points in their comment letter provide adequate substantiation for such a broad assertion. However, we did enhance our report to provide additional information on developments prior to the negotiation of the Protocol, better specified the report's objectives, and clarified the importance of assumptions about how the Protocol might be implemented and the effect of these assumptions on the cost estimates. In addition, the Councils provided one technical comment, which we incorporated. EIA suggested that we include additional material on its approach to modeling, and we did so. EIA also provided technical comments, which we incorporated where appropriate.

Background

Carbon dioxide and certain other gases trap some of the sun's heat in the earth's atmosphere and prevent it from returning to space. The trapped heat warms the earth's climate, much like glass in a greenhouse. Hence, the gases that cause this effect are often referred to as greenhouse gases. The most prevalent of the six greenhouse gases covered by the Protocol is carbon dioxide, which

results from combustion of coal and oil in power plants and industrial boilers, the burning of gasoline in vehicles, and other sources. The six gases covered by the Protocol differ in their effects on the atmosphere and their expected lifetimes.

In recent decades, concentrations of greenhouse gases have built up in the atmosphere, giving rise to concern that continuing increases might interfere with the earth's climate system, for example, by increasing temperatures or changing precipitation patterns. In 1992, the United States joined with other nations in developing the United Nations Framework Convention on Climate Change, which does not impose specific binding targets or timetables for emissions reductions. In contrast, in the Kyoto Protocol, a follow-on to the Convention signed by the United States and about three dozen other nations—most of them economically developed—emissions were limited by specific amounts over a specified time frame. To help achieve the required reductions, the Protocol allows countries to purchase emissions reductions from other countries or to offset their emissions through the use of sinks, such as trees, which capture and store carbon dioxide.

Over the past decade or longer, there have been many efforts to estimate the cost to the U.S. economy of implementing various regimes for regulating greenhouse gas emissions. In the area of climate policy, two basic types of models, often referred to as top-down and bottom-up, are frequently used in assessing potential costs and benefits of reducing emissions. The two model types are based on fundamentally different perspectives, although in recent years the distinctions between the two model types have narrowed as modelers have begun to integrate features of the two types.

- Top-down models are economywide models that describe, among other things, the relationships between energy and the rest of the economy, based on observations of past experience, to project future policy-induced changes. One type of top-down model, a macroeconomic model, starts from a view of how the economy as a whole functions and how macroeconomic variables, such as economic output (known as gross domestic product, or GDP), consumption, and aggregate savings and investment, are determined and interrelated. Another type of top-down model, a computable general equilibrium model, draws from microeconomic theory and assumes that markets adjust efficiently in the long run as consumers and producers adapt to changing prices in response to, for example, a new policy regulating greenhouse gas emissions.

- Bottom-up models generally contain a great deal of technological detail, but less detail on the rest of the economy. Their projections are based on, among other things, calculations of future technological possibilities under different economic or policy conditions. In contrast to top-down models, bottom-up models used for analyzing climate policy focus primarily on the energy sector of the economy, with less detail on the economy as a whole. They contain extensive information about specific energy technologies, identifying the least expensive technology options available for energy savings and fuel-switching to reach a specific emissions target. Unlike top-down models that project possibilities for technological substitution based on trends observed in the past, bottom-up models allow for the substitution of new technologies at various prices, if, for example, the price of energy increases in response to a new carbon policy. Because they lack detail about the general economy, they are sometimes linked to top-down models, which can provide such detail.

Even among models of the same type (e.g., macroeconomic or computable general equilibrium models) results can vary because each model is designed with different features and may include different input assumptions.

CEA and EIA posed the same basic question about the potential costs to the U.S. economy of implementing the Kyoto Protocol but took different approaches to modeling these costs and produced different results.

CEA's study. CEA's 1998 study sought to estimate the costs to the U.S. economy of complying with the Kyoto Protocol by 2010. CEA modeled 10 scenarios of how the Protocol might be implemented, which differed in the extent to which they allowed international emissions trading and the purchase of emissions credits in developing countries.[5] Among these were scenarios in which the United States traded emissions only with certain other industrialized countries (i.e., other nations signing Annex I of the 1992 Framework Convention on Climate Change[6]); with Annex I countries and certain developing countries; and with certain Annex I countries, as well as the countries of Eastern Europe and certain developing countries. Under the last scenario—the least restrictive—the cost to the U.S. economy in 2010 was estimated to be 0.07 percent of GDP, or about $7 billion a year in total resource costs, which are defined by CEA as the direct costs to the U.S. economy of meeting its Kyoto target, including both the cost of abating emissions domestically and the cost of purchasing emissions reductions from abroad. CEA estimated that under this scenario the corresponding cost of reducing emissions would be $14 a ton in 2010.[7] At the other extreme, the CEA report implied that if the United States made all its reductions domestically, the cost would be $192 to $200 a ton.[8]

Table 1 shows selected results for four of CEA's scenarios, from the least restrictive to the most restrictive. For each scenario, cost is represented both as the percentage by which GDP would decrease and the incremental cost of reducing emissions by one ton. As the scenarios become increasingly restrictive, total resource costs and the incremental cost of reducing emissions by one ton increase. (The costs shown do not include short-term adjustment costs, such as the temporary unemployment of workers due to high energy prices, which is discussed in more detail on pp. 7 and 8.)

[5]CEA's report presents the results of nine scenarios that incorporated international emissions trading. It also refers to a tenth scenario, involving no emissions trading, assuming rather that all reductions occurred domestically. Although CEA did not present the results for that scenario, the inferred cost is $54 billion to $60 billion.

[6]Thirty-six developed countries are listed in Annex I. These countries include all the countries belonging to the Organization of Economic Cooperation and Development in 1990, plus most of the central and eastern European economies-in-transition.

[7]Costs per ton refer to costs per metric ton of carbon.

[8]We estimated this range on the basis of information provided in the CEA report on the trading scenarios.

Table 1: CEA's Cost Estimates under Four Scenarios

Sources of emissions reductions from other nations	Decrease in GDP in 2010		Incremental cost to reduce emissions (dollars per ton)[a]
	Total resource costs (1992 dollars in billions)	Percentage of GDP	
Certain Annex I nations, Eastern Europe, and key developing nations	$7	0.07	$14
Annex I and key developing nations	12	0.11	23
Annex I nations[b]	23-26	0.23-0.24	54-56
No international trading (domestic reductions only)[b]	54-60	0.54-0.55	192-200

Source: GAO analysis of CEA data.

[a]We estimated these figures on the basis of information provided for other scenarios. The estimates were derived based on information provided by CEA for the $14-per-ton and $23-per-ton carbon price scenarios.

[b]The cost to reduce emissions is referred to by CEA as the permit price. We refer to the permit price as the incremental (marginal) cost of reducing emissions.

EIA's study. EIA's 1998 study estimated the costs[9] in 2010 of reducing carbon dioxide under six scenarios showing how the Protocol might be implemented. Because the exact rules that would govern final implementation of the Kyoto Protocol were not fully determined at the time of its analysis, EIA did not know the specific reduction in energy-related emissions that would be required. Therefore, EIA created six scenarios that assume a range of emission reductions levels. For example, the 1990 level minus 7 percent scenario was chosen to resemble the Kyoto Protocol target requiring the United States to reduce its emissions 7 percent below its 1990 baseline, without allowances for sinks, other greenhouse gases, or international activities; the 1990 level minus 3 percent scenario was chosen to represent a case where sinks and offsets from other gases produce a 4 percentage point contribution toward meeting the 7 percent target.[10] EIA modeled four other scenarios: no change in emissions and emissions increases of 9 percent, 14 percent, and 24 percent above the 1990 level. Under these scenarios, it was assumed that the United States would purchase varying amounts of its required reductions abroad, with the most international purchases occurring under the 1990 level plus 24 percent scenario.

EIA estimated that the costs would be between 1.0 and 4.2 percent of U.S. GDP in 2010, depending on the scenario, and that the corresponding incremental cost of reducing carbon emissions would be between $67 and $348 a ton. The lowest cost estimate was based on the scenario in which emissions in 2010 would be 24 percent above the 1990 level. The highest cost estimate was based on the scenario in which emissions in 2010 would be 7 percent below the 1990 level.

Table 2 shows selected results for the six EIA scenarios, from the least restrictive to the most restrictive. Under each scenario, cost is represented both as the percentage by which GDP would

[9]EIA estimated incremental costs in 1996 dollars per metric ton of carbon.

[10]According to the EIA study, a January 1998 fact sheet by the Department of State noted that the provisions of the Protocol would yield this 4 percentage-point difference—3 percentage points due to the counting of sinks and 1 percentage point due to the use of 1995, rather than 1990, as the base year for the three synthetic greenhouse gases.

be reduced and the incremental cost of reducing emissions by one metric ton. As the scenarios become increasingly restrictive, the cost to the overall economy and the incremental cost of reducing emissions by one metric ton increase.

Table 2: EIA's Cost Estimates under Six Scenarios

Scenario	Decrease in economic output in 2010		Incremental cost to reduce emissions (1996 dollars per metric ton)
	1992 dollars in billions	Percentage of GDP	
1990 level + 24 percent	$96	1.0	$67
1990 level + 14 percent	161	1.7	129
1990 level + 9 percent	188	2.0	163
1990 level	292	3.1	254
1990 level – 3 percent	327	3.5	294
1990 level – 7 percent	397	4.2	348

Source: GAO analysis of EIA data.

Note: The decrease in GDP and the cost to reduce emissions in EIA's model include short-term adjustment costs, such as temporary unemployment of workers resulting from higher energy prices. The incremental costs represent the carbon prices resulting from each scenario. These carbon prices result in higher energy prices and lower GDP.

Using Different Types of Economic Models Likely Contributed to Higher Cost Estimates from EIA than from CEA

In estimating the costs to the U.S. economy of implementing the Protocol, CEA and EIA used economic models that differ in the way they represent how the economy functions. The models focus on different time periods and measure costs differently. These differences likely contributed to higher cost estimates from EIA than from CEA.

CEA used a top-down computable general equilibrium model that describes the economy's path over the long term. Such models generally represent markets as adjusting smoothly in the long run to price changes resulting from, for example, new regulations for greenhouse gas emissions. Because they are generally not as well suited as macroeconomic models to represent the near-term effects of government policies, computable general equilibrium models may tend to underestimate the short-term costs of adjustments to a policy change. In contrast, EIA used a bottom-up energy sector model linked to a top-down macroeconomic model. Macroeconomic models often yield higher cost estimates than computable general equilibrium models because they are better able to capture short-term economic adjustment costs, such as those that might be caused by limiting greenhouse gas emissions.

Because of differences in how they represent the economy, the models include different measures of costs. The total loss in GDP attributable to emissions reduction policies has two components:

- Loss of potential GDP measures the loss of productive capacity of the economy. This loss is directly attributable to the reduction in energy resources available to the economy. (Polices to reduce greenhouse gas emissions raise the price of energy, leading to reduced use.)

- Adjustment costs reflect frictions to the economy that result from the policies to reduce emissions. These frictions would include the temporary unemployment of workers and other resources resulting from higher energy prices.

The model used by CEA assumes that the economy makes a smooth transition to a new path over the long term, losing some productive capacity as a result of higher energy prices. Thus, CEA's cost estimate includes only the loss in potential GDP, or the loss in GDP if employment were full. In contrast, EIA's model captures both types of costs. EIA's approach to modeling energy markets explicitly incorporates, on an annual basis, such as factors as technological change and costs, consumer choice behavior, and changes to energy infrastructure. Thus, in addition to the loss in potential GDP, the EIA model also estimates the adjustment costs, and the estimates shown in table 2 include both types of losses.[11] Compared to CEA, therefore, EIA's estimate of economic loss is a broader measure of the costs of implementing the Protocol.

EIA separately estimated economic losses in potential GDP, which is similar to the measure used by CEA. These estimates are shown in table 3. In all of these scenarios, the losses in potential GDP are smaller than the corresponding losses in total GDP shown in table 2. For example, for the most restrictive scenario—achieving emissions 7 percent less than the 1990 level—the estimated reduction in potential GDP was $72 billion, while the estimated reduction in total GDP was $397 billion.

Table 3: EIA's Cost Estimates (in terms of potential GDP) under Six Scenarios

	Decrease in economic output in 2010		Incremental cost to reduce emissions (1996 dollars per metric ton)
Scenario	1992 dollars in billions	Percentage of GDP	
1990 level + 24 percent	$13	0.1	$67
1990 level + 14 percent	27	0.3	129
1990 level + 9 percent	34	0.4	163
1990 level	53	0.6	254
1990 level – 3 percent	62	0.7	294
1990 level – 7 percent	72	0.8	348

Source: GAO analysis of EIA data.

Note: Like the CEA results in table 1, the decrease in GDP and costs to reduce emissions in this table do not include short-term adjustment costs, such as temporary unemployment of workers resulting from higher energy prices. The incremental costs represent the carbon prices resulting from each scenario. These carbon prices result in higher energy prices and lower GDP.

[11]EIA refers to the sum of loss in potential GDP and economic adjustment costs as "actual GDP."

Using Different Assumptions Also Likely Contributed to Higher Cost Estimates from EIA Than from CEA

Of the many assumptions incorporated into the two modeling efforts, we identified two used by CEA and EIA that likely contributed to their different results. One of these relates to how the Protocol would operate, while the other relates to the economy's growth rate. Both assumptions would likely yield higher cost estimates from EIA than from CEA in the scenarios we examined.

International trade in emissions reductions. A scenario that does not allow the United States to purchase emissions reductions from other nations will likely yield higher estimated costs than a scenario that does allow such purchases, because the United States' cost of reducing its emissions is likely to be higher than many other nations' costs. The most restrictive of the scenarios modeled by EIA did not allow for international trade in emissions reductions, while the least restrictive of the CEA scenarios did allow for such trade.[12] In fact, according to the CEA study, an effective international market for emissions trading among industrialized countries would potentially reduce the resource costs to the United States by more than half relative to a scenario in which all emissions reductions occur domestically. Moreover, if the United States were allowed to purchase emissions from developing countries, the costs could be reduced even further. Thus, as would be expected, EIA's no-trading scenario cost estimate was higher than CEA's full-trading scenario estimate.

Economic growth rates. The rate at which an economy's GDP grows is important in determining the costs to limit emissions. A slower-growing economy uses less energy and produces fewer emissions; therefore, smaller emissions reductions are needed to meet a given target. Conversely, a faster-growing economy uses more energy and produces more emissions; therefore, larger reductions are needed to meet a given target. In its analysis, CEA assumed that the economy would grow by 2.1 percent between 1995 and 2010, while EIA assumed that the economy would grow by 2.3 percent during the same time period, a difference of 0.2 percentage points. This difference increases in significance when compounded over many years. In this case, CEA assumed that the economy would grow about 37 percent between 1995 and 2010, while EIA assumed it would grow about 41 percent. In the context of a roughly $10 trillion economy, this difference can be significant.

CEQ's Chairman Cited a Cost Estimate Based on EIA's Most Restrictive and Expensive Scenario

In prepared testimony in support of the administration's 2002 climate change strategy, the Chairman of CEQ stated that implementing the Kyoto Protocol would cost the U.S. economy "up to $400 billion" in 2010. By citing this estimate, the CEQ Chairman focused on the most restrictive of the six scenarios modeled by EIA. This scenario required the deepest reduction in U.S. emissions (to 7 percent below the 1990 emissions level) and did not allow for, among other things,

[12]As noted above, CEA modeled a range of scenarios with different levels of trading. The inferred cost of the no-trading CEA scenario is about $54 billion to $60 billion a year, while the estimated cost of the no-trading EIA scenario of 7 percent below the 1990 level is $72 billion in terms of potential GDP. The comparable EIA estimate in terms of actual GDP is $397 billion.

emissions trading with other nations. Under this scenario, EIA estimated that the cost to the U.S. economy (in terms of reduced GDP) would be $397 billion in 2010.

In answering follow-up questions after the hearing, the Chairman recognized that the United States might not be required to reduce its emissions to 7 percent below the 1990 level. Specifically, he stated that "the inclusion of sinks provides a 3 percent offset to the most stringent case."[13] He did not provide an estimate for the cost of reaching that less stringent level.

Agency Comments

We provided a draft of this report to the Secretary of Energy; the Chairman, CEA; and the Chairman, CEQ, for review and comment. We received written comments jointly from the Chairman, CEA, and the Chairman, CEQ (see enc. I), and from the Administrator, EIA (see enc. II). The Councils characterized our draft as, among other things, "incorrect, incomplete, and lacking in analytical rigor in several significant areas." We disagree with this characterization and do not find that it is substantiated in the Councils' letter. However, we have provided additional information on developments prior to the negotiation of the Protocol, better specified the report's objectives, and clarified the importance of assumptions about how the Protocol might be implemented and the effect of these assumptions on the estimated costs to the economy. Our objective was to explain the differences in the results of the 1998 economic modeling studies by CEA and EIA. In addition, we addressed the technical comment made by the Councils.

EIA suggested that we include additional material on its approach to modeling, and we did so. EIA also provided technical comments, which we incorporated where appropriate.

Scope and Methodology

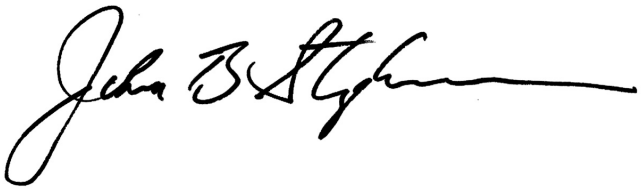
To answer the first and second objectives, we reviewed the CEA and EIA studies and literature on economic modeling. To answer the third objective, we reviewed the CEQ Chairman's July 2002 testimony and his responses to follow-up questions. We did not independently assess the validity of the CEA and EIA models in this report. (In addition, we did not attempt to track the continuing international negotiations on the details of the Protocol or to determine whether the CEA's and EIA's assumptions about the Protocol's operation turned out to be accurate.) We performed our work from July through December 2003 in accordance with generally accepted government auditing standards.

As arranged with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the date of this report. At that time, we will send copies to the appropriate congressional committees; the Secretary of Energy; the Chairman, CEA;

[13]Response of the Honorable James Connaughton, Chairman, Council on Environmental Quality, to questions posed by Senators after the July 2002 hearing.

and the Chairman, CEQ. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

Should you or your staff need further information, please contact me or David Marwick at (202) 512-3841. Chuck Bausell and Anne K. Johnson made key contributions to this report. Karen Keegan, Cynthia Norris, and Anne Stevens also made important contributions.



John B. Stephenson
Director, Natural Resources
and Environment

Enclosures

Comments from the Council of Economic Advisers and Council on Environmental Quality

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

EXECUTIVE OFFICE OF THE PRESIDENT
COUNCIL OF ECONOMIC ADVISERS
WASHINGTON, DC 20503

EXECUTIVE OFFICE OF THE PRESIDENT
COUNCIL ON ENVIRONMENTAL QUALITY
WASHINGTON, DC 20503

December 10, 2003

Mr. John Stephenson
Director, Natural Resources and Environment
General Accounting Office

Dear Mr. Stephenson,

Thank you for the opportunity to respond to your request for comments on the GAO report, *Climate Change: Analysis of Two Studies of Estimated Costs of Implementing the Kyoto Protocol*. Our staffs have reviewed the report, and their joint comments are enclosed.

Sincerely,

N. Gregory Mankiw
Chairman
Council of Economic Advisers

James L. Connaughton
Chairman
Council on Environmental Quality

Enclosure

Subject: Joint CEA/CEQ Staff Comments on GAO's Proposed Report, *Climate Change: Analysis of Two Studies of Estimated Costs of Implementing the Kyoto Protocol*

The CEA and CEQ staffs have reviewed the proposed report and find it to be incorrect, incomplete, and lacking in analytical rigor in several significant areas. The report has questionable intentions and its inferences are not grounded in sound analysis.

See comment 1.

See comment 2.

First, the Report analyzes an Agreement that the Senate—including the two Senators who requested the Report—rejected. The report states that its goal is to compare the models and assumptions of two different analyses: the Energy Information Agency's (EIA) 1998 analysis of the costs of Kyoto to the Council of Economic Advisers' (CEA) 1998 analysis of the costs of Kyoto. According to the report, this examination of five-year-old models is done because "there is continuing interest in estimating how reducing greenhouse gas emissions could affect the U.S. economy." While there may be an interest in estimating the cost of greenhouse gas (GHG) reductions, it appears highly unlikely that today's Congress is interested in a comparison of the 1998-estimated costs of reductions that would be achieved by the Kyoto Protocol. Indeed, 95 Senators—including the two Senators who requested this report from the GAO—voted for a July 1997 resolution (with no votes in opposition) that the Senate would not support any international climate change agreement that did not mandate commitments from developing countries. The previous Administration's position was that "The President has made it clear that he does not intend to send the Kyoto Protocol to the Senate for ratification until we have achieved meaningful participation by key developing countries" (February 4, 1998, Congressional testimony of Kathleen A. McGinty, CEQ Chair). The Kyoto Protocol has never mandated such commitments from developing countries. Two different Administrations and an overwhelming majority of the Senate (with no dissents) are thus on record as opposing the Kyoto Protocol assessed in this GAO analysis. These facts, which were previously noted to GAO staff, should have been included in the Report. Instead, the GAO report concludes incompletely and misleadingly that "In March 2001, the President announced he opposed the Protocol."

See comment 3.

Second, GAO fails to take into account that the CEA modeling effort wrongly assumed that developing countries would have greenhouse gas caps under the Kyoto Protocol, and further would participate in an efficient global emissions trading system, In fact, the Kyoto Protocol did not impose emissions reduction obligations on developing country Parties. Given that the CEA analysis is five years old, GAO should have included a section on the Kyoto negotiations between 1998 and the present. The report frequently cites the least-restrictive assumptions of CEA's 1998 analysis, but does not note that these assumptions for increased operational flexibility were never realized in subsequent negotiations and thus are now demonstrably incorrect. Indeed, in addition to omitting that developing countries do not face firm caps under the Kyoto Protocol, GAO's proposed report misleadingly states that under the Protocol, "developing nations can generate emissions reductions for developed countries by participating in certain projects." GAO fails to mention that, to date, only a handful of these projects (known as Clean Development Mechanism projects) have been approved. The 1998 CEA analysis also assumed the existence of an effective global market for trading of emission allowances. This assumption was also incorrect, as evidenced by the difficulty the European Union alone is currently having establishing their emissions trading scheme (ETS). In fact, according to a recent Deutsche Bank report, the ETS faces unresolved problems with deciding on the number of

emissions credits to issue, measuring emissions, choosing an appropriate base year, determining criteria as proof of reductions, and harmonizing emissions trading with other environmentally-motivated policy measures of individual Member States ("EU trade in CO_2 Emissions: 2005 Launch Deadline at Risk," *Deutsche Bank Research*, December 2, 2003). The GAO report should therefore mention that all of the least-restrictive assumptions behind the 1998 CEA report have proven to be incorrect. From this, one can only conclude that the 1998 CEA model is therefore not an accurate prediction of the costs of Kyoto.

By comparison, the EIA analysis case cited by Chairman Connaughton in his July 2002 testimony assumed that the U.S. target in the Kyoto Protocol would be met entirely by reducing energy-related carbon emissions. This assumption more nearly reflects the actual outcomes of the Kyoto negotiations, especially with respect to the status of developing countries' participation, credits for carbon sinks, the efficacy of the Clean Development Mechanism and emissions trading. Any defensible analysis of the validity of economic model cost estimates must include a discussion of these assumptions. CEA Chairman Yellen, in her testimony on this topic to the House Commerce Committee on March 4, 1998, noted that "(e)ven within a given model, answers depend critically on the precise nature of the question asked. For example, the costs of emissions reductions depend critically on the extent of global participation and international trading that a treaty is assumed to feature." Openly reconciling the assumptions of five years ago with the realities of what has transpired subsequently in international negotiations is a fair expectation of the GAO, but unfortunately it is absent in this report.

See comment 4.

Accordingly, in the "Results in Brief" section, GAO should have made it clear that there are *three* reasons why the cost estimates differed between EIA and CEA, the third (and most obvious) being that the underlying assumptions about the Kyoto Protocol differed. These differences in modeling approach were extensively documented in a hearing before the House Commerce Committee on March 4, 1998, as well as in another hearing before the Senate Energy and Natural Resources Committee on March 25, 1998. The report also presents inconsistent estimates implied from the 1998 CEA analysis. Table 1 presents CEA's cost estimates under four scenarios where the "no international trading scenario" is reported to have a total resource cost of $54-$60 billion. Footnote number 10, however, states that the inferred cost of a no-trading CEA scenario is about $100 billion a year.

See comment 5.

See comment 6.

Third, it is misleading for GAO to rely on the 1998 State Department "analysis," because it ignores later developments on the role of carbon sinks in the Kyoto Protocol. The GAO report cites a 1998 State Department "analysis" on "how the Protocol would likely function," to claim that the United States' burden would be lower than implied by the 7 percent target cited by Chairman Connaughton in his 2001 testimony. It is misleading to call this State Department document an "analysis," since it is actually a "Fact Sheet" that makes claims about the effective targets under the Kyoto Protocol. The GAO report cites this 1998 advocacy document as evidence that the Kyoto Protocol promises to provide emissions reduction credits for sinks, but the report fails to mention that Article 3.4 of the Protocol is vague on the specifics concerning credits for sinks: the critical details were to be worked out after 1998. Indeed, a State Department Fact Sheet of August 1, 2000, reports that the Kyoto Protocol "leaves open the exact ways that sinks will count." It goes on to say that, "One of the central issues at the next Conference of the Parties [COP] to the Framework Convention (scheduled for November 13-24,

[2000,] in The Hague) will be to elaborate the Protocol's carbon sinks provisions. Currently, the Protocol addresses only a few limited land-use change activities such as reforestation and deforestation. The inclusion of other land-use activities such as forest, cropland and grazing land management will require a decision of the Parties." Finally, in support of broad allowance of carbon sinks, this 2000 State Department Fact Sheet states that "The United States believes that a comprehensive approach would best account for the full range of natural and human activities that could affect the global climate system." The GAO report also does not mention that the 2000 Sixth Conference of the Parties in The Hague broke down largely because the United States argued unsuccessfully for wide access to credits for sinks whereas the European Union insisted on more restrictive credits for sinks. The GAO report points out that the EIA-estimated economic cost of a 3 percent reduction is $327 billion, $70 billion less than the most restrictive scenario. Since the implementation of sinks in the Protocol had not been finalized in 1998, however, the implication that the 3 percent reduction is the more realistic scenario is wrong. Given the failure to include wide access to credits for sinks within the Protocol, the 7 percent reduction target is indeed the more accurate one (this is the reduction level explicitly assigned to the United States in the Protocol), and GAO is incorrect to assert (based on an outdated State Department Fact Sheet) that the 3 percent reduction target is more realistic.

In conclusion, by selectively relying on a flawed CEA economic modeling effort based on inaccurate assumptions and evidence from the previous Administration's advocacy documents to assess Chairman Connaughton's 2002 testimony, the GAO report is incomplete and misleading.

The following are GAO's comments on the joint Council of Economic Advisers/Council on Environmental Quality letter dated December 10, 2003.

GAO's Comments

1. We prepared this report in response to a request from the Ranking Minority Members of the Senate Committee on Commerce, Science and Transportation and its Subcommittee on Oceans, Fisheries and Coast Guard.

2. We added information on developments prior to the negotiation of the Protocol.

3. We stated that developing nations can generate emissions reductions, which CEA/CEQ does not dispute. As noted earlier, we did not attempt to track developments since 1998, such as how many such projects have been approved.

4. We believe that the first two paragraphs of our Results in Brief section appropriately summarize the results of our work on the likely reasons for the differences between the two cited cost estimates based on (1) the economic models used to prepare these estimates and (2) the economic and other assumptions incorporated into these models. However, in the body of the report, we have clarified in several places the importance of assumptions about how the Protocol might be implemented and the effect of these assumptions on the estimated costs to the economy.

5. We revised the report as suggested.

6. We deleted a comparison of the basis of the cost estimate cited by the CEQ chairman to a 1998 State Department fact sheet. However, we cite the fact sheet in the section dealing with EIA's cost estimates, because—according to EIA officials—one of EIA's six scenarios (a target of 3 percent below the 1990 emissions level) is based on the fact sheet.

Comments from the Energy Information Administration

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

Department of Energy
Washington, DC 20585

DEC 10 2003

Mr. John Stephenson
Director, Natural Resources and Environment
General Accounting Office
441 G Street, N.W.
Washington, D.C. 20548

Dear Mr. Stephenson:

The Energy Information Administration (EIA) appreciates the opportunity to comment on the General Accounting Office (GAO) draft report "Climate Change: Analysis of Two Studies of Estimated Costs of Implementing the Kyoto Protocol," Report No. GAO-04-144R. The report largely explains the reasons for differences in cost estimates between EIA's 1998 study of the Kyoto Protocol and an estimate prepared by the Council of Economic Advisors (CEA) that same year. We had the opportunity to provide informal comments on an earlier draft as well. To a great extent, the latest draft report addresses our previous comments.

The following comments suggest areas for improvement or elaboration:

See comment 1.

- The first paragraph of "Results in Brief" (page 3) identifies two likely reasons why the cost estimates differ. Another reason that is also addressed in your draft report, differences in international emissions trading assumptions in the cases compared, is arguably more important than either of the cited reasons in explaining the divergence in results. Therefore, we recommend that this section prominently note that the difference GAO was asked to examine is between EIA's most restrictive case (no emissions trading) and CEA's least restrictive case (frictionless global emissions trading), that both studies provide a range of relevant cases, and that estimates provided for comparable cases are in much closer accord. The second sentence of the second paragraph of "Results in Brief" which suggests that the difference in trading assumptions across cases being compared reflects modeler choices, rather than the selection of scenarios made by users of the modeling results, does not properly capture the main point and should be deleted.

  Beyond the change recommended above, the two reasons cited in the current version of the first paragraph of the draft report do not adequately summarize the findings and seem to address only one of the reasons for the differences: the type of macroeconomic modeling methodology used. Another reason that should be included relates to the distinction between actual and potential GDP impacts.

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While EIA estimated both impacts, the estimated costs cited from EIA's report are those for actual GDP. Actual GDP impacts include transitional impacts not reflected in potential GDP, or GDP under assumptions of full employment, as is assumed in the CEA estimates of the Kyoto impact. Since this issue is not merely a difference in modeling approaches, but a key source of differences, it should be highlighted up front as a third key difference.

See comment 2.

The GAO report correctly cites the macroeconomic modeling differences as a key source of differences in the cost estimates (pages 3 and 9/10). Equally important, though, is the difference in the EIA and CEA approaches to modeling energy markets, per se. While the GAO report has a section (page 5) to describe modeling approaches as either "bottom-up" or "top-down" the report does not at that point identify which approaches EIA and CEA used. Later, on page 9, only the macroeconomic modeling differences used are discussed. The section on pages 9 and 10 should be expanded to address the differences between EIA's and CEA's modeling of energy markets. EIA's study included a chapter comparing cost estimates for the Kyoto Protocol, and addresses some of these modeling differences, including the approach used by the CEA (based on a model developed by the Pacific Northwest National Laboratory).

EIA simulates U.S. energy markets with explicit regional, technological, and sectoral detail on an annual basis. EIA's energy modeling approach incorporates explicit assumptions and modeling structures to address such factors as technological change and costs, consumer choice behavior, changes to energy infrastructure, and energy/environmental regulation. As a result, EIA's approach estimates higher emission reductions costs than models which assume energy use and substitution are more responsive to energy prices.

The CEA's report was based upon a model developed by the Pacific Northwest National Laboratory (PNNL). Their approach modeled energy markets and the economy on a national basis at five year intervals. The approach is based on aggregate assumptions about consumer price-responsiveness (demand elasticities and capital/energy substitution elasticities) over a long term time frame (50-to-100 years). Applying the long-term elasticities to the short-term and mid-term period can overstate the extent consumers can reduce energy-related carbon dioxide emissions in response to energy-based carbon prices.

See comment 3.

While the GAO study identifies the issue of "different time periods" as critical to the assessment process, this view needs to be broadened. The report appropriately addresses the differences regarding the modeling of a long-run equilibrium and assessing the short-run adjustment cost (on page 9 of the draft). Omitted, however, is the issue of how the economy's response to the Kyoto Protocol was assumed to be phased-in prior to the actual commitment period. The CEA analysis implicitly assumed a start date of 2000 and a ten-year adjustment period to meet a target reduction in 2010. The EIA analysis, however, assumed market-based controls on emissions begin in 2005 and are phased-in over three years in

advance of the 2008 reduction target, the first year of five-year commitment period. This three-year phase-in of the market controls on emissions results in a larger peak impact than the longer run-up implied by the CEA analysis, independent of the model selected. The issue of the length-of-time to full implementation was addressed in a subsequent EIA analysis in July 1999 (Analysis of the Impacts of an Early Start for Compliance with the Kyoto Protocol.), which considered a case where the market controls on emissions began in 2000. Compared with the earlier EIA study, the macroeconomic impacts start earlier in the 1999 analysis, but the peak impact is less severe.

See comment 4.

- On page 6, the last sentence of footnote 5 should be corrected to indicate that the results for the CEA's scenario with no international trading, while not presented explicitly, are readily derived from the other information presented in the report, as is reflected later in Table 1

See comment 4.

- The point made as a footnote to Table 1, that the decrease in GDP and costs to reduce emissions in CEA's model do not include short-term adjustment costs, is an important one and a key source of the differences. This point should be made directly in the paragraph that discusses Table 1.

See comment 4.

- On page 11, the section on International Trade in emissions reductions makes a confusing comparison between EIA and CEA's results for two different scenarios: "The most restrictive scenario modeled by EIA did not allow for international trade in emissions reductions, while the least restrictive CEA scenario did allow such trade." The point should be made that both organizations analyzed cost impacts from scenarios with and without trading, and both organizations found trading scenarios to be substantially lower in costs. Then, the point that the scenario cited from EIA's report was one without trading (the most costly), while the scenario cited from CEA was with trading can be made in the proper context.

See comment 4.

- On page 3, the economic growth rates cited should provide the year range explicitly.

- The units for emission costs should be identified as dollars per metric ton of carbon.

Thank you for the opportunity to comment on this report.

Sincerely,

Guy F. Caruso
Administrator
Energy Information Administration

The following are GAO's comments on the Energy Information Administration's letter dated December 10, 2003.

GAO's Comments

1. We believe that the first two paragraphs of our Results in Brief section appropriately summarize the results of our work on the likely reasons for the differences between the two cited cost estimates based on (1) the economic models used to prepare these estimates and (2) the economic and other assumptions incorporated into these models.

2. We expanded our discussion of its approach to modeling energy markets. See page 8.

3. EIA notes that we did not discuss the difference between CEA and EIA's approaches for estimating the economy's response as the Kyoto Protocol was phased in over time. We recognize that this assumption could have affected the agencies' respective cost estimates. Whereas EIA notes that CEA "implicitly" assumed a particular phase-in period, we did not find explicit documentation in the CEA study for its assumption in this regard and, therefore, did not report on this issue.

4. We clarified our discussion, as suggested.

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