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DENNIS J. KUCINICH
10TH DISTRICT, OHIO

1730 LONGWORTH OFFICE BUILDING
WASHINGTON, D.C. 20515
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14400 DETROIT AVENUE
LAKEWOOD, OHIO 44107
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Congress of the United States
House of Representatives

Committees:
Government Oversight
Education and the Workforce

May 14, 1998

Dr. Janet L. Yellen
Chairman
Council Of Economic Advisors
Old Executive Office Building
Washington, D.C. 20502

Dear Dr. Yellen:

I appreciated you taking the time to visit this morning.

Please forward to me all requests from the subcommittee for information regarding global climate change and its economic impact on the US economy. I need this information.

Thank you for your cooperation in this matter.

Sincerely,

Dennis J. Kucinich

Dennis J. Kucinich
Member of Congress

DJK:jm

response to Cong Kucinich's COS attached.

DENNIS J. KUCINICH
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Congress of the United States
House of Representatives

Committees:
Government Oversight
Education and the Workforce

FAX MEMORANDUM

Date: 5/18/98

TO: Dr. Janet Yellen Phone: 202-395-5084
FAX: (202) 395-6958

FROM:
___ Rep. Dennis J. Kucinich Phone: 202-225-5871
___ Jaron Bourke FAX: (202) 225-5745
___ Lisa Chamberlain
___ John Edgell
___ Jill Johnson
___ Zeenat Khan
___ Daniel Marschall
X Julie Moses
___ Michael Yarbrough
___ Other_____

MESSAGE:
Request follows.

1 pages to follow

EXECUTIVE OFFICE OF THE PRESIDENT

COUNCIL OF ECONOMIC ADVISERS

Date: May 14, 1998

Please deliver to: John Edgell

FAX number of addressee: 225-5745

Telephone number of addressee: 225-5871

From: Michele Jolin
CEA Chief of Staff

FAX number of sender: (202) 395-6958

Telephone number of sender: (202) 395-5084

Number of pages, including cover sheet: 12

Message: "Attached" is a copy of the request from Chairman McDonald on which we have been working.

ONE HUNDRED FIFTH CONGRESS

Congress of the United States

House of Representatives

COMMITTEE ON GOVERNMENT REFORM AND OVERSIGHT
2157 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515–6143

MAJORITY (202) 225–5074
MINORITY (202) 225–5051
TTY (202) 225–6852

March 13, 1998

BY FACSIMILE

The Honorable Janet Yellen
Chairman
Council of Economic Advisers
Old Executive Office Building
Washington, D. C. 20500

Dear Chair Yellen:

The Subcommittee on National Economic Growth, Natural Resources, and Regulatory Affairs is conducting oversight of the Administration's global climate change policies and its initiatives to jump-start U.S. efforts to achieve the Kyoto Protocol greenhouse gas emissions reductions targets.

Pursuant to the Constitution and Rules X and XI of the United States House of Representatives, please provide the Subcommittee with detailed information in response to the questions in sections A and B of the attached inquiry, to the extent that they are applicable to your agency, and the questions in sections C through E. In responding to this inquiry, please restate each question and subpart with each of your answers, and follow the attached definitions and instructions concerning the production of records.

Please provide your responses to the written questions and requests for production of records not later than 12 noon, April 7, 1998 to the Subcommittee in Room B-377 Rayburn. In addition, please contact Larisa Dobriansky, Senior Counsel, at (202) 225-4407 as soon as practicable to coordinate the timely production of the information to the Subcommittee.

Thank you in advance for your attention to this request.

Sincerely,

David McIntosh

David M. McIntosh
Chairman
Subcommittee on National Economic Growth,
Natural Resources, and Regulatory Affairs

cc: The Honorable Dan Burton
The Honorable John Tierney

Enclosure

Questions Regarding Global Climate Change Policies and Initiatives

A. Budget Information and Performance Measures

1. Please provide a table with Fiscal Year (FY) 89 - FY 99 historical budget authority for your agency for the various components of the President's "Climate Change Technology Initiative," including the previous "Climate Change Action Program/Plan" and any other new or previously authorized Research and Development (R&D) herein (except for the U.S. Global Change Research Program included in Question 3 below). For each component, please indicate each specific budget account, the specific legislative authority (including the specific statute, the section citation, and the language of the section) for the program, and a brief description of the program.

2. In Section 2 ("Programmatic Details") of OMB's February 2, 1998 handout, "Climate Change Technology Initiative - 1999 Budget Briefing Materials," please provide the following information associated with each paragraph description in which your agency has been funded or is requesting funding: the associated funding in FY 97, FY 98, and FY 99. Also, for each paragraph, for the requested funding in FY 99, please provide evidence of any accomplishments from the FY 93 - FY 97 funding, if any. Lastly, for each paragraph, please indicate any program performance measures for the requested funding, and, for each such measure, please provide data for the 1990 base year and annual data for the most recent three-year period for which data are available.

3. Please provide a table with FY 89 - FY 99 historical budget authority for your agency for the various components of the "U.S. Global Change Research Program" which were or are devoted exclusively to climate change R&D. For each component, please indicate each specific budget account, the specific legislative authority for the program (including the specific statute, the section citation, and the language of the section), and a brief description of the program.

- If funded in any of FY 93 - FY 97, please provide evidence of any accomplishments from these dollars. Also, for requested funding in FY 99, please indicate any program performance measures for the requested funding, and, for each such measure, please provide data for the 1990 base year and annual data for the most recent three-year period for which data are available.

4. Please provide a table with FY 89 - FY 99 historical budget authority for your agency for any other components of the Administration's climate change program (i.e., in addition to those included in answer to questions 1 and 2). For each component, please indicate each specific budget account, the specific legislative authority for the program (including the specific statute, the section citation, and the language of the section), and a brief description of the program.

5. For the FY 99 request, please provide a table showing what part is funding to continue initiatives funded in FY 98 or prior years and what part is brand new activity. For each component, please indicate each specific budget account, the specific legislative authority for the program (including the specific statute, the section citation, and the language of the section), and

a brief description of the program. For each brand new activity, please indicate expected requested funding annually through FY 03.

6. Please identify the full set of your agency-specific performance measures for the Administration's Climate Change proposal (besides those indicated in response to questions 2 and 3), including data for at least the 1990 base year, FY 97, FY 98, and FY 99. Also, please identify how any of your agency-specific measures (including those in response to questions 2 and 3) relate to those for any other Federal agency. Lastly, please describe any interagency efforts to identify and relate the entire set of climate change performance measures, including which agencies are involved and the names of the agency representatives.

7. Please provide a table for FY 93 - FY 97 identifying all assistance (including grants, cooperative agreements, and other transactions) and contract awards to non-profit and for-profit organizations for any climate change activity, including the date, amount of the award, name of the organization, purpose of the award, and a summary of any result(s) from the award. Please provide a copy of any final report from these awards.

B. Economic, Policy, and Legal Analyses

8. Since January 1993, has your agency participated in any interagency effort(s) relating to climate change in any of the following areas: (a) review of current legislation and/or the need for any new legislation; (b) review of current rules, any needed revisions to current rules, and/or any needed new rules; (c) production or review of any environmental data and/or analyses; (d) production or review of any cost-benefit data or analyses; and/or (e) production or review of any economic data and/or economic analyses? If so, please identify the interagency effort, its member agencies, its membership not only from your agency but also from other Federal agencies and/or any non-Federal parties, all drafts and analyses from the effort(s), and any comments from your agency on any drafts.

9. Has your agency either prepared or reviewed any environmental, cost-benefit, and/or economic data and analyses relating to the White House Initiative on Global Climate Change? If so, please provide a copy of all data, analyses, and any comments by your agency.

10. Did your agency comment on any of the draft testimony on climate change by Administration witnesses since the President's 1998 State-of-the-Union address? If so, please provide a copy of the draft testimony and any comments by your agency.

11. Has your agency suggested any alternative policy options for climate change? If so, please provide a copy of all drafts and supporting analyses and any comments from other Federal agencies on your alternatives.

12. Does your agency plan to revise any existing legislation or propose any new legislation relating to climate change (including legislation that will have the effect of reducing greenhouse

gas emissions whether or not that is the intended purpose of the legislation)? If so, please identify and describe all such initiatives, including a timetable for their development and submission to Congress. Also provide any and all legal and policy analyses regarding the applicability and availability of existing legislation to implement the Kyoto Protocol and any comments from other Federal agencies on the analyses.

13. Does your agency plan to revise any existing rules or propose any new rules relating to climate change (including regulatory actions that will have the effect of reducing greenhouse gas emissions whether or not that is the intended purpose of the regulatory action)? If so, please identify and describe all such initiatives, including any cost-benefit analysis, and a timetable for their development and promulgation. Also, provide any and all analyses that were prepared or considered of the cumulative effects on the U. S. economy and/or energy system of all or any combination of regulations that were issued since 1992, that were proposed, and that are being developed that have or will have such effects.

14. Has your agency participated in discussions or reviewed any documents relating to international emissions trading, joint implementation, and/or the Clean Development Mechanism? If so, please provide a copy of all drafts and any comment provided by your agency.

C. Dr. Yellen's Testimony before the House Commerce Committee on March 4, 1998

15. Please provide any and all analyses that support the Administration's conclusion that impacts on the U.S. economy of complying with the terms of the Kyoto Protocol "are likely to be modest." Also, explain fully how the Administration can make such a forecast responsibly when, as Dr. Yellen stated, "it is not yet possible to provide a full authoritative analysis" of the Kyoto Protocol. Among other things, Dr. Yellen noted that there is still "much that we do not know" because much has been left unresolved by this treaty (for example, implementation issues, the rules and procedures governing international emissions trading, joint implementation projects, and the Clean Development Mechanism, and future emissions reductions obligations). Moreover, Dr. Yellen asserted that, to her knowledge, " no [economic] model -- whether used inside the government or not -- has yet been set up to analyze the implications of the Kyoto Protocol, since this agreement is only a few months old. . . ."

16. In her testimony, Dr. Yellen supported the Administration's conclusion that "economic impacts are likely to be modest" with other optimistic conclusions about the effects of the Kyoto treaty "flexibility" mechanisms and U.S. electricity restructuring, and about the rate of technological progress. Please provide any and all analyses that support the following estimates:

16a. U.S. electricity restructuring "will offer approximately $20 billion in cost savings."

16b. Emissions trading among Annex I countries "can reduce the cost to the United States of achieving its targets for 2008-20012 emissions by about half."

16c. Emissions trading among a subset of Annex I countries (for example, the United States, Australia, Canada, New Zealand, and Russia) "can reduce costs by an estimated 60-70 percent." Also, based on the estimates presented in Dr. Yellen's testimony, please explain and fully document how more limited trading among this subset of countries would produce greater cost reductions than from either trading among all Annex I countries or trading with the full participation of non-Annex I countries.

16d. The Clean Development Mechanism "might shave costs by roughly another 20 to 25 percent."

16e. Overall costs "would reach roughly one tenth of one percent of projected GDP in 2010" (resource costs of achieving Kyoto targets for emissions reductions were estimated to be $7 to $12 billion per year in 2008 to 20012). Also, please explain how it is possible that compliance with the Kyoto Protocol, which has been projected by independent economists to be the most expensive environmental undertaking ever, could cost less than compliance with the recently issued U.S. air quality rules for particulate matter and ozone (the final Regulatory Impact Analysis for those rules estimated costs of $46 billion).

16f. The assumption that the rate of improvement in energy efficiency (Autonomous Energy Efficiency Index) will be 1.0 percent per year (which is greater than that assumed by the Energy Information Administration). In particular, please reconcile this assumption with the statement of the Council of Economic Advisers in its 1998 Annual Report that, "[u]ntil an emissions cap and trading system are in place, however, the economic incentive to use [technologies supported by the Administration's budget] may be low." Is the Administration assuming that such a system will be put into place in the short-term?

16g. The estimated effect on energy prices will range from "$14 to $23 per ton of carbon equivalent."

16h. "In energy-intensive sectors some employment reduction could occur, although given the very small predicted change in energy prices, impacts in most such sectors are apt to be minimal. Furthermore, a large number of jobs will be created in other sectors--many of them high-tech jobs paying high wages."

16i. As to each analysis, please indicate who prepared the analysis and provide all records of comments from other federal agencies.

17. Please provide any and all analyses that support the Administration's estimate that benefits relating to traffic congestion, highway accidents, and air pollution unrelated to climate change "could offset approximately a quarter of the resource cost of the climate change policy." As to each analysis, please indicate who prepared the analysis and provide all records of comments from other federal agencies.

18a. In her testimony, Dr. Yellen stated that, in evaluating the "likely net economic impact of the Kyoto Protocol," the Administration has "drawn upon a broad array of analytical tools" and a "wide range of models of the energy sector and economy over the next 25 years" to assess the various possible costs and non-climate benefits of the Administration's emissions reduction policy. Please specify all of the models and analytical tools that the Administration has used and describe in detail their strengths and weaknesses.

18b. According to the testimony, the Administration has relied particularly on the Second Generation Model (SGM) of Battelle Laboratories for many of its estimates. However, the Interagency Analytical Team report indicated that the SGM model "focuses on long-term transitions and measures the economy in five-year intervals," so that "it risks racing past short-term transition issues," such as GDP loss and impacts on specific industries. Specify all of the Administration's estimates that were derived by this model. Also, indicate why many of the Administration's key estimates were derived from this model? Finally, please identify the corresponding estimates derived from each model that the Administration has used in assessing the impacts of the Kyoto Protocol.

19. What are the 1990 baseline, the Fiscal Year 1997, 1998 and1998 data, and the annual outyear estimates until 2012 for the following outcome performance measures mentioned in Dr. Yellen's testimony: morbidity rates for some diseases, mortality rates for some causes, monetary damages from temperature increases, consequences from some catastrophes, traffic congestion, highway accidents, and air pollution unrelated to climate change?

20. Why does the Administration maintain that the U. S. acid rain program experience "clearly demonstrates how programs like international permit trading, joint implementation and the Clean Development Mechanism will lead firms to find cheaper ways of reducing emissions that can lead to unexpectedly low costs"? Why does the Administration believe that it is appropriate to extrapolate from that experience to the global arena? Won't the effectiveness of the international system, joint implementation, and the Clean Development Mechanism depend on different factors, such as the rules and procedures governing these mechanisms, the extent of participation by other countries, including developing countries, etc?

21a. In her testimony, Dr. Yellen stated that part of doing it smart (i.e., lowering the costs of reducing greenhouse gas emissions) under the Kyoto Protocol means "taking serious and responsible steps in the short run to prepare us to meet our obligations in the longer term." She indicated that these steps include a $6.3 billion program of tax cuts and R&D investments, industry-by-industry consultations to prepare emission reduction plans in key industrial sectors, and legislation to restructure the electrical industry. Under what authority is the Administration pursuing this unilateral executive branch course of action in furtherance of the treaty's emissions reductions targets and without Senate ratification?

21b. If the Administration is delaying the submission of the treaty to the Senate until it obtains "meaningful participation" by developing countries, doesn't that decision also require the

Administration to delay any unilateral executive branch action to address global warming until that cooperation is forthcoming?

21c. Given that the Kyoto Protocol seeks to address a global issue, isn't harmful to U.S. interests to proceed without the full participation of developing countries?

21d. Besides being unconstitutional, isn't it also premature and harmful to U.S. interests to take such unilateral actions, without ratification, when the Administration has characterized the Protocol as a "work in progress" -- a Protocol that "is not yet fully complete nor ready for the President's submission to the Senate"?

D. Cost/Benefit Analysis of the Kyoto Treaty

22a. Please provide any and all analyses that the Administration or any federal agency prepared (or had prepared) or is preparing (or is having prepared) of the costs and benefits of imposing on the U.S. the binding targets and timetables set forth in the Kyoto Protocol for reducing greenhouse gas emissions, taking into account the global implications of the way in which this agreement is structured. Also, please analyze and document the following:

22b. Whether the benefits of implementing this Protocol are justified by the costs;

22c. Evaluate the effectiveness of this agreement by comparing the marginal abatement costs of the most plausible alternative scenarios for meeting the Kyoto targets, given the way in which this agreement is structured, with the marginal costs of other reasonable alternative compliance schemes;

22d. With respect to each scenario that is analyzed, identify the assumptions used, explain any uncertainties concerning the assumptions, and examine the sensitivity of net effects to the different compliance strategies, using a range of plausible assumptions about future economic development and about fundamental climate processes;

22e. Evaluate the opportunity costs of pursuing the Administration's strategy for the abatement of greenhouse gas emissions under the terms of the treaty; and

22f. Evaluate how the benefits and burdens of complying with this treaty would be distributed on the national and household levels, describing, among other things, the disparate regional and industrial sector impacts, and the effects on different income levels.

23a. In evaluating alternative scenarios, please examine the following:

23b. Compare the economic and environmental effects of not including developing countries in the effort to reduce global emissions (with the potential for binding developed

countries to even greater obligations, without limiting developing countries at all) against the effects of addressing greenhouse gas mitigation on a global scale by the international community.

23c. Compare the economic and environmental effects of complying within the timeframes set forth in the Kyoto Protocol with the effects of complying over a longer time period.

23d. Compare the impacts of reducing greenhouse gas emissions using international emissions trading, joint implementation, and the Clean Development Mechanism with the impacts of relying upon domestic emissions permit trading. In this regard, evaluate alternative international trading scenarios: trading only between Annex I countries, trading that extends to a number of "key" developing countries, and trading in which all countries are fully participating.

24. With respect to any analysis provided, please identify and explain the basis for assumptions used regarding such factors as the rate of improvement in energy efficiency, the effectiveness of market incentives in increasing the market share of fuels that emit less carbon, and economic and demographic growth. Also, explain fully any assumptions on how emissions reductions will be achieved as, for example, through the early retirement of coal plants or nuclear plant life extensions.

25. In considering the opportunity costs, evaluate the extent to which the Administration's climate change strategy will require the diversion of funds from savings and/or investments which would have provided other benefits, such as saving social security, or more funding for education, health care, etc.

26. In assessing the impacts on the U.S. of complying with the Kyoto targets and timetables, please explain in detail the potential effects on the following indicators of economic performance: gross domestic product (GDP), per capita GDP, unemployment, income and real wages, trade competitiveness, and energy prices.

27. In assessing the benefits of complying with the Kyoto treaty, please evaluate fully the potential offsetting negative effects of exempting developing countries and of "carbon leakage." Also, if the economies of developed countries experience reductions in economic growth, evaluate the impact that this will have on the ability of emerging countries with export markets to transition to more energy efficient technologies.

28. President Clinton has suggested that the U.S. economy can continue to grow under this agreement. Please indicate at what rate the Administration expects that the economy will continue to grow during the next ten to 20 years if the treaty is ratified and at what rate it is expected to grow if the treaty is not ratified.

29. Have any of the cost-benefit analyses performed by the Administration or any agency been peer-reviewed? If so, please identify the reviewers and provide their comments on all drafts of

the analyses. If not, does the Administration plan to do so? Please describe fully the steps that the Administration plans to take.

30. In connection with these cost-benefit analyses, fully explain how the baseline(s), against which costs and benefits were calculated, was determined.

31a. Please provide all records of written or oral comments from other federal agencies on each of the cost-benefit analyses that were performed.

31b. Please provide all records of comments submitted by federal agencies on Dr. Janet Yellen's draft testimony about the economics of Kyoto for the hearing before the House Commerce Committee on March 4, 1998.

32a. Given the significant economic costs projected by private sector studies, why did the Administration abandon a year and a half-long effort to develop cost estimates of the President's proposed policies to reduce greenhouse emissions?

32b. Please identify any and all private parties that are currently performing economic analyses of the Kyoto treaty or any aspect of it for the Administration. Describe their work and provide all products of their work in draft or final form.

E. International Emissions Trading

33a. Even assuming that effective rules and procedures can be developed for an international emissions trading system and for joint implementation projects and that key developing countries agree to participate, isn't there a real risk that these mechanisms could effect an enormous transfer of wealth and jobs out of this country overseas, especially to the countries of the former Soviet Union, China, India, South Korea, Brazil, and Mexico (i.e., that this system would be essentially a foreign aid program)? Some studies have estimated that more than 50% of our reductions would have to be purchased from other countries.

33b. Please provide and document estimates of the percentage of U.S. emissions reductions that might have to be purchased from other countries to minimize the costs of reducing emissions and which countries likely would be the beneficiaries.

34. What real incentives do developing countries have to participate in the international emissions trading system, which would require them to commit to mandatory reductions, when they can transfer emissions reductions credits in connection with joint implementation projects and obtain financing through the Clean Development Mechanism?

Definitions and Instructions for the Production of Records

1. When a request calls for the production of records, the Subcommittee requests all responsive records that are in the agency's possession, custody, or control through the date of the final submission of records to the Subcommittee, unless the request clearly states that the Subcommittee is only interested in records received during a particular time period.

2. Please sequentially number all records that you produce to the Subcommittee, and indicate the source of any record if the source is not accurately reflected on the record itself. Please submit all records on single-sided paper and submit an inventory of records produced if the volume is more than 100 pages.

3. To the extent practicable, please organize the records or documents in tabbed binders or folders that indicate which records are responsive to which requests for information.

4. For the purposes of this and related requests in the future, the "record" or "records" shall include any and all drafts, originals, and non-identical copies of any item whether written, typed, printed, electronically recorded, transcribed, punched, or taped, however produced or reproduced, and includes but is not limited to any writing, transcription, or recording, produced or stored in any fashion, including any and all computer entries, memoranda, notes, talking points, letters, journal entries, reports, studies, calendars, manuals, press releases, opinions, documents, analyses, messages, summaries, bulletins, e-mail messages (in hard copy and electronic forms), disks, the text of any alphanumeric messages or other electronic paging devices, briefing materials, cover sheets or routing cover sheets and any other machine readable material of any sort whether prepared by current or former officers and employees, agents, consultants or by any non-employee without limitation. "Record" or "records" shall also include redacted and unredacted versions of the same record.

United States Senate

WASHINGTON, DC 20510

May 22, 1998

JL4
JAF
RL
AH
JA
HC

The Honorable Bill Clinton
President
The White House
Washington, D.C.

Dear Mr. President:

The latest protocol to the climate change treaty that was negotiated in Kyoto was an important step towards international collaboration in addressing the environmental effects of rising concentrations of greenhouse gases in the atmosphere. It could be improved, however, by encouraging investment in the natural mitigation capacity of forestry and agricultural sinks. In a market-based system that encourages the most cost-effective methods for reducing net emissions of carbon, forestry and agricultural carbon sinks are a profitable pathway to reducing excess atmospheric concentrations of greenhouse gases.

Forestry and agriculture play a significant role in sequestering atmospheric carbon and economic analysis shows these strategies to be cost-effective. With costs of $2-$20 per ton of carbon, domestic forest conservation and management strategies achieve not only greenhouse gas mitigation but, a host of other environmental benefits such as protection of watersheds, water supplies, and critical wildlife and fish habitat, increased soil conservation, and reduction of storm water runoff and landslides.

Unfortunately, ambiguous language in the Kyoto Protocol appears to foreclose the highly effective, credible, and low-cost option of reducing carbon dioxide emissions through improved forestry and agricultural management and conservation practices. Without clarifying existing language, the treaty may have unintended negative impacts on vital forest resources and actually increase forest-based carbon emissions, both in this country and abroad. Such incentives are contrary to a number of national policies and international programs such as the Northwest Forest Plan, the Clean Water Act, the Endangered Species Act, the International Tropical Timber Agreement, the Montreal Process, the Gore-Chernomyrdin agreements and the recently convened Intergovernmental Forum on Forests. Consequently, the effectiveness of the treaty can be enhanced by simplifying the language to enable the use of forestry and agricultural practices.

We urge you to promote domestic policy initiatives and seek clarifications to existing Protocol language that would establish comprehensive accounting for forestry and agriculture and enable the issuing of credit for domestic forest and agriculture management and conservation strategies. Furthermore, we recommend directing the Environmental Protection Agency and the Department of Agriculture to work with forest products, agriculture, research, and conservation groups to help develop standardized carbon stock methodology and accounting principles for carbon

sequestration which are key to establishing the credibility of any action undertaken to mitigate excess atmospheric greenhouse gases. To this end, we strongly encourage development of pilot projects investigating the effectiveness of management approaches in selected forests and fields of the United States. As reflected by the sense of the United States Senate and expressed in a Wyden amendment to the FY 1999 Senate Budget Resolution, these elements should be among our initiatives to foster cost-effective and performance-based methodologies to reduce greenhouse gasses.

We appreciate your attention to our call for expanding the role of forests and agriculture in the scientific strategy for mitigating atmospheric greenhouse gases and look forward to working with you on this important matter.

Respectfully,

Senator Ron Wyden

Senator Patrick J. Leahy

Senator Richard G. Lugar

Senator Tom Harkin

Senator James M. Jeffords

Senator J. Robert Kerrey

Senator Barbara Boxer

Senator Dianne Feinstein

Senator Tim Johnson

Senator Thomas A. Daschle

Senator Patty Murray

Senator Joseph I. Lieberman

Senator John H. Chafee

UNION OF
CONCERNED
SCIENTISTS

JCY
JAF
RL
AM
JA
MJ

Attention: Climate Change Aide

May 20, 1998

Dear Senator:

Attached is a letter to Senator Craig that we are copying to the entire Senate. It responds to comments he made in a Senate floor speech and clarifies the current nature of scientific evidence and opinion on climate change. Our *World Scientists' Call for Action* is also included.

For further information, contact Jim Ball, Union of Concerned Scientists, (202) 332-0900.

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20500

FROM: 5-28-98

JCY,

Rosina

Washington Office: 1616 P Street NW Suite 310 • Washington, DC 20036-1495 • 202-332-0900 • FAX: 202-332-0905
Cambridge Headquarters: Two Brattle Square • Cambridge, MA 02238-9105 • 617-547-5552 • FAX: 617-864-9405
California Office: 2397 Shattuck Avenue Suite 203 • Berkeley, CA 94704-1567 • 510-843-1872 • FAX: 510-843-3785

UNION OF
CONCERNED
SCIENTISTS

May 20, 1998

The Honorable Larry Craig
United States Senate
Washington, DC 20510

Dear Senator Craig:

I write to respond to comments you made in a Senate floor speech on April 20 where you suggested that "the vast majority (of U.S. scientists) believe the commitments for reduction of greenhouse gas emissions made by the Administration in the Kyoto Protocol is an unnecessary response to an exaggerated threat" (*Congressional Record*, page S3244).

Let me share with you a few facts that highlight the true nature of where the world's senior scientists and experts stand on the threat of climate change.

- More than 1,500 senior scientists from 65 countries recently signed our ***World Scientists' Call for Action at the Kyoto Climate Summit*** (see attachment). It stated that global climate change is "one of the most serious threats to the planet and to future generations" and concluded, "There is only one responsible choice—to act now." It called upon government leaders to complete "a strong and meaningful Climate Treaty at Kyoto." Signatories included 104 of the 178 living Nobel Prize winners in the sciences and 62 U.S. National Medal of Science Winners.

- More than 2,500 of the world's leading climate scientists, economists, and risk-analysis experts from more than 80 countries participated in the production of the *1995 Second Assessment Report* from the Intergovernmental Panel on Climate Change (IPCC). That report concluded that "the balance of evidence suggests that there is a discernible human influence on global climate," and that the potential serious impacts of climate change include "an increase in some regions in the incidence of extreme high-temperature events, floods, and droughts, with resultant consequences for fires, pest outbreaks, and ecosystem composition, structure, and functioning, including primary productivity." The IPCC cautioned that delaying mitigation measures "may leave a nation or the world poorly prepared to deal with adverse changes and may increase the possibility of irreversible or very costly consequences."

In addition to these statements, since the 1995 IPCC report the scientific evidence continues to mount that the threat of climate change is real. Let me highlight a few findings from articles recently published in prominent scientific journals.

- 1990, 1995, and 1997 were the warmest years since at least 1400, with the 20th century being the warmest century during this time period. Greenhouse gases are the dominant factor in the anomalous warming that began in the 19th century and has accelerated in the 20th. (Mann et al. [1998] *Nature* vol. 392, p. 779).

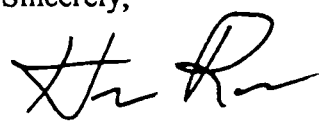
Washington Office: 1616 P Street NW Suite 310 • Washington, DC 20036-1495 • 202-332-0900 • FAX: 202-332-0905
Cambridge Headquarters: Two Brattle Square • Cambridge, MA 02238-9105 • 617-547-5552 • FAX: 617-864-9405
California Office: 2397 Shattuck Avenue Suite 203 • Berkeley, CA 94704-1567 • 510-843-1872 • FAX: 510-843-3785

- New modeling studies indicate with 90% confidence a strong correlation between rising sea surface temperatures due to global warming and increased intensity of Pacific hurricanes (Knutson et al. [1998] *Science*, vol. 279, p. 1018).

- In the U.S., temperature and precipitation have become more extreme, and there is 95% confidence that this is a result of global warming (Karl et al. [1996] *Bulletin of the American Meteorological Society*, vol. 77, pp. 279-292).

To provide you with the most up-to-date assessment of the science available, Alden Meyer, our Director of Government Relations, would be happy to work with your staff to arrange a briefing—for you and other interested Senators—by senior climate scientists, including the Chairman of the IPCC, Dr. Robert Watson. We at UCS look forward to working with you as the debate on this critical issue continues in the months ahead.

Sincerely,



Howard Ris, Executive Director
Union of Concerned Scientists

cc: the Senate

World Scientists' Call for Action at the Kyoto Climate Summit

Attached is the World Scientists' Call for Action at the Kyoto Climate Summit, a document initiated by the Union of Concerned Scientists. This statement urges all government leaders to (1) act immediately to prevent the potentially devastating consequences of human-induced global warming, and (2) demonstrate a new commitment to protecting the global environment.

At the Climate Summit in Kyoto, Japan, to be held in December 1997, nations of the world will decide whether to strengthen the 1992 Framework Convention on Climate Change by agreeing to effective controls on human practices affecting climate. In advance of the Summit, the Union of Concerned Scientists circulated the Call for Action for endorsement to leading scientists from around the world, including all scientists who have been awarded the Nobel Prize and National Academy–level scientists on all continents.

Over 1500 scientists have signed the Call for Action. Their signatures demonstrate that the world's senior scientific community believes that global warming is a serious threat, and that steps to address it must begin with meaningful action in Kyoto. A strong climate change treaty would further represent a landmark precedent for tackling other grave environmental problems, many of which have worsened in recent years.

- Total number of signatories as of October 24, 1997: 1,558
- Countries represented: 65
- Nobel laureates: 109, including 104 of the 178 living Nobel Prize winners in the sciences

A list of selected prominent scientists who signed the Call for Action, as well as the full list of signatories, is also attached.

Union of Concerned Scientists, Two Brattle Square, Cambridge, MA 02238-9105; 617-547-5552

World Scientists' Call for Action at the Kyoto Climate Summit

Five years ago, in the World Scientists' Warning to Humanity, 1600 of the world's senior scientists sounded an unprecedented warning:

> Human activities inflict harsh and often irreversible damage on the environment and on critical resources. If not checked, many of our current practices put at serious risk the future that we wish for human society and the plant and animal kingdoms.

Addressed to political, industrial, religious, and scientific leaders, the Warning demonstrated that the scientific community had reached a consensus that grave threats imperil the future of humanity and the global environment. However, over four years have passed, and progress has been woefully inadequate. Some of the most serious problems have worsened. Invaluable time has been squandered because so few leaders have risen to the challenge.

The December 1997 Climate Summit in Kyoto, Japan, presents a unique opportunity. The world's political leaders can demonstrate a new commitment to the protection of the environment. The goal is to strengthen the 1992 Framework Convention on Climate Change by agreeing to effective controls on human practices affecting climate.

This they can and must do, primarily by augmenting the Convention's voluntary measures with legally binding commitments to reduce industrial nations' emissions of heat-trapping gases significantly below 1990 levels in accordance with a near-term timetable. Over time, developing nations must also be engaged in limiting their emissions. Developed and developing nations must cooperate to mitigate climatic disruption. The biosphere is a seamless web.

Completion of an effective treaty at Kyoto would address one of the most serious threats to the planet and to future generations. It would set a landmark precedent for addressing other grave environmental threats, many linked to climate change. It would demonstrate that the world's leaders have now recognized, in deeds and words, their responsibility for stewardship of the earth. The stark facts carry a clear signal:

There is only one responsible choice—to act now.

We, the signers of this declaration, urge all government leaders to demonstrate a new commitment to protecting the global environment for future generations. The important first step is to join in completing a strong and meaningful Climate Treaty at Kyoto. We encourage scientists and citizens around the world to hold their leaders accountable for addressing the global warming threat. Leaders must take this first step to protect future generations from dire prospects that would result from failure to meet our responsibilities toward them.

The Web of Environmental Effects

Atmospheric Disruption

Predictions of global climatic change are becoming more confident. A broad consensus among the world's climatologists is that there is now "a discernible human influence on global climate."

Climate change is projected to raise sea levels, threatening populations and ecosystems in coastal regions. Warmer temperatures will lead to a more vigorous hydrologic cycle, increasing the prospects for more intense rainfall, floods, or droughts in some regions. Human health may be damaged by greater exposure to heat waves and droughts, and by encroachment of tropical diseases to higher latitudes.

The developing world is especially vulnerable to damage from climatic disruption because it is already under great stress and has less capacity to adapt.

Climate Change: Linkages and Further Damage

Destructive logging and deforestation for agriculture continue to wreak havoc on the world's remaining tropical forests. The burning of the Amazonian rain forests continues largely unabated. Other forests in developed and developing nations are under heavy pressure. Destruction of forests greatly amplifies soil erosion and water wastage, is a major source of loss of species, and undermines the environment's natural ability to store carbon. It releases additional carbon to the atmosphere, thereby enhancing global warming.

Fossil-fueled energy use is climbing, both in industrial nations and in the developing world, adding to atmospheric carbon. Efforts to enhance energy conservation and improve efficiency are much hindered by low energy costs and by perverse incentives that encourage waste. Without firm commitments, most industrial nations will not meet the carbon-emission goals they agreed to at the 1992 Rio conference. The transition to renewable, non-fossil-carbon-based energy sources is feasible but is not in sight for lack of aggressive political will.

The insurance industry has recognized the risks posed by climate change. Leading economists have identified viable policies for reducing these risks. Markets undervalue ecosystems worldwide and inflict few penalties against practices that do long-term environmental and resource damage. Political leadership must introduce incentives that reward sound practices.

Water Scarcity and Food Security

Humanity now uses over one-half of the total accessible freshwater runoff. Freshwater is the scarcest resource in the Middle East and in North Africa. Efforts to husband freshwater are not succeeding there, in East Asia, or in the Pacific.

Global food production now appears to be outpaced by growth in consumption and population. There is broad agreement that food demand will double by 2030. Most land suitable for agriculture is already in production. Sub-Saharan Africa's increase in agricultural production is one-third less than its population growth. The region now produces 80 percent of what it consumes, and per capita production is declining. Projections indicate that demand for food in Asia will exceed the supply by 2010.

Thus, food consumption levels in many countries are likely to remain totally inadequate for good nutrition. Widespread undernutrition will persist unless extraordinary measures are taken to ensure food for all, measures not now even contemplated by governments. Climate change is likely to exacerbate these food problems by adversely affecting water supplies, soil conditions, temperature tolerances, and growing seasons.

Destruction of Species

Climate change will accelerate the appalling pace at which species are now being liquidated, especially in vulnerable ecosystems. One-fourth of the known species of mammals are threatened, and half of these may be gone within a decade. Possibly one-third of all species may be lost before the end of the next century.

Biodiversity gives stability to the ecosystems that we are so dependent on, enhances their productivity, and provides an important source of new foods, medicines, and other products. ❖

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Selected Prominent Signatories to the World Scientists' Call for Action

❖ Nobel Laureates

Philip W. Anderson, USA. Physics 1977
Kenneth J. Arrow, USA. Economics 1972
Julius Axelrod, USA. Physiology/Medicine 1970
David Baltimore, USA. Physiology/Medicine 1975
Georg J. Bednorz, Switzerland. Physics 1987
Baruj Benacerraf, USA. Physiology/Medicine 1980
Hans A. Bethe, USA. Physics 1967
J. Michael Bishop, USA. Physiology/Medicine 1989
James W. Black, UK. Physiology/Medicine 1988
Konrad E. Bloch, USA. Physiology/Medicine 1964
Nicolaas Bloembergen, USA. Physics 1981
Paul D. Boyer, USA. Chemistry 1997
Thomas R. Cech, USA. Chemistry 1989
Stanley Cohen, USA. Physiology/Medicine 1986
Claude Cohen-Tannoudji, France. Physics 1997
Elias James Corey, USA. Chemistry 1990
John W. Cornforth, UK. Chemistry 1975
James W. Cronin, USA. Physics 1980
Paul J. Crutzen, Germany. Chemistry 1995
Jean Dausset, France. Physiology/Medicine 1980
Hans G. Dehmelt, USA. Physics 1989
Johann Deisenhofer, USA. Chemistry 1988
Peter C. Doherty, USA. Physiology/Medicine 1996
Renato Dulbecco, USA. Physiology/Medicine 1975
Christian R. de Duve, Belgium. Physiology/Medicine 1974
Manfred Eigen, Germany. Chemistry 1967
Gertrude B. Elion, USA. Physiology/Medicine 1988
Richard R. Ernst, Switzerland. Chemistry 1991
Leo Esaki, Japan. Physics 1973
Edmond H. Fischer, USA. Physiology/Medicine 1992
Ernst Otto Fischer, Germany. Chemistry 1973
Val L. Fitch, USA. Physics 1980
Jerome I. Friedman, USA. Physics 1990
Donald A. Glaser, USA. Physics 1960
Sheldon L. Glashow, USA. Physics 1979
Roger Guillemin, USA. Physiology/Medicine 1977
Herbert A. Hauptman, USA. Chemistry 1985
Dudley Herschbach, USA. Chemistry 1986
Antony Hewish, UK. Physics 1974
Roald Hoffmann, USA. Chemistry 1981
Godfrey Hounsfield, UK. Physiology/Medicine 1979
David H. Hubel, USA. Physiology/Medicine 1981
Robert Huber, Germany. Chemistry 1988
Sir Andrew Huxley, UK. Physiology/Medicine 1963
Jerome Karle, USA. Chemistry 1985
Henry W. Kendall, USA. Physics 1990
John Kendrew, UK. Chemistry 1962
Klaus von Klitzing, Germany. Physics 1985
Sir Aaron Klug, UK. Chemistry 1982
Arthur Kornberg, USA. Physiology/Medicine 1959
Edwin G. Krebs, USA. Physiology/Medicine 1992
Harold Kroto, UK. Chemistry 1996
Leon M. Lederman, USA. Physics 1988
David M. Lee, USA. Physics 1996
Yuan T. Lee, Taiwan. Chemistry 1986
Jean-Marie Lehn, France. Chemistry 1987
Wassily Leontief, USA. Economics 1973
Rita Levi-Montalcini, Italy. Physiology/Medicine 1986
Edward B. Lewis, USA. Physiology/Medicine 1995
William N. Lipscomb, USA. Chemistry 1976
Rudolph A. Marcus, USA. Chemistry 1992
Simon van der Meer, Switzerland. Physics 1984
R. Bruce Merrifield, USA. Chemistry 1984
Hartmut Michel, Germany. Chemistry 1988
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Mario J. Molina, USA. Chemistry 1995
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Louis Néel, France. Physics 1970
Erwin Neher, Germany. Physiology/Medicine 1991
Marshall W. Nirenberg, USA. Physiology/Medicine 1968
Christiane Nusslein-Volhard, Germany. Physiology/Medicine 1995
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George E. Palade, USA. Physiology/Medicine 1974
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Ilya Prigogine, Belgium. Chemistry 1977
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Burton Richter, USA. Physics 1976
Frederick C. Robbins, USA. Physiology/Medicine 1954
Richard J. Roberts, USA. Physiology/Medicine 1993
Martin Rodbell, USA. Physiology/Medicine 1994
Heinrich Rohrer, Switzerland. Physics 1986
Joseph Rotblat, UK. Peace 1995
F. Sherwood Rowland, USA. Chemistry 1995
Bengt Samuelsson, Sweden. Physiology/Medicine 1982
Frederick Sanger, UK. Chemistry 1958, 1980
Arthur L. Schawlow, USA. Physics 1981
Glenn T. Seaberg, USA. Chemistry 1951
Herbert A. Simon, USA. Economics 1978
Jens C. Skou, Denmark. Chemistry 1997
Richard E. Smalley, USA. Chemistry 1996
Michael Smith, Canada. Chemistry 1993
Jack Steinberger, Switzerland. Physics 1988
Henry Taube, USA. Chemistry 1983
Richard E. Taylor, USA. Physics 1990
E. Donnall Thomas, USA. Physiology/Medicine 1990
Samuel C. C. Ting, USA. Physics 1976
James Tobin, USA. Economics 1981
Susumu Tonegawa, USA. Physiology/Medicine 1987
Charles H. Townes, USA. Physics 1964
Desmond Tutu, South Africa. Peace 1984

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John Vane, UK. Physiology/Medicine 1982
John E. Walker, UK. Chemistry 1997
Thomas H. Weller, USA. Physiology/Medicine 1954
Torsten N. Wiesel, USA. Physiology/Medicine 1981
Robert W. Wilson, USA. Physics 1978
Rolf M. Zinkernagel, Switzerland. Physiology/Medicine 1996

❖ Crafoord Laureates

Vladimir I. Arnold, France. Mathematics 1982
Paul R. Ehrlich, USA. Biosciences 1990
Daniel H. Janzen, USA. Biosciences 1990
Eugene P. Odum, USA. Biosciences 1987
Edward O. Wilson, USA. Biosciences 1990

❖ Selected Officers of National and International Scientific Academies and Associations

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A. Andreev, Vice-President, Russian Academy of Sciences
Sir Michael Atiyah, Former President, The Royal Society (UK)
Francisco J. Ayala, Former President, American Association for the Advancement of Science
Carl Gustaf Bernhard, Former President, Royal Swedish Academy of Sciences
Bert Bolin, Former Chair, Intergovernmental Panel on Climate Change
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Sir Christopher Zeeman, UK
E-An Zen, USA
Lars Zetterberg, Sweden
Guang-Zhao Zhou, China
Zhenda Zhu, China
W. G. Zijlstra, Netherlands
John Ziman, UK
Rolf Martin Zinkernagel, Switzerland
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Martin Zuckermann, Canada
Tomas Zylicz, Poland

EXECUTIVE OFFICE OF THE PRESIDENT
COUNCIL OF ECONOMIC ADVISERS
WASHINGTON, D.C. 20500

THE CHAIRMAN

May 14, 1998

MEMORANDUM FOR THE VICE PRESIDENT

FROM: JANET L. YELLEN Janet L Yellen

SUBJECT: Discussion of Climate Change with Chinese Officials

I wanted you to know that, during my recent visit to China, I raised the issue of climate change in meetings with both China's Premier Zhu Rongji and with officials from China's State Development and Planning Commission (SDPC).

In both instances, I discussed the fact that China could clearly gain from participating in the international greenhouse gas emissions trading regime proposed as part of the Kyoto Protocol (see attached, *Weekly Economic Briefing*, April 3, 1998). I argued that there is a great deal of misunderstanding about the international permit trading system and the potential role of developing countries in this trading regime. I encouraged the Chinese to engage in further discussions with the United States on this issue.

Premier Zhu and the other Chinese economic officials responded with some interest. They expressed concern about the impact of climate change policies on China's economic growth and they emphasized the problem of China's serious dependence on coal. But, in the end, Premier Zhu and the others agreed to further discussions on the issue of the benefits of an international emissions trading regime.

I was encouraged by Premier Zhu's apparent curiosity about international trading and about his willingness to continue discussions. If Chinese leaders understand that China will gain from participating in international permit markets, it may make it easier to convince China and other developing countries to accept the binding targets for greenhouse gas emissions.

Please let me know if you would like any additional information.

Attachment

EYES ONLY

SPECIAL ANALYSIS

Opportunities for Mutually Beneficial Trade in Emissions Permits with Developing Countries

Many observers worry that it will be difficult to entice developing countries to accept binding targets for greenhouse gas emissions under the Kyoto agreement. But evidence on compliance cost differences between industrialized and developing countries suggests that, with the right emissions targets for developing countries, both they and industrialized countries can gain from trade in international permit markets.

Gains from targets and trade. An analysis conducted prior to Kyoto found that developing countries would gain if they adopted greenhouse gas emissions targets slightly below their business-as-usual (BAU) levels. The gains come about because developing countries have per-ton reduction costs substantially below those of industrialized countries. This difference allows them to sell tradable permits to industrialized countries and thereby earn billions of dollars over and above their emissions reduction costs. Industrialized countries would also gain, because the permits let them avoid more costly domestic emissions reductions.

A CEA analysis of the Kyoto agreement finds results similar to this earlier work. During the initial 2008-2012 commitment period, for example, estimates of annual gains from trade are roughly $900 million for Mexico, $1.6 billion for India, or $3.6 billion for China, if each alone were to adopt a target set at its BAU emissions level and trade permits with industrialized countries. The cost to the United States of meeting the Kyoto commitments would fall with such participation; for example, Chinese participation alone would reduce U.S. compliance costs by an estimated $12 billion (see box on next page).

Environmental benefits. These estimates of gains from trade reflect binding emissions targets for developing countries at the BAU level. Targets slightly below BAU would provide climate benefits from reduced carbon emissions and preserve most of the gains from trade. Reducing carbon emissions through this "target and trade" approach has the additional environmental benefit of reducing emissions of local air pollutants in developing countries.

Allaying competitiveness concerns. Adoption of targets even at BAU levels by developing countries would result in carbon permit prices and energy price increases that are the same in these countries as in the United States. With comparable energy price changes, the Kyoto agreement would leave the competitive playing field level among all countries with targets, alleviating concern that energy-intensive industries would flee to developing countries.

EYES ONLY

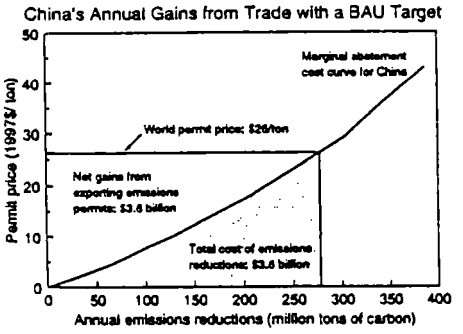
Uncertainty about BAU emissions levels. Uncertainty about future economic growth and technological improvements implies that a developing country's emissions in the absence of a binding target may exceed or fall short of a BAU forecast. For example, if economic growth is unexpectedly high, the target would turn out to be inadvertently stringent. The costs of such stringency may underlie developing countries' concern that targets may hinder economic growth and may explain their reluctance to adopt targets. Similarly, if economic growth is unexpectedly low, developing country targets could turn out to be too lax. Developing countries could then sell emissions permits abroad without achieving real reductions, thereby increasing global emissions. One way to reduce the risks of inadvertent stringency or increases in global emissions would be to make targets contingent on economic growth between now and 2007.

Conclusion. Differences in the costs of controlling carbon emissions between developed and developing countries make it possible for developing countries to gain from accepting emissions targets and participating in international permit markets. Such participation could generate cost savings for the United States and address concerns about competitiveness. These gains are similar to those realized through international agreements to liberalize trade in goods and services such as NAFTA and the Uruguay Round.

Chinese Participation: An Illustration

Analysis suggests that if China adopts an emissions target set at its business-as-usual (BAU) level and participates in international permit markets, the world permit price would fall by about half, to $26 per ton. At this permit price, the Chinese could profitably reduce their carbon emissions by approximately 275 million tons per year (see chart), selling unused emissions permits to industrialized countries and earning $7.2 billion annually in revenue (the rectangle in the chart). Subtracting the cost of reducing emissions, approximately $3.6 billion per year (the shaded area), leaves China with a net gain of about $3.6 billion per year. The gains to the United States from the permit price decrease would amount to about $12 billion per year.

China's Annual Gains from Trade with a BAU Target



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Congress of the United States
House of Representatives

Committees:
Government Oversight
Education and the Workforce

May 14, 1998

Dr. Janet L. Yellen
Chairman
Council Of Economic Advisors
Old Executive Office Building
Washington, D.C. 20502

Dear Dr. Yellen:

I appreciated you taking the time to visit this morning.

Please forward to me all requests from the subcommittee for information regarding global climate change and its economic impact on the US economy. I need this information.

Thank you for your cooperation in this matter.

Sincerely,

Dennis J. Kucinich

Dennis J. Kucinich
Member of Congress

DJK:jm

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Congress of the United States
House of Representatives

Committees:
Government Oversight
Education and the Workforce

FAX MEMORANDUM

Date: 5/18/98

TO: Dr. Janet Yellen Phone: 202-395-5084
FAX: (202) 395-6958

FROM:
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___ Lisa Chamberlain
___ John Edgell
___ Jill Johnson
___ Zeenat Khan
___ Daniel Marschall
X Julie Moses
___ Michael Yarbrough
___ Other_____

MESSAGE:
Request follows.

1 pages to follow

THE WHITE HOUSE

WASHINGTON

April 17, 1998

JCY
JAF
MJ
RL
AM
JA

MEMORANDUM FOR THE PRESIDENT

FROM: TODD STERN

SUBJECT: Climate Change Weekly Report

Domestic/Communications

PATH. We are working on a May 4 event for you in Los Angeles: the formal roll out of PATH -- the Partnership for Advancing Technologies in Housing. PATH is designed to be a partnership among builders, suppliers, insurers, State/local officials and the federal government, led by HUD and DOE, to develop hi-tech homes and move them to market. Compared to ordinary homes, PATH homes would be affordable, more durable, cheaper to maintain and cut energy use by 50% within a decade. LA is a good site for the roll out because the first PATH pilot project -- 186 moderate income homes -- is ready for ground breaking there. This event would also present a good opportunity for you to plug our budget initiative, which includes hi-tech housing measures on both the appropriations and tax sides. As you know, the building sector accounts for around 30% of all greenhouse gases, half of that from residential and half from commercial.

Energy Star Buildings. There is action on the commercial side as well. On April 21, the day before Earth Day, Secretaries Pena and Browner will announce a new Energy Star Buildings program at the site of a 48-story building going up in Times Square. The big news for this program, however, is that three of our great landmark buildings -- the Empire State Building, the World Trade Center and Chicago's Sears Tower -- are joining the program with pledges to reduce their energy use by 30%. To highlight this, we worked the story with *USA TODAY* and gave them an advance copy of a Presidential Statement; they plan to run the story Monday. And we are working with the Vice President's office on a radio actuality, also for Monday.

Diplomatic/Communications

Chile. Your agreement with President Frei was an important step forward, with Chile becoming only the second developing country, after Argentina, to suggest that it might be appropriate for developing countries to take on emissions targets -- though Chile itself hasn't yet agreed to do so. At the same time, our unsuccessful efforts to include strong climate language in the Santiago Plan of Action underscored the difficulties we face with developing counties. Venezuela, an OPEC member, predictably acted to block progress.

Secretary of State. On April 21, the Secretary of State will give a major climate change speech to an invited audience of NGOs, business people and diplomats at the Museum of Natural History. Dr. James Baker of NOAA will open the event. Sec. Albright will focus on the need for all countries -- developing as well as developed -- to do their part. After the speech, she will participate in an interactive session with D.C. kids in the audience, other children from around the country, and a scientist from the Brazilian rain forest.

Congressional

During the second week of the recess, we continued to meet with staff in support of our budget priorities. Senator Bumpers has tentatively agreed to circulate a Dear Colleague which would attach a Presidential letter (1) reaffirming that our climate budget initiative is a high priority and (2) refuting the bogus claim that this initiative is "back door" implementation of the Kyoto Protocol. We will seek to have a similar circulation in the House. On April 23, Congressman McIntosh (R-IN) will hold a wide-ranging hearing in his Government Reform and Oversight Subcommittee aimed at demonstrating that our climate change initiative will hurt ordinary workers, farmers, etc. Our witnesses will likely be from EPA, DOE and DOL and State. One other interesting tidbit: Newt Gingrich has asked Dr. Jane Lubchenco and Nobel Laureates Sherwood Rowland and Mario Molina, all of whom participated in our East Room science round table on climate change last July, to brief him on climate change April 20 in Atlanta.

Science

Seitz petition. A petition critical of climate change science and the Kyoto Protocol, with over 16,000 signatures, may be released Monday, April 20. The petition was circulated by a past President of the National Academy of Sciences, Frederick Seitz, and encloses a non-peer reviewed article by a father and son team from the Oregon Institute of Medicine and two others from the conservative George C. Marshall Institute. The article is deceptively made to look like published proceedings from the National Academy of Sciences. It claims that global warming is a blessing: "Our children will enjoy an Earth with far more plant and animal life as that with which we now are blessed. This is a wonderful and unexpected gift from the Industrial Revolution."

The petition, sent to tens, perhaps hundreds, of thousands of scientists, has caused a stir in the scientific community. *Science* and *Nature* have covered the story, focussing on the deceptive nature of the petition. On April 16, six prominent National Academy members, led by Nobel Laureate Sherwood Rowland and Harvard physicist John Holdren, distributed a letter attacking the petition to 400 editors and journalists. Should release of the petition stir mainstream press interest, top science supporters (like Holdren) will be available for press calls.

Breakup of an Antarctic Ice Shelf. Recent images from a NOAA satellite show that Antarctica's 12,000 square km Larsen B ice shelf appears to have started breaking up, receding past its historical minimum extent. A 40 km long and 5 km wide section broke off, according to the National Snow and Ice Data Center (NSIDC) in Boulder. This appears to be a consequence of a

regional climate warming of 4.5 degrees F since the 1940s -- a rate of warming several times that of the global average -- but its exact cause is not known. An NSIDC research associate said: "The warming trend appears to be related to a reduction in sea ice. The question now is what is causing the reduction. At this point we do not have enough evidence to find a smoking gun."

cc: Vice President
Erskine Bowles
John Podesta
Ron Klain
Katie McGinty
Gene Sperling
Jim Steinberg
Janet Yellen

emp JLY

cc: JPT
AM
AL
JA

"Thank you for meeting last Friday's initial deadline. Please find attached a very rough (preliminary and incomplete) climate change economic analysis packet. I would appreciate your comments on this informal draft by COB Thursday, April 16. You will have another opportunity to comment on a subsequent draft. Our goal is to release the final version on Friday, April 24. Thank you again for your help."

Sincerely,

Peter Orszag
April 14, 1998

PRELIMINARY & INCOMPLETE

CLIMATE CHANGE ECONOMIC ANALYSIS

DRAFT #1

April 13, 1998

TABLE OF CONTENTS

Tab A:

Testimony of Dr. Janet Yellen before the House Commerce Committee, March 4, 1998

TESTIMONY OF DR. JANET YELLEN
CHAIR, COUNCIL OF ECONOMIC ADVISERS
BEFORE THE HOUSE COMMERCE COMMITTEE
ON THE ECONOMICS OF THE KYOTO PROTOCOL
MARCH 4, 1998

Thank you, Mr. Chairman. The President has said that we can work to avert the grave dangers of climate change, while at the same time maintaining the strength of our economy. I agree and am pleased to have this opportunity to appear before the Committee to elaborate on the Administration's views on these issues.

The international agreement that was reached in Kyoto this past December is a crucial step forward in addressing global climate change. But it is only one step in a journey. Since the international effort to reduce greenhouse gas emissions is still in some respects a work-in-progress, it is not yet possible to provide a full authoritative analysis of it. Many of the specifics in several crucial areas are not completely resolved in the diplomatic arena, forcing analysts to make a variety of assumptions about the ultimate form of the international regime. In my testimony today, I will attempt to identify key elements of the agreement and the Administration's policy, such as international emissions trading, meaningful developing country participation, inclusion of land-use activities that absorb carbon ("sinks") and six categories of gases, as well as domestic initiatives, that together can ensure that reductions in global greenhouse gas emissions are consistent with continued strong economic growth. I will explain the reasoning underlying our conclusion that, under these conditions, economic impacts are likely to be modest.

The Administration is strongly committed to ensuring that these key elements are reflected in our domestic and international climate change policies. We are firmly committed to

meaningful developing country participation, the use of sinks to offset emissions requirements, and emissions trading both domestically and internationally. And as you know, the President's FY 1999 budget includes a $6.3 billion package of tax cuts and R&D investments over the next 5 years; this package makes good sense in terms of energy policy and will jumpstart our efforts. A final component of the President's climate change policy is his support for electricity restructuring in a manner that will offer approximately $20 billion in cost savings to electricity consumers, while reducing greenhouse gas emissions.

I. Basic Economic Rationale of the Kyoto Treaty

To begin our analysis, it may be worth stepping back and examining the larger question of the basic rationale, from an economist's perspective, for the Kyoto Protocol.

The earth's surface appears to be warming from the accumulation of greenhouse gases from myriad sources worldwide. None of these emitters presently pays the cost to others of warming's adverse effects -- a classic externality in the language of economists. As a result of these distorted incentives, disruption of the Earth's climate is likely to proceed at an excessive pace and if left uncontrolled may pose substantial costs in terms of harm to commerce and the environment alike. The fundamental economic logic of the Kyoto Protocol is thus that without such an international agreement, individual nations will not have the proper incentives to address the threats from global climate change.

II. Costs of Climate Change

In evaluating efforts to mitigate global warming, the first step is to consider the costs

of inaction. These costs --and they are significant-- provide the primary motivation for actions to reduce greenhouse gas emissions.

The Intergovernmental Panel on Climate Change (IPCC) jointly established by the World Meteorological Organization and the United Nations Environment Programme, concluded in 1995 that "the balance of evidence suggests that there is a discernible human influence on global climate." Current concentrations of carbon dioxide, methane, nitrous oxide, and the other so-called greenhouse gases have reached levels well above those of preindustrial times. Of these, carbon dioxide (CO_2) is the most important: net cumulative CO_2 emissions resulting from the burning of fossil fuels and deforestation account for about two-thirds of potential warming from changes in greenhouse gas concentrations related to human activity.

Climatic Impact

If growth in global emissions continues unabated, the atmospheric concentration of CO_2 will likely double relative to its preindustrial level by midway through the next century and continue to rise thereafter. As a result of the increased concentration of CO_2, the IPCC estimates that global temperatures will increase by between 2 to 6 degrees Fahrenheit in the next 100 years, with a best guess of about 3.5 degrees Fahrenheit. While scientists believe that human activities are leading to a gradual warming of the *average* temperature of the earth, the change in temperature in a given region at a given time may differ substantially from this average. Indeed, models predict warming will be greater in high latitudes than in the tropics, and greater over land than ocean.

Potential consequences associated with this shift in climate include a rise in sea levels, greater frequency of severe weather events, shifts in agricultural growing conditions from

changing weather patterns, threats to human health from increased range and incidence of diseases, changes in availability of freshwater supplies, and damage to ecosystems and biodiversity.

Economic and Monetary Damages

The derivation of quantitative or monetary estimates of the damages from such a change in the climate is extremely difficult given the capacity of today's models. Estimates of the economic damages from climate change fall into the following broad areas: agriculture, sea-level rise, air conditioning and heating, water supply, human life and health, air pollution, and other costs (hurricanes, relocation costs, human amenity, construction, leisure activities, urban infrastructure, and ecological damages such as forest loss and species loss). Although the quantification of these effects is quite demanding, researchers have developed estimates that prompt substantial concern. The IPCC reports that a doubling of carbon dioxide levels would lead to approximately 10,000 estimated additional deaths per year for the current U.S. population from higher summer temperatures, even after netting out the effects of warmer winters and assuming acclimatization. Other researchers have predicted sea level increases of about 20 inches by 2100, with greater increases in subsequent years.

Despite the difficulties, respected researchers have developed estimates of the monetary damages expected from an average worldwide temperature increase. For example, William Cline, then of the Institute for International Economics, estimated that a temperature change of 4.5 degrees Fahrenheit would impose annual damages of about 1.1 percent of GDP per year on the U.S. economy. That amounts to $89 billion in today's terms. (Cline's original estimate is quoted in 1990 dollars. The figure given above translates this number into 1997

terms by scaling it to current GDP.) William Nordhaus of Yale University has likewise computed estimates of the dollar loss attributable to a doubling of greenhouse gas concentrations. Although he uses methods that differ from Cline's in several respects, Nordhuas estimates that a slightly larger temperature change of 5.4 degrees Fahrenheit would impose losses equal to about 1 percent of GDP. A third independent estimate reported by Nordhaus is close to Cline's. It must be noted, however, that this similarity among aggregated estimates masks the true uncertainty associated with forecasts of the damages from given increases in global warming -- the estimates are all fundamentally based on extrapolations from current and past experience, and may not fully incorporate effects that will unfortunately become apparent only with future experience.

One key difficulty in interpreting and monetizing these estimates of damages is uncertainty over the extent that they should be discounted because they occur in the distant future. Since the benefits of stemming future climate change accrue over not only decades but centuries, small changes in the discount rate can produce substantial changes in the results. But the precise discount rate that should be used to evaluate questions as important as the future climate of the planet remains a subject of intense debate. It is safe to say that there is, as yet, no professional consensus on the issue. Indeed there can be no technical answer to the ethical question how we should value the welfare of future generations.

A similar difficulty with such estimates is that they do not include potential non-linearities in the relationships between greenhouse gas concentrations and temperature, between temperature and economic damages, or in the various other complicated relationships governing interactions between greenhouse gas emissions, the climate, and the economy. Current estimates

of damages do not, and cannot, accurately reflect the value of reducing the unknown risk of large-scale and potentially irreversible discrete events with potentially catastrophic consequences.

Two such possibilities serve as illustrations. Warming of Northern tundra may release huge amounts of methane from the permafrost, thereby leading to accelerated warming. We do not know at what point, if any, such potentially unstable activity would be triggered. Second, evidence from climate models suggests that some types of climate change may lead to changes in ocean currents, including weakening of the Gulf Stream that warms Western Europe. Scientific evidence suggests that abrupt seawater temperature shifts have occurred over periods as short as decades.

To what extent are we willing to take such chances with our planet? There is a strong argument for the Kyoto Protocol as a form of planet insurance. But what numerical weight should one assign to these catastrophic risks? In other words, what is the value of the insurance policy? Although it is difficult for an economist, or anyone, to know, reductions in the risk of such catastrophic outcomes must be considered in addition to the costs and benefits that can be reasonably quantified. Since human beings are typically averse to risk, such catastrophic risks are especially important in evaluating whether the benefits of a particular climate control policy justify the costs. One must have at least some sympathy with those who criticize economists on the grounds that the effects of climate change are extremely difficult to quantify in a single monetary number.

III. Addressing Global Climate Change in an Efficient Manner

The costs of unabated climate change may thus be difficult to quantify, but they are nonetheless real and provide the motivation for reducing greenhouse gas emissions. In taking action to reduce those emissions, economic analysis suggests that two elements are absolutely essential:

- The effort must be global, to address the global externality inherent in the nature of the problem.
- The effort must be flexible and market-based, to ensure that we achieve our objectives in the most efficient manner possible.

Need for Global Action

Climate change is a global problem requiring a global solution. As I mentioned earlier, no single country has an incentive to reduce emissions sufficiently to protect the global environment against climate change. Each has an economic incentive to "free ride" on the efforts of others. Even if the United States sharply reduced its emissions unilaterally without an international agreement limiting emissions abroad, greenhouse gas emissions from all other countries would continue to grow, and the risks posed by climate change would not be significantly reduced. It is important to emphasize that emissions of different gases anyplace in the world have very similar effects on global climate.

The threat of disruptive climate change has led to coordinated international efforts to reduce the risks of global warming by reducing emissions of greenhouse gases. A landmark international agreement to address global warming was the Framework Convention on Climate

Change signed during the Earth Summit in Rio de Janeiro in 1992. This convention established an objective of limiting greenhouse gas concentrations and called upon industrial countries to return their emissions to 1990 levels by 2000. Since then, it has become clear that the United States and many other participating countries will not meet this voluntary goal; quite the contrary, emission levels have continued to rise not fall among both developed and developing countries.

To address the lack of progress among many industrialized countries toward meeting the Rio objective, the United States and approximately 160 other nations agreed in negotiations held in Kyoto, Japan, last December, to reduce emissions of greenhouse gases. The Kyoto Protocol, which requires the advice and consent of the Senate, would place binding limits on each industrial country's combined emissions of the six principal categories of greenhouse gases: carbon dioxide (CO_2), nitrous oxide (N_2O), methane, sulfur hexafluoride, perfluorocarbons, and hydrofluorocarbons. These limits apply to the 38 so-called Annex I countries, which are the industrialized countries, defined to include Russia, Ukraine, and most Eastern European countries.

Under the Kyoto Protocol, each industrial country's baseline is its 1990 emissions of CO_2, methane, and N_2O and its choice of 1990 or 1995 levels of the other three categories of gases. The United States agreed to a target of 7 percent below this baseline by the period between 2008 and 2012. Given the changes in the definition of the baseline for the three long-lived chemical compounds (HFCs, PFCs and SF6) from 1990 to 1995 combined with a change in the way sinks are accounted for in the baseline, the actual reduction required in the U.S. is no more than 2-3% more than the President originally proposed as the U.S. negotiating

position. The targets for the European Union and Japan are 8 percent and 6 percent below 1990 levels, respectively. Australia, New Zealand, Norway, Russia, and Ukraine all have limits somewhat less ambitious when phrased as cuts relative to their 1990 levels. In sum, over the period from 2008 to 2012, the industrial countries are expected to reduce their average emissions of greenhouse gases to about 5 percent below their 1990 levels.

The President has made clear that he will not submit the Kyoto Protocol to the Senate without meaningful participation from key developing countries (who are not included in Annex I).

There are several reasons why meaningful participation from developing countries is essential. First, developing countries are projected to contribute a majority of world emissions around 2030 under a continuation of business-as-usual. Without the participation of developing economies, efforts by the industrialized countries to limit emissions will therefore not provide adequate protection from climate change.

Second, developing country participation is crucial because it would permit relatively low-cost emissions reductions to be internationally recognized as a substitute for more expensive emissions reductions that might otherwise be achieved domestically by U.S. companies and those in other industrialized countries. Since greenhouse gas emissions have the same basic impact on the climate regardless of where they occur, emission reductions in developing countries have the same environmental benefit as reductions in the U.S. But these reductions are much less costly than reductions in the U.S. or in other developed nations, because of the very inefficient and carbon-intensive uses of energy in these countries today. It thus makes sense, from both an environmental and an economic perspective, to incorporate emissions reductions in

developing countries into the international system.

Third, principles of basic fairness suggest all countries should do their part, depending, in part, on their ability to contribute to the solution. Thus even poor countries should participate, although the lack of resources in such countries may limit the extent of their participation.

Some have expressed fears that the Kyoto Protocol might adversely affect the competitive position of American industry. Evaluating how the Kyoto Protocol could affect competitiveness of a few specific manufacturing industries -- especially those that are especially energy-intensive, such as aluminum and chemicals -- is complex. The answer depends, in part, on the impact of the agreement on energy prices, which we will shortly address. In general it is difficult to undergo a structural change in the economy without having the effect of expanding some sectors and contracting others. But to provide some perspective on this issue, consider the following facts. First, on average, energy constitutes only 2.2 percent of total costs to U.S. industry. Second, energy prices already vary significantly across countries. According to the *1997 Statistical Abstract,* for example, in 1996 premium gasoline cost $1.28 per gallon in the United States -- but only 8 cents per gallon in Venezuela. Similarly, gas prices were $3.71 per gallon in Switzerland and $4.41 per gallon in France. Electricity prices also vary significantly: in the U.S. they were 5 cents per kilowatt hour in 1995, a fraction of prices in Switzerland of 13 cents per kilowatt hour. Yet U.S. industry is not moving en masse to Venezuela, nor is Swiss industry moving to the United States. Third, roughly two-thirds of all emissions are not in manufacturing at all, but in transportation and buildings, sectors which, by their very nature, are severely limited in their ability to relocate to other countries. We therefore believe we need

developing country participation because the problem is global and cost-effective solutions are essential, than to avoid adverse effects on competitiveness.

Flexibility and Market Mechanisms

A global solution is thus critical to the global problem of climate change. Globalizing the solution is not, however, enough by itself. We must also ensure that our efforts to reduce global greenhouse gas emissions reductions in the most efficient manner possible. The nature of the climate change problem suggests three basic methods to lower costs of achieving given levels of environmental protection. They can be characterized in terms of three categories of flexibility: (1) "when" flexibility; (2) "what" flexibility; and (3) "where" flexibility, which may be the most important of all. Such methods have long been championed by economists interested in increasing the efficiency of protection. Indeed, over 2,500 economists from academia, industry, and government alike urged such approaches in a letter they signed last year advocating action on climate change:

> "Economic studies have found that there are many potential policies to reduce greenhouse gas emissions for which the total benefits outweigh the total costs...The most efficient approach to slowing climate change is through market-based policies."

1. "When flexibility" (timing)

First is "when flexibility" or timing. Since climate change is a long-term problem, the exact timing of emissions reductions is, within some range, not of primary importance. Thus the freedom to delay or accelerate reductions within an agreed upon time frame -- while ensuring credibility of emissions reductions -- lowers costs.

As a result of U.S. leadership, the Kyoto Protocol incorporates this principle of "when

flexibility" in four ways:

- First, the initial emissions reductions are less severe, and the period over which they occur ends much later than what had been proposed by many other countries. By adopting a gradual and credible path of reductions in the early years, we can greatly reduce costs such as those from prematurely scrapping coal-fired electricity plants, while attaining the same ultimate environmental goals.
- Second, under the Kyoto Protocol, the emissions target is not specified in terms of a specific year, but rather in terms of an average over a five-year period (2008-2012). Averaging over five years, instead of requiring countries to meet a specific target each year, can lower costs, especially given an uncertain future. The averaging can smooth out the effects of short-term events such as fluctuations in the business cycle and energy demand, or hard winters and hot summers that would increase energy use and emissions.
- Third, there is allowance for "banking" emission reductions within the 2008-2012 commitment period, for use in a subsequent commitment period [although the emission targets of the subsequent periods have not yet been specified].
- Fourth, CDM credits achieved between 2000 and 2008 may be banked until 2008 to 2012.

2. "What flexibility" (gases and sinks)

The second type of flexibility is "what flexibility", along two dimensions. The first is the inclusion in the agreement of all six greenhouse gases. Emissions of different kinds of gases, not just carbon dioxide, contribute to the greenhouse effect. Since the IPCC has developed

conversion factors for all greenhouse gases by estimating their global warming potentials, reductions in emissions of one gas can be used to substitute for increases in emissions of another by an amount that has equivalent environmental effects. Again at U.S. urging, all six gases are included, while Japan and the EU had insisted until the end on covering only three. Thus the U.S. succeeded in having the Kyoto Protocol stipulate that countries with binding targets are to reduce their *total* greenhouse gas emissions by certain percentages, but does not require specific reductions for specific gases. Since a molecule of sulfur hexafluoride is 23,900 times more potent over 100 years than a molecule of CO_2, it may be cheaper to achieve the same environmental benefit by eliminating one molecular unit of SF_6 than nearly 24,000 units of CO_2.

Some initial analysis indicates that a strategy of reducing non-CO_2 greenhouse gas emissions by a greater percent than CO_2 emissions could lower prices by as much as 10 percent. Thus allowing countries flexibility in what gases they reduce -- essentially trading emissions reductions across gases -- can help lower significantly the costs of meeting their targets.

The second source of "what flexibility" is the treatment of sinks, i.e., land use activities that promote the removal of carbon from the atmosphere through the growth of plants. At the urging of the U.S. delegation, sinks can be used to offset emissions targets. Promoting such sinks through afforestation and reforestation may reduce atmospheric concentrations of CO_2 at much lower costs than reducing emissions of greenhouse gases.

3. "Where flexibility" (international)

The third type of flexibility, and perhaps the most important, is "where flexibility" (international). As I have already emphasized, emissions have the same environmental consequences regardless of where in the world they occur. Therefore, the least-cost approach to

controlling climate change is to reduce emissions wherever such reductions are cheapest. The Kyoto Protocol, because of U.S. insistence and persistence, includes three important cost-saving provisions of this nature.

- First, it provides the opportunity for countries that take on binding targets to trade rights to emit greenhouse gases with each other. This market in emissions permits could ensure that emissions reductions occur where they are least expensive within the industrial countries. In particular, U.S. companies could purchase emissions reductions in other participating countries when doing so would reduce their costs -- thus lowering costs without affecting the level of environmental protection. While currently only industrialized countries have emissions caps, this mechanism also offers an incentive for developing countries to take on emissions targets.
- Second, the agreement provides for Joint Implementation by Annex I countries. Thus if some countries do not develop programs to trade permits internationally, U.S. firms could nonetheless implement projects in those countries for which they could receive emissions reductions credits in the U.S.
- Third, the agreement allows industrial countries to invest in "clean development" projects in the developing world and use these projects' certified emissions reductions toward meeting their targets. Many such clean development projects may be quite cheap in terms of the cost per ton of emissions avoided, as has been illustrated by the Joint Implementation pilot program that is already in place in the U.S.

Details of how these provisions will operate will be discussed in future negotiations such as the one in Buenos Aires later this year. Nonetheless, effective international trading of

emission credits, Joint Implementation, and the Clean Development Mechanism can lead to substantial reductions in costs relative to alternative policies that do not exploit the power of market incentives. To illustrate briefly the ability of U.S. industry to perform beyond expectations when given appropriate economic incentives, consider further EPA's highly acclaimed sulfur dioxide (SO_2) program, which relies, among other things, on a system of tradeable permits to reduce emissions of SO_2 from electric utilities. The SO_2 program has been successful in several ways: a large number of utilities participate, SO_2 emissions and ambient concentrations have fallen and the costs of reducing emissions are considerably lower than originally forecast.

As has been frequently noted, the average cost of SO_2 emissions reductions has recently been significantly lower than was originally forecast, in part due to the role of incentives in fostering innovation. Emission permit prices, currently at approximately $100 per ton of SO_2, are well below earlier estimates of around $250 to $400 per ton.

Trading programs may not always bring cost savings as large as those achieved by the SO_2 program; trading programs will not always be accompanied by the discovery of much cheaper control strategies. However, the SO_2 experience demonstrates clearly how programs like international permit trading, Joint Implementation, and the Clean Development Mechanism will lead firms to find cheaper ways of reducing emissions that can lead to unexpectedly low costs.

IV. Difficulties of Economic Analysis of the Kyoto Protocol

Now that we have a Protocol -- even if it is not yet fully complete nor ready for the President's submission to the Senate -- it is possible to examine it in somewhat more detail from

an economic perspective. But, once again the inherent limitations of any such estimates deserve emphasis. Such limitations should not be surprising to you: economists have a difficult enough time projecting the behavior of the economy over the next quarter or year, let alone over the next two decades. The scale of the forecasting exercise is therefore daunting, and any specific results should be treated with substantial caution.

The difficulties associated with economic analysis of climate change fall into three broad categories. First are the uncertainties that still remain over the terms of the ultimate treaty, necessitating assumptions on which the analysis is predicated. Second are the inherent limitations of available models to analyze even short-term costs and benefits. And finally is a topic discussed earlier: the impossibility of putting a single monetary number on the long-term benefits of climate change mitigation, although there will clearly be economic benefits of emission reductions.

Uncertainties in the International Effort to Combat Climate Change

The Kyoto Protocol was an historic accomplishment, delineating the broad terms of the international effort to address climate change. But although we know a lot more than we did before Kyoto about how that international system can work, and that informs our analysis, there is still much that we do not know.

First, some provisions raise complex implementation issues. At issue here is the treatment of so-called sinks -- activities that affect the rate at which carbon is removed from the atmosphere and "sequestered," e.g., by the planting of trees.

Second, the details of a number of items -- primarily concerning international trading, the Clean Development Mechanism, and developing countries -- are the subject of further

discussions including future negotiations in Buenos Aires next fall, because they had not been definitively settled by the end of the Kyoto talks.

Finally, and most importantly, we have not yet negotiated international agreements to limit emissions beyond the 2012 window. The emission cuts agreed upon at Kyoto are only a first step on a long journey. The first step that we propose to take over the next 15 years is critical. But the reason it is critical is *not* that, by itself, it will solve the climate change problem -- emissions during any given decade are small compared to the cumulative concentrations in the atmosphere. Rather, the first step is critical because we can not take the second and third steps until we have taken the first. At the same time, any analysis is complicated by the lack of knowledge over what the subsequent steps will be.

Inherent Limitations of Models

In addition to these uncertainties about the details of the international effort to address climate change, are the inherent limitations of the models used to evaluate that effort. Even 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. But in addition to the dependence of the results from a given model on the precise assumptions, different models can give different answers even when all the assumptions are specified to be the same -- a concrete illustration of the range of uncertainty to which we must assign the predictions of any one individual model.

One area in which the uncertainty is particularly large is the pace of technological progress --especially the diffusion of existing energy-efficient technologies, but also the development of new technologies -- and the extent to which the pace will accelerate in response

to government programs. Models and experts on climate change policy tend to have a wider range of disagreement on the scope for speeding the diffusion of existing energy-efficient technologies than on any other single issue.

Furthermore, each model has strengths and weaknesses; each has questions to which it is better or worse suited to answer. Some, for example, model the energy sector in detail. Some allow for the fact that a coal-fired power plant cannot costlessly be converted to one that runs on natural gas. Some show the effects of hypothetical tax cuts made possible by the new revenues earned through the auction of emissions permits. Some are capable of showing recessions and booms. Others include a long-term "carbon cycle" model that can keep track of the accumulation of greenhouse gas concentrations in the atmosphere and their climatological effects. Some break down the rest of the world into regions and so can model international trade. No one model does everything, and therefore we must not rely blindly on the results of any one model or set of models. Professional judgement and economic intuition, along with diplomatic assessments, are also crucial.

Benefits of Averting Climate Change

As discussed above, it is evident that the benefits of averting climate change are potentially immense. But we have chosen not to try to quantify them in monetary terms, in light of the difficulties we have enumerated. These include the uncertainty of these benefits, their timing and therefore the extreme sensitivity of the results to the chosen discount rate, and the dependence of benefits on emissions paths after the 2008 to 2012 budget period specified in Kyoto.

V. Assessing the Kyoto Protocol

In order to evaluate the likely net economic impact of the Kyoto Protocol, *excluding the benefits of mitigating climate change itself*, we have drawn upon a variety of tools to assess the various possible costs and non-climate benefits of the Administration's emissions reduction policy. To give away the punch line, our conclusion is as follows: the net costs of our policies to reduce emissions are likely to be small, assuming those reductions are undertaken in an efficient manner and we are successful in securing meaningful developing country participation as well as effective international trading, and the Clean Development Mechanism in future negotiations. That potential small net premium, even excluding the benefits of mitigating climate change, in effect, purchases a partial insurance policy against a serious environmental threat.

Because the results from any model must be treated with caution, the Administration has employed a broad set of economic tools to assess the Kyoto Protocol. We have drawn on the insights of a wide range of models of the energy sector and economy over the next 25 years, including but not limited to the results of the Stanford Energy Modeling Forum exercises, the IPCC's review of the economic and social dimensions of climate change, the work of the OECD on Economic Dimensions and Policy Responses to Global Warming, and the staff-level Interagency Analytical Team analysis produced last year. Other tools include simple relevant statistics, "meta-analyses" such as work by the World Resources Institute, models, and basic economic reasoning. Drawing on this broad array of analytical tools is crucial to an intelligent evaluation of the policy alternatives.

To our knowledge, no model -- whether used inside the government or not -- has yet been set up to analyze the implications of the Kyoto Protocol, since this agreement is only a few

months old and remains unfinished. In particular, no model is currently designed to assess Kyoto's treatment of sinks, or all six greenhouse gases. Some model-builders outside the government tend to take as long as several years to incorporate changes in policy parameters into their models.

Our thinking has been informed, however, by simulations conducted with the Second Generation Model of Battelle Laboratories, one of the leading models in the field. The SGM is one of the models best positioned to analyze the role of international trade in emission permits, which we consider to be a critical element of the Kyoto Treaty. However, the SGM does not cover all six gases included in the Kyoto Protocol or include a role for sinks. We have used the SGM model as one input into our overall assessment of the Kyoto treaty, but have attempted to supplement its results with additional analysis to account for such special features of the agreement as the inclusion of six gases, a possible trading arrangement that could include a subset of the Annex I countries and the Clean Development Mechanism. We will share with you today some preliminary results of this analysis. To the extent possible, we have compared results obtained with the SGM model with those of other modelling efforts.

Mindful of the limitations of any single model, we are eager to see features of the Kyoto Protocol assessed by other models to obtain a better feel for the range of possible effects. This work is just beginning and much of it will continue to go on outside the government. For example, the Energy Modeling Forum, based at Stanford University, is a long-running model comparison exercise involving many of the leading climate models. EMF is currently studying

how features of the Kyoto legal language can be translated into terms recognizable to economic modelers. We expect that the group will conduct a full scale analysis of the Kyoto Protocol. The Energy Modeling Forum believes that its members will need at least until mid-year to update their results.

VI. Assessing the Potential Costs of Emissions Reductions

I said in Congressional testimony last July that we can do this smart or we can do this dumb. I was referring to the point that the costs of cutting emissions can be much reduced if flexible, market-based mechanisms are used. Our economic analysis highlighted the importance of such flexible, market-based mechanisms -- which are therefore reflected, at the President's insistence, in the Kyoto Protocol and our ongoing diplomatic strategy.

Within the Kyoto Protocol, this means an insistence on international trading, Joint Implementation, the Clean Development Mechanism, and, ultimately, on meaningful developing country participation. Domestically, this means that we implement any emissions reductions through a market-based system of *tradeable* emissions permits, which ensures that we achieve reductions wherever they are least expensive. But this also means taking serious and responsible steps in the short run to prepare us to meet our obligations in the longer term.

The first such step is the inclusion in this year's budget of an aggressive, $6.3 billion program of tax cuts and R&D investments -- $1.3 billion more than the $5 billion package the President promised in his October 22 speech on this issue. The goal is both to stimulate the development of new energy-saving and carbon-saving technologies and to encourage the dissemination of those that exist already. The proposed package contains $3.6 billion over the

next 5 years in tax cuts for energy efficient purchases and renewable energy, including tax credits of $3,000 to $4,000 for consumers who purchase highly fuel efficient vehicles, a 15 percent credit (up to $2,000) for purchases of rooftop solar equipment, a 20 percent credit (subject to a cap) for purchasing energy-efficient building equipment, a credit up to $2,000 for purchasing energy-efficient new homes, an extension of the wind and biomass tax credit, and a 10 percent investment credit for the purchase of combined heat and power systems. The package also contains $2.7 billion over the next 5 years in additional research and development investments -- covering the four major carbon-emitting sectors of the economy (buildings, industry, transportation, and electricity), plus carbon removal and sequestration, Federal facilities, and cross-cutting analyses and research. One example of the R&D effort is the Partnership for a New Generation of Vehicles (PNGV). PNGV is a government-industry effort to develop attractive, affordable cars that meet all applicable safety and environmental standards and get up to three times the fuel efficiency of today's cars. In FY99, the combined proposal for PNGV is $277 million, up from $227 million appropriated in FY98. Similar government-industry efforts are proposed to develop more efficient diesel engines for both light trucks and heavy trucks.

A second responsible step entails industry-by-industry consultations to prepare emission reduction plans in key industrial sectors. The Administration will work in partnership with industry to identify ways in which the Federal government might remove regulatory hurdles that discourage energy efficiency. In addition, DOE will spearhead a comprehensive effort to improve the energy efficiency of the Federal government's own operations and purchases.

The third step is the promotion of an environmentally-responsible electricity restructuring bill, which the President identified as part of his domestic climate change package

in his address to the National Geographic Society on October 22. An electricity sector freed from government regulation would be a more efficient energy sector. Costs to consumers would fall. In addition, stronger incentives for improved generation efficiency in conjunction with appropriate market based provisions could achieve modest reductions in emissions. A reasonable overall estimate of the contribution of federal electricity restructuring to the rest of the President's program to address climate change is that it would make further progress to the same emission reduction goals at a cost saving of roughly $20 billion per year. These steps should be taken regardless of Kyoto, because they make sense in terms of energy efficiency. But they have the added benefit of preparing us for Kyoto.

Estimated Reduction in Costs from Annex I Trading

In the language of the treaty, "Annex I," is the set of countries that have agreed to take on binding limitations in emissions of greenhouse gases. Even without meaningful developing country participation -- which, again, the President has emphasized is essential before the treaty would be submitted for ratification -- costs could be reduced substantially by emission trading among the Annex I countries. To provide some indication of the possible efficiency improvements, Russia and Ukraine consume six times as much energy per dollar of output as does the United States. Such large international differences in energy efficiency suggest that adoption of existing U.S. technology would yield very large emissions reductions in these countries.

Estimates derived from the SGM model confirm that emissions trading among Annex I countries can reduce the cost to the United States of achieving its targets for 2008-2012 emissions by about half relative to a situation in which such trading was not available. This

concept of costs is meant to capture aggregate resource costs to the US economy, including the cost to domestic firms of purchasing emission permits from other countries where emission reductions may be cheaper than in the United States. Although these estimates reflect idealized international trading in efficient markets, the overall conclusion is clear. The dramatic reduction in costs potentially available from Annex I trading within the SGM model -- cutting the costs involved by half -- highlights why the President insisted that international trading be part of the Kyoto Protocol; and why its achievement by our negotiators in Kyoto was such an important accomplishment.

Estimated reduction in costs from umbrella trading

One possibility that emerged in Kyoto, which none of us foresaw, was the idea developed there by the U.S. delegation, that the United States might undertake trading with a subset of Annex I countries, dubbed the "umbrella". Countries that have expressed interest in the umbrella include the United States, Australia, Canada, New Zealand and Russia, with strong indications of interest from some others. This subset of Annex I countries shares a common interest in promoting market-based mechanisms, most specifically, fully flexible rules for international trading of emissions permits.

It is too early to state the precise form the umbrella will take. But we can envision a number of potential benefits. The umbrella could, for example greatly reduce costs to the U.S. Results that we have derived from various SGM simulations of efficient international trading suggest that, relative to the situation in which there is no trading at all, the umbrella can reduce costs by an estimated 60-75 percent, depending on whether the former Warsaw Pact countries fall within the umbrella. The Kyoto Protocol classifies these countries outside of the EU bubble

for the first budget period 2008-2012.

Estimated reduction in costs from developing country participation

The next consideration is participation by developing countries. The President has said that he will not submit the treaty for ratification without meaningful participation by key developing countries. Such participation would further reduce the costs involved.

The substantial potential gains from meaningful developing country participation are highlighted by the significant benefits that will likely accrue from the limited role that the developing countries have already agreed to: the Clean Development Mechanism (CDM), modeled after the U.S. joint implementation concept. The CDM cannot realistically be expected to yield all the gains of binding targets for developing countries, but it might shave costs by roughly another 20 to 25 percent from the reduced costs that result from trading among Annex I countries.

Another possibility is that we persuade some of the key developing countries that are the largest emitters to commit to targets, and allow us to buy emission reductions from those paths. Simulations with the SGM model suggest that full participation by non Annex I countries could cut roughly 55 percent off the reduced costs that result from Annex I trading. The actual cost reduction would depend on the extent of developing country participation that is ultimately obtained, as well as the effectiveness of international trading arrangements. The more developing countries that take on modest binding targets and trade in international permit markets, the lower will be costs.

These cost-saving opportunities are fundamental tenets of the U.S. position. The promise of Kyoto cannot be achieved without effective emissions trading. Moreover, if we do

not get meaningful participation by key developing countries, we won't submit the treaty for ratification to the Senate. So, while our analysis may be predicated on some ambitious conditions concerning trading and developing country participation, it is exactly those conditions that form the foundation of the U.S. position in international negotiations including those at Buenos Aires.

Accounting for Carbon Sinks

The preceding discussion has emphasized the importance of trading arrangements and the CDM. In reaching an overall economic assessment, it is also important to factor in the potential role of carbon sinks. Again, the U.S. delegation obtained a novel concept, that carbon absorbing activities called sinks could be used to offset emissions. The arrangements concerning carbon sinks in the Kyoto Protocol have received less attention than they merit. The Kyoto Protocol specifies that removals of CO_2 by sinks count toward meeting the target. The Kyoto Protocol counts the net emissions effects of three sink activities --afforestation, reforestation, and deforestation. Very preliminary estimates of the implications for the United States of the Kyoto provision on sinks indicate that carbon sinks could comprise a significant portion of the total required emissions reductions. Moreover, decreasing the required emissions reduction by, for example, 10% would likely result in cost-savings greater than 10%.

Even this estimate of the effect of sinks is conservative in one respect: it is based on an assumption for sink activity in the U.S. over the 2008-2012 period, and no assumed benefits from sinks elsewhere in the world. Very preliminary estimates suggest that incorporating the gains from sinks *throughout the world* can substantially reduce the costs of meeting the Kyoto target, on top of the gains from trading among Annex I countries. (Furthermore, no model has yet

even tried to take into account that government policies can help increase the activities qualifying as allowable sinks, like some tree-planting.) Because the quantitative uncertainty is so large, we do not yet have an estimate with which we are comfortable. But we expect that complete modelling of the Kyoto provision pertaining to sinks will likely have favorable and potentially large effects on projected costs.

Accounting for the role of improvements in energy efficiency

Another issue in analyzing the Kyoto protocol concerns future improvements in energy efficiency due to innovation and diffusion of existing technology. The parameter that figures most prominently in analysis of energy efficiency is the rate of improvement in the so-called Autonomous Energy Efficiency Index (AEEI), that is the rate at which the total use of energy falls relative to GDP. A plausible assumption on the AEEI is an improvement of 1.0 percent per year. Reflecting a conservative interpretation of the 15-year impact of various climate change initiatives, this is only a small increase above the 0.9 percent number in the Energy Information Administration's Annual Energy Outlook. That assumption is not the most optimistic outcome that might occur. Some authorities in the field of energy policy forecast more rapid technological progress. Experts at five national laboratories managed by the Department of Energy, using an engineering approach rather than an economic paradigm, found that a third of the emissions reductions necessary to return to 1990 levels by 2010 could be achieved through the adoption of existing energy-efficient technologies at no net resource cost, or even some savings. The National Academy of Sciences reached qualitatively similar conclusions in a 1992 report.

The President's FY 1999 budget, as I have noted, includes a $6.3 billion package of

tax cuts and R&D investments intended to spur the discovery and adoption of new technologies. If the Administration is successful in this effort, the rate of improvement in energy efficiency could rise and such improvements would lower the cost of meeting our Kyoto target. For example, published results based on SGM model simulations with different assumed rates of AEEI suggest that an increase in the AEEI of 25 percent could lead to declines in the permit price of approximately 40 percent.

Our justification for incorporating into our assessment a small assumed impact of Administration technology policies is somewhat analogous to the Administration's rationale for employing mainstream economic assumptions in our budget forecasts: in the presence of uncertainty, we are conservative in our estimates of the speed with which the economy will grow, tax receipts will rise, and the budget will improve. That way, any revisions or surprises that occur are likely to be in the pleasant direction. In this instance, we prudently and conservatively assume that there will be substantial delays between investments in new technology or the diffusion of existing technology, and the returns to such investments.

Moreover, at the recent automobile show in Detroit, General Motors announced that it has developed a hybrid-based vehicle that can achieve fuel efficiency of 80 miles per gallon, and that this car could be in commercial production within a few years. Ford also exhibited a prototype of a light-weight highly fuel efficient sedan that could be in commercial production by the middle of the next decade. These announcements followed an earlier breakthrough announced by DOE and its partners of a fuel cell that could run on gasoline and double current fuel economy while reducing conventional air pollution emissions by 90 percent. These technological advances have been made possible through the efforts of the Partnership for a New

Generation of Vehicles between the Administration and the U.S. auto companies and their suppliers.

Such progress may be replicated in other sectors. VCRs and TVs, while switched off, consume about $1 billion worth of electricity annually. EPA has established a partnership with major manufacturers that has a goal of achieving up to a 70 percent reduction in energy use by VCRs and TVs while they are switched off, without sacrificing product quality, usefulness, or increasing costs. This partnership offers promise of substantial improvements in energy efficiency.

Non-Climate Benefits

A final factor that should be included in any comprehensive assessment of the economic implications of the Kyoto protocol are the benefits of the agreement. The literature has emphasized that any relative price shifts that prove necessary to reduce emissions should produce non-climate benefits in three areas: traffic congestion, highway accidents, and air pollution unrelated to climate change. These benefits are hard to quantify precisely but are potentially significant: our rough estimates suggest that these three benefits could offset approximately a quarter of the resource cost of the climate change policy.

Synthesis

A comprehensive evaluation of the economic impact of the Kyoto Protocol must integrate all of the factors described above: reliance on flexible market-based mechanisms domestically; international trading and Joint Implementation among Annex I countries; the Clean Development Mechanism; meaningful developing country participation; the potential cost-mitigating role of including six gases and carbon sinks; the benefits of electricity restructuring;

and emissions reductions achieved as a consequence of other proposed Administration climate change initiatives. Assuming that effective mechanisms for international trading, Joint Implementation and the Clean Development Mechanism are established, and assuming also that the U.S. achieves meaningful developing country participation, our overall assessment is that the economic cost to the United States in aggregate and to typical households of attaining the targets and timetables specified in the Kyoto Protocol, will be modest.

This conclusion that the impact will be modest is not entirely dependent upon, but is fully consistent with, formal model results. I have previously emphasized the limitations of relying on any single model in assessing the economic impact of the Kyoto Protocol, and continue to view any such results as just one input into an overall analysis. But it is worth emphasizing that model results reflecting the details of the Kyoto Protocol are consistent with our conclusion. For example, under the assumptions of either trading under the umbrella or within Annex I, the CDM and permit trading with developing countries, estimates derived using the SGM model, which adjust for the inclusion of six gases and assume little banking of credits beyond 2012, suggest that the resource costs of attaining the Kyoto targets for emission reductions might amount to $7 to $12 billion per year in 2008 to 2012. This implies that overall costs, excluding not only climate and non-climate benefits, but also such cost mitigating factors as sinks and payoffs from the President's electricity restructuring and climate change initiatives, would reach roughly one tenth of one percent of projected GDP in 2010.

A more tangible measure of costs is the estimated effects on energy prices. Excluding the impact of electricity restructuring and the ancillary benefits of mitigation and better forest management, the SGM-based estimate, corresponding to the gross resource cost estimate cited

above, is an emissions price in the range of $14 to $23 per ton of carbon equivalent. This translates into an increase in energy prices between 2008 and 2012 at the household level of between 3 and 5 percent, an increase in fuel oil prices of about 5 to 9 percent, natural gas prices of 3 to 5 percent, gasoline prices of 3 to 4 percent (or around 4 to 6 cents per gallon), and electricity prices of 3 to 4 percent. This increase in energy prices at the household level would raise the average household's energy bill in ten years by between $70 and $110 per year, although such predictions may not be observable because they would be small relative to typical energy price changes, and nearly fully offset by electricity price declines from Federal electricity restructuring. In particular, this increase in energy prices is small relative to the average of *year to year* real energy price changes experienced by U.S. consumers since 1960: such *annual* changes have averaged 3.8 percent. In addition, by 2008-2012, the anticipated 10 percent decline in electricity prices from the restructuring that is part of our climate change agenda is projected to lead to expenditure reductions of about $90 per year for the average household.

As highlighted earlier, there are substantial but unavoidable uncertainties surrounding estimates like these. For example, the estimate just discussed is predicated, among other things, on the developing country participation that we are insisting upon as a condition for our ratifying the Kyoto Protocol, but which is not yet part of that Protocol, and on effective international trading. Moreover, other models will yield other answers and much work remains to be done by the modeling community to test the robustness of these results. Preliminary comparisons of the SGM model to the few other models that have attempted to evaluate the Kyoto accord, suggest that its predictions concerning the impact of the Kyoto Protocol on carbon permit prices are neither the most conservative nor the most optimistic of the models that have been developed.

The predictions of the SGM model are robust in the sense that virtually all energy models reveal the potency of effective, flexible, domestic and international trading mechanisms to reduce substantially the cost and energy price impact of meeting the Kyoto targets.

Of course, the most important factor that has been left out of the above assessment is the benefit of mitigating climate change itself. A full cost-benefit analysis would include mitigation in the benefits column. The only reason we have not done so, explained repeatedly above, is the difficulty in coming up with a number to capture the monetary benefits. But nobody should lose sight of our ultimate objective -- keeping our planet the hospitable home that we enjoy today.

Effects on employment and aggregate output

So far we have said nothing about job losses resulting from climate change policy. Although there may be job gains in some sectors and job losses in others, we do not anticipate any significant aggregate employment effect if we achieve the conditions we have discussed. The effects on energy prices described above will occur only 10 to 14 years in the future. Not only are these effects small relative to historical variations in energy prices, and offset by other policies like electricity restructuring, they would occur sufficiently far in the future to enable monetary policy to keep the economy operating at its potential. In energy-intensive sectors some employment reduction could occur, although given the very small predicted change in energy prices, impacts in most such sectors are apt to be minimal. Furthermore, a large number of jobs will be created in other sectors -- many of them high-tech jobs paying high wages. The President is firmly committed to assisting any workers who are adversely affected during the transition to a climate-friendly economy.

VII. Conclusion

In conclusion, the Kyoto Protocol and the President's general approach to climate change reflect the insight of economic analysis. The Kyoto Protocol includes key provisions on international trading and Clean Development projects. The President's approach relies on market incentives -- first, with a system of tax cuts and R&D investments, and then later with a market-based system of tradeable permits -- to ensure that our objectives are achieved as efficiently as possible.

Our overall conclusion is that the economic impact of the Protocol will be modest under the conditions we have identified. The purpose of this testimony has been to explain the reasoning underlying this conclusion, which draws insights from not only the forecasts of individual models, any one of which has its own strengths and limitations, but also a broad variety of additional analyses.

I look forward to continuing to work with members of this Committee, as well as other interested parties, in further analyzing the Kyoto Protocol and evaluating the net effects of reducing greenhouse gas emissions. It is my hope that economic analysis will continue to play a key role in designing policies in this area.

I welcome your questions.

Tab B:

Economic Report of the President, February 1997

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Transmitted to the Congress
February 1997

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February 1996 the Wisconsin Public Service Commission submitted a proposal to the State legislature describing a 32-step plan to bring retail competition to consumers there by 2001. In September 1996 California enacted a plan that would offer consumers a choice of power providers as early as January 1998, with deregulation of retail power prices by 2002. These initiatives illustrate how complementarity between public policy and private markets holds at the State level as well as for Federal regulation.

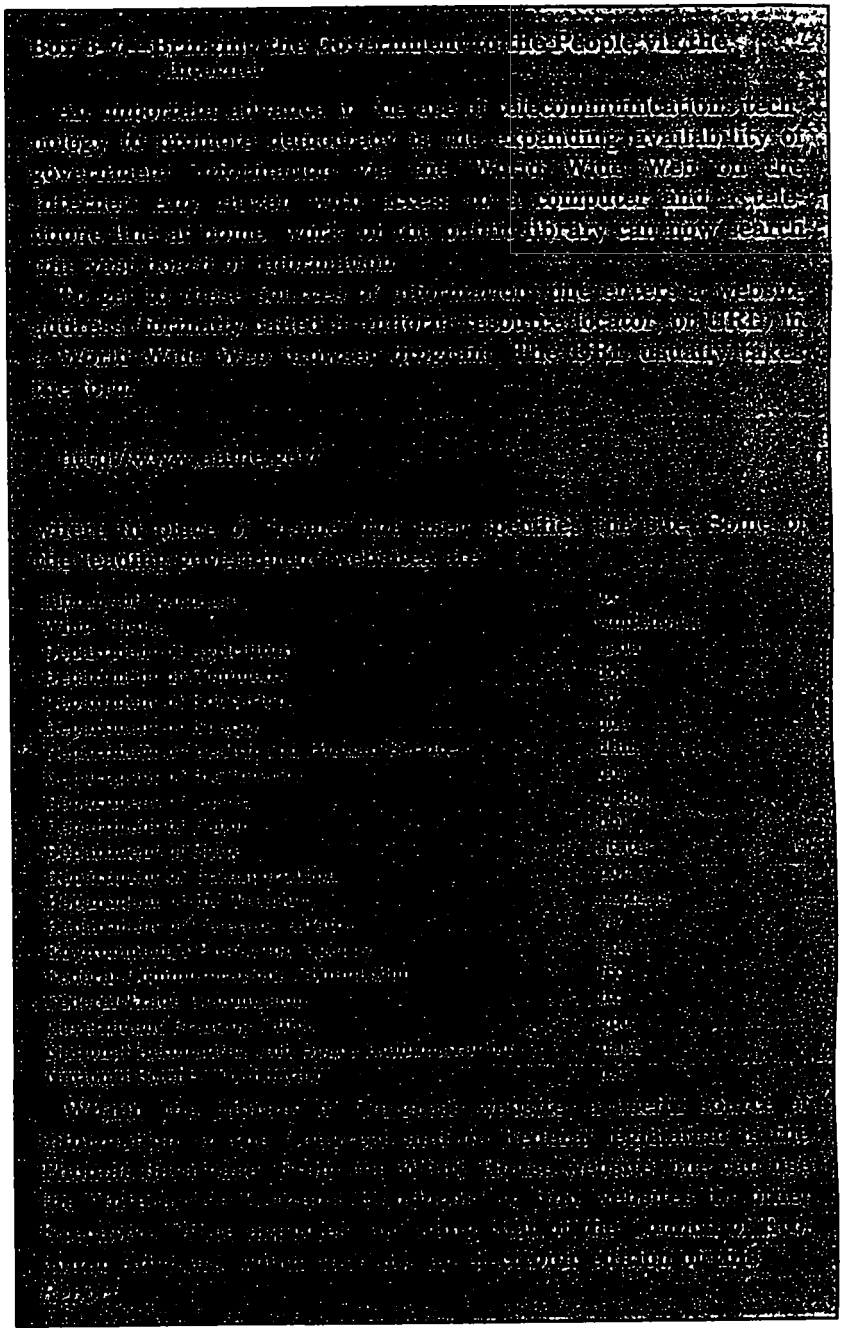
The existing statutory and regulatory framework may make it difficult to resolve the complex issues, such as ensuring system reliability, that are sure to arise as competition in electricity evolves. Accordingly, the Administration is considering a variety of legislative proposals to modify existing regulatory frameworks. Such legislation could promote competition and efficiency in the electricity industry by permitting more flexible industry structures and clarifying the jurisdictional boundaries between State and Federal Governments.

MARKETS COMPLEMENTING GOVERNMENTS

The Telecommunications Act, the FERC's open access orders, and State and Federal actions to implement them illustrate how government policy can facilitate the development of responsive, competitive markets. The street goes both ways, however. Recent policy developments regarding pollution control, spectrum management, and land use show how government can use market forces to help achieve important social objectives. (Box 6–7 indicates how advances in telecommunications are making the government more accessible to the public.)

EMISSIONS TRADING: APPLICATIONS TO AIR POLLUTION

Concerns about environmental degradation and resource depletion have led to an intensified search for innovative, cost-effective solutions. One fairly new approach is emissions permit trading. Proposed at least as long ago as the 1971 *Economic Report of the President,* emissions trading is now often regarded as the preferred policy approach to a range of environmental problems. By giving polluters a financial incentive to reduce emissions in the least expensive possible way, emissions trading reduces the costs of environmental protection. Firms with high abatement costs can purchase permits from firms with low abatement costs, which thus find it profitable to reduce their emissions and sell their surplus permits. As a result, greater responsibility for reducing emissions is allocated to those firms that can do so at least expense.



Emissions Trading in Practice

Much of the enthusiasm for emissions trading is due to its success in attaining mandated reductions in sulfur dioxide (SO_2) emissions from electric utilities, at lower-than-expected costs. The Environmental Protection Agency (EPA) implemented emissions trading as part of its Acid Rain Program. That program, instituted under the 1990 Clean Air Act Amendments, called for major reductions of atmospheric SO_2 and nitrogen oxides (NO_x), the pollutants that cause acid rain. To hold SO_2 emissions to a targeted maximum total level, the EPA issued each polluter a number of permits based on fossil-fuel usage in the mid-1980s. (Box 6–8 discusses the relative merits of giving away emissions permits, auctioning them to the highest bidder, and charging emissions fees.) After the initial distribution, permitholders were allowed to buy or sell permits or use them to offset excess pollution in other parts of their own operations.

During the debate over the Clean Air Act in the 1980s, utilities warned that annual compliance costs could exceed $4 billion by the year 2000, and SO_2 pollution allowances were predicted to trade at prices ranging from $170 to almost $1,000 per ton of emissions. By the end of 1995, however, the price of SO_2 permits was around $80 per ton. Some preliminary analyses suggest that several factors—deregulation that reduced the cost of shipping Western low-sulfur coal by rail, improvements in fuel blending technology, and subsidies for the installation of equipment (called "scrubbers') to filter out emissions from smokestacks—reduced demand for and thus the price of SO_2 permits. The flexibility provided by the emissions trading system, however, is credited with promoting competition in coal markets and encouraging innovation that led, at least in part, to these cost reductions. Whatever the linkage, as market-based methods reduce the costs of abatement, more stringent environmental standards become easier to justify.

The first phase of SO_2 emissions trading, affecting 110 plants, began January 1, 1995. Phase II of the Acid Rain Program is slated to begin in 2000, when an additional 700 fossil fuel-burning plants will be subject to emissions caps. Moreover, analysts expect that permit trading will play a greater role in other ways as the market expands. The EPA is examining ways to respond to increased competition following the FERC's Order No. 888, which according to the EPA's analysis will increase the market share of relatively high emission coal-fired plants. A trading system for NO_x is a strong contender.

Emissions Trading and Climate Change Policy

In July 1996 the Administration announced that the United States would support an international effort to set reasonable and attainable, binding emissions-reduction targets for greenhouse

Box 6–8—Taxing Pollution Versus Giving Away Emissions Trading Permits Versus Auctioning

The first emission permits under the EPA's Acid Rain Program were issued to utilities without charge. But handing out tradable emissions permits for free is not the only way to introduce markets into environmental protection. Other policy options include placing fees on emissions, and auctioning rather than giving away permits. By changing relative prices, and therefore incentives, all of these policies seek to improve upon traditional command-and-control methods that specify pollution limits for each plant and, in some cases, even the technologies to be used to achieve those limits. Market-based incentive policies tend to increase efficiency by imposing a marginal cost on firms for polluting, through either paying more fees, purchasing more permits, or forgoing the opportunity to sell permits to someone else. Facing these costs gives firms the incentive to reduce pollution most at plants where it costs the least to do so, and by developing and using less expensive abatement technologies.

Economically, the choice between fees and marketable permits is of secondary importance. What is crucial to set some absolute limit on the amount of pollution introduced into the environment, permits together with stringent enforcement can achieve that limit, fees cannot. If the incremental social cost from adding pollution is known to be relatively constant, the theoretically better approach would be to set fees equal to that cost. Auctioning permits and auctioning rather than giving away permits also generate revenue that can be used for deficit reduction or to eliminate other distortionary taxes.

Whether the government gives away permits, auction them off, or imposes pollution fees, anything that forces firms to abate pollution tends to raise the cost of supplying the goods and services those firms produce. These higher costs translate into higher product prices. Higher prices, however, lead consumers to take pollution costs into account when making their own purchasing decisions.

gases—the gases whose emission is believed to cause global warming. The possible effects of global warming include risks to coastal areas from rises in sea level; changes in rainfall and agricultural productivity; and increased incidence of diseases such as malaria, yellow fever, and cholera. Combustion of fossil fuels, primarily coal and oil, is the main source of elevated levels of carbon dioxide, the most prevalent of the greenhouse gases.

The United States has called for flexible and market-based approaches for reducing these emissions, one of which may be domestic and international greenhouse gas emissions trading systems. Extending trading internationally is especially intriguing. An international trading system would be able to take advantage of greenhouse gas reductions in those participating nations where the marginal cost of reducing emissions is relatively low.

Other Implementation Issues

Determining the initial distribution of emission permits can be contentious. The alternative to allocating permits through the market by auctioning them is to rely on a formula, which may be based on past and current pollution. Such formulas can be controversial because recipients of permits are given a scarce and valuable resource. Moreover, companies anticipating an allocation based on current practices have an incentive to delay actions to limit pollution or other environmentally harmful activities, in order to qualify for more permits. This incentive can be partially neutralized by linking reductions to some prior historical baseline. However, this approach can make the choice of allocation formula more difficult, since participants will realize that a distribution of permits based on historical practices penalizes those who were the first to undertake actions to improve the environment.

In cases where the incremental harm from emissions is relatively constant over time, the efficiency of emissions trading can be enhanced, at least in the short run, by allowing polluters to bank and borrow permits. Under such a system, polluters could defer their use of a permit, or borrow against future allowances, as their costs dictate. Where workable, this can allow the emissions trading market to allocate reductions over time in a more efficient manner. Timing flexibility can reduce compliance costs through better coordination of emissions reductions when replacing old facilities with less polluting technology. In the first year of the EPA's SO_2 trading program, emissions reductions were about 40 percent greater than the target level, as utilities "banked" allowances for future years.

A problem can arise when the damages from emissions are not distributed evenly over the geographic area in which firms can trade permits. If polluters with high abatement costs—the ones most likely to buy permits—are geographically concentrated, a "hot spot" area that is persistently in serious noncompliance may result. Hot spots are a potential problem with SO_2, but they may be more serious with regard to NO_x. Better market mechanisms for dealing with hot spots should be developed.

Despite these and other complications, interest in emissions trading remains strong, primarily because of the potential cost savings and efficiency gains. The EPA estimates that meeting possible SO_2, NO_x, and mercury targets through an emissions trading program with banking would reduce abatement costs in 2005 by almost two-thirds compared with a traditional command-and-control approach. Researchers at the Stanford Energy Modelling Forum have predicted that international emissions trading for carbon dioxide could reduce costs as much as 50 percent below the minimum achievable using purely domestic programs—and as much as 80 percent if flexibility in the timing of emissions reductions is allowed. These cost savings do not conflict with considerations of intergenerational equity, because they take place within a program designed to ensure that concentrations of carbon dioxide never exceed critical target levels in any year.

SPECTRUM AUCTIONS

Auctions of rights to use publicly owned resources can allocate those resources efficiently, as well as generate revenues to help cover the costs of government programs. The chief example in 1996 was the FCC's auctions of rights to use parts of the radio spectrum for personal communications systems (PCS). By virtually all accounts, this was an enormously successful example of using market forces to complement the public sector.

Auctions can be designed in numerous ways. Some feature one-time sealed bids, whereas others feature repeated open bids. Rights or permits to be auctioned can be offered together or one at a time. Winning bidders may pay the bid they offer or, to limit strategic incentives to underbid, they may pay the second-highest bid offered. The winner can be determined either as the last to make an offer higher than all preceding offers, or as the first to speak up as an auctioneer offers a succession of declining sales prices. Regardless of the method, the goals are the same: to get assets into the hands of those who will derive the greatest economic value from them, and to do so rapidly and efficiently. How best to design the auction depends on a variety of strategic considerations. A primary factor in the PCS auctions (Box 6–9) was to enable bidders to pursue collections of licenses and preserve their options when strategies needed revision. This added flexibility is likely to have increased firms' willingness to bid, allowing the government to capture some of the economic benefits created by making it easier for firms to place bids for one license based on their beliefs about whether they will win others.

Spectrum auctions have particular advantages over earlier methods of issuing spectrum licenses. Comparative hearings, in which the FCC attempted to distinguish among prospective licensees on noneconomic grounds, generated enormous delay and expensive litigation with little if any public benefit. Using lotteries to distribute licenses randomly to applicants eliminated the need for the

Tab C:

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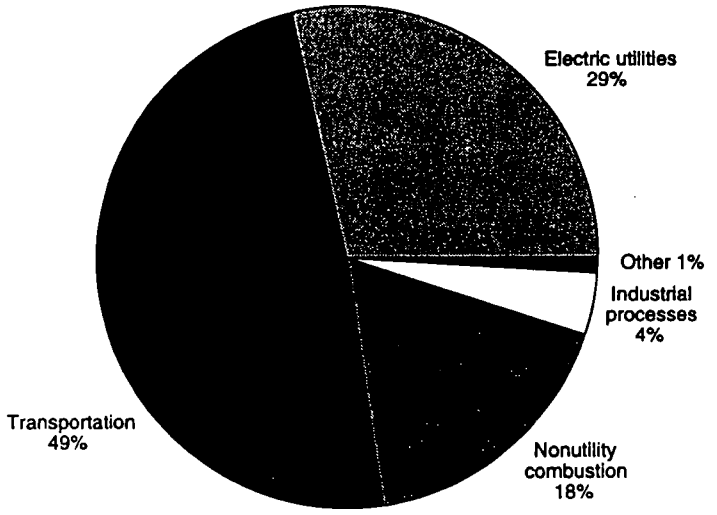
Chart 5-3 **Sources of Nitrogen Oxides Emissions in 1995**
Vehicles are the principal source of nitrogen oxides emissions.



Note: Nonutility combustion includes residential and commercial heating.
Source: Environmental Protection Agency.

Thus, extending NO_x trading to nonutility sources could reduce costs. However, the scope of the program may be limited by the need to ensure accountability. For example, some smaller sources have considerably lower control costs than electric utilities, but their claimed emissions reductions may be more costly to monitor.

Including more sources from different sectors in the trading program may also have desirable distributional effects. Utilities are likely to pass the cost of compliance on to consumers in the form of higher electricity prices, and low-income households spend a higher share of their income on electricity bills than do households near the median income. Moreover, broader scope can decrease the average cost of pollution abatement, reducing the burden on all parties, including the poor.

Another challenge in designing a trading program for NO_x within the context of the regional ozone reduction strategy is to maintain broad geographic scope while ensuring that trading does not result in significant adverse environmental effects. The goal of this strategy is to improve air quality in nonattainment areas cost-effectively. In its simplest form, the problem of pollution transport can be thought of in terms of a single downwind nonattainment area that is affected by a number of upwind pollution sources located at varying distances from it along a line indicating wind direction. In this case, sources that are farther upwind will have less impact on the air quality of the area than sources that are closer, all other things being equal, and such differences may be as large as 10 to 1. It might then appear that emissions trading could undercut the effectiveness of pollution controls if it resulted in shifting emission reductions farther upwind. Trading ratios that weight the reductions made at different sources according to their distance from the downwind nonattainment area might be considered to address this problem. In reality, however, there are a large number of nonattainment areas spread out over the region, and several different weather patterns and wind conditions characterize the ozone pollution episodes that the program is trying to remedy. Sources affect multiple nonattainment areas in a variety of directions from them, and it affects any single nonattainment area differently under different weather conditions. The polycentric nature of this problem complicates the identification of a unique and stable set of trading ratios that would work for all relevant cases. Thus, striking the proper balance between achieving the cost savings from larger geographic scope and limiting the potentially significant adverse environmental effects of trading is an ongoing challenge.

Like most air pollution control programs, NO_x trading programs would require an estimate of emissions from each regulated source in order to ensure compliance. The estimation method can have significant implications for cost-effectiveness, both directly, through the cost of performing the estimate, and indirectly. One indirect implication is that more costly requirements may limit the number of sources that could meet the estimation requirements and participate in trading, and thereby raise costs. On the other hand, a more reliable estimation method may offer regulators and sources greater confidence in the permits, and thereby increase the willingness of sources to buy them or offer them for sale. For example, the SO_2 program requires continuous emissions monitoring to provide precise information on emissions. Such monitoring is expensive and impractical for many smaller sources and thus may effectively exclude such sources from participating. But such precise monitoring may not always be necessary. Methods for estimating emissions that provide unbiased, although less precise, estimates of emissions may be accurate enough to ensure accountability.

CLIMATE CHANGE

Climate change is a global environmental externality: warming of the earth's surface results from the accumulation of greenhouse gases from myriad sources worldwide, none of which presently pay the cost to others of warming's ill effects. The Intergovernmental Panel on Climate Change, jointly established by the World Meteorological Organization and the United Nations Environment Programme, concluded in 1995 that "the balance of evidence suggests that there is a discernible human influence on global climate." Current concentrations of carbon dioxide (SO_2), methane, nitrous oxide (N_2O), and other so-called greenhouse gases have reached levels well above those of

preindustrial times. Of these, CO_2 is the most important: net cumulative CO_2 emissions resulting from the burning of fossil fuels and deforestation account for about two-thirds of potential warming from changes in greenhouse gas concentrations related to human activity. If growth in global emissions continues unabated, the atmospheric concentration of CO_2 will likely double, relative to its preindustrial level, midway through the next century.

The accumulation of greenhouse gases poses significant risks to the world's climate and to human well-being. Potential impacts include a rise in sea levels, greater frequency of severe weather events, shifts in agricultural growing conditions from changing weather patterns, threats to human health from increased range and incidence of diseases, changes in availability of freshwater supplies, and damage to ecosystems and biodiversity.

Climate change is a complex, long-term problem requiring global cooperation and a long-term solution. No single country has an incentive to reduce emissions sufficiently to protect the global environment against climate change. Even if the United States sharply reduced its emissions unilaterally, greenhouse gas emissions from all other countries would continue to grow, and the risks posed by climate change would not be significantly abated. Since many of these gases remain in the atmosphere for a century or more, the climatic effects of actions taken today will primarily benefit future generations. But delaying action to reduce greenhouse gas emissions until the disruptive effects of climate change become widespread will considerably reduce the options for remedial or preventive measures.

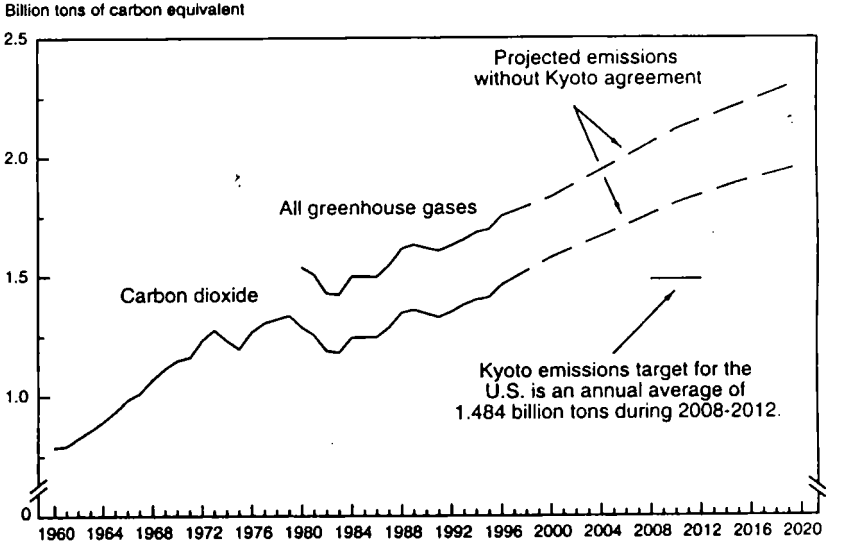
The Framework Convention on Climate Change

The threat of disruptive climate change has led to coordinated international efforts to reduce the risks of global warming by reducing emissions of greenhouse gases. The first international agreement to address global warming was the Framework Convention on Climate Change signed during the Earth Summit in Rio de Janeiro in 1992. This convention established a long-term objective of limiting greenhouse gas concentrations and encouraged the established industrial countries to return their emissions to 1990 levels by 2000. Since then it has become clear that the United States and many other participating countries will not meet this goal.

To address the lack of progress among many industrial countries toward meeting this first target, the United States and approximately 159 other nations, in negotiations held in Kyoto, Japan, last December, agreed to take substantial steps to stabilize atmospheric concentrations of greenhouse gases. The Kyoto agreement, which requires the advice and consent of the Senate, would place binding limits on industrial countries' emissions of the six principal categories of greenhouse gases: CO_2, methane, N_2O, sulfur hexafluoride, perfluorocarbons, and hydrofluorocarbons. Each industrial country's "1990

baseline" is actually based on its 1990 emissions of CO_2, methane, and N_2O and its choice of 1990 or 1995 levels of the other three categories of gases. The United States agreed to a target of 7 percent below 1990 levels over 2008-2012. To meet that target, net U.S. emissions of greenhouse gases—all emissions minus removals of CO_2 by certain forest activities such as planting trees—must average no more than 1,484 million metric tons of carbon equivalent per year during that period (Chart 5-4). The targets for the European Union and Japan are 8 percent and 6 percent below 1990 levels, respectively. Australia, New Zealand, Norway, Russia, and Ukraine all have less stringent limits. In sum, over the period from 2008 to 2012, the industrial countries are

Chart 5-4 **U.S. Greenhouse Gas Emissions, Actual and Projected**
The U.S. emissions target under the Kyoto agreement is about 25 percent below current projections in 2008-2012.



Notes: All greenhouse gases include carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. Carbon equivalence is calculated assuming a global warming potential over a 100-year time horizon. Targets can be met through forest activities that remove carbon from the atmosphere and international permit purchases and credits in addition to domestic emissions reductions.
Sources: Department of Energy, United Nations Framework Convention on Climate Change, and U.S. Climate Action Report 1997.

expected to reduce their average emissions of greenhouse gases to about 5 percent below their 1990 levels.

The Kyoto agreement provides opportunities for the industrial countries to trade rights to emit greenhouse gases with each other. They may also invest in "clean development" projects in the developing world and use these projects' certified emissions reductions toward meeting their targets. Both of these mechanisms allow for emissions reductions to occur where they are least expensive. Many of the details of these provisions will be worked out in subsequent negotiations.

Emissions Permit Trading for Greenhouse Gases

One component of the Administration's climate change proposal, announced last October by the President, is a domestic emissions permit trading program for greenhouse gases starting in 2008. As in the similar program for SO_2, permit trading would allow emissions targets to be met at a lower cost than under a traditional regulatory approach that sets fixed limits on individual firms' emissions.

As previously discussed, one consideration in designing an emissions permit trading program for greenhouse gases is how initially to distribute permits. The method of initial allocation would not generally affect the efficiency with which emissions reductions are achieved, but would have significant distributional implications. Another issue is where, in the marketing chain of products responsible for greenhouse gas emissions, permits would be required. One approach, called the permit-to-market approach, would impose the emissions limits at the point of first sale of the commodities responsible for greenhouse gases. In the case of SO_2 emissions, permits would be required for the sale of fossil fuels and specified in terms of the amount of SO_2 released in their combustion. The requirement would be imposed at the wellhead or the refinery (in the case of oil or natural gas), at the mine (in the case of coal), or at the port of entry (in the case of imported fossil fuels). Alternatively, a permit-to-emit approach would issue permits to consume these fuels or to sell products, such as automobiles, that do so. A hybrid of the two approaches may also be possible.

The design of an effective greenhouse gas permit system needs to take several other issues into account. First, a sufficient number of participants must be included in the domestic permit market to ensure that the market is competitive and efficient.

Second, the system should include a monitoring mechanism that assesses compliance in the most cost-effective manner possible. In the case of a permit-to-market system, since the amount of SO_2 emitted per barrel of oil or ton of coal consumed is relatively fixed, the task of measuring SO_2 emissions is straightforward. Moreover, for accounting purposes firms already collect information and keep records about their fuel transactions. Under the permit-to-emit approach, monitoring would likely involve a more complex combination of emissions calculation and measurement for all regulated greenhouse gas emitters.

Third, a permit system that would allow trades across all sectors of the economy would minimize total cost. If, for example, the incremental cost of reducing emissions is much lower in electric power generation than in transportation, one could reduce the cost of meeting the reduction target by allowing permit trading between the two sectors. The permit-to-market approach would generally allow trades across sectors. The permit-to-emit approach could also yield the same result, depending on how it is implemented.

Timing Flexibility in Meeting Emissions Reductions

Flexibility about *when* emissions reductions take place can further lower the cost of reducing greenhouse gas emissions. A system that allows participants to borrow emissions permits from the future or to save unused permits for future use would take advantage of differences in cost abatement opportunities across time.

Three features of the Kyoto agreement contribute to timing flexibility. First, the target for emissions reductions is based on a 5-year commitment period. For example, the target set for the United States of a 7-percent reduction in emissions below 1990 levels is specified as an annual average over 2008-2012. By averaging over 5 years instead of requiring the United States to meet the 7-percent target each year, the agreement provides flexibility in the timing of reductions that can lower costs, especially given an uncertain future. Averaging can smooth out the effects of short-term events such as fluctuations in the business cycle and energy demand. It can also lessen the impact of a year with a hard winter, when energy demand, and thus emissions, would increase. Further, if firms anticipate that a new technology will soon be available that lowers the cost of reducing emissions, they could emit more greenhouse gases in the early years of the period and less after the technology becomes available. Another advantage of this approach is that it may avoid forcing a costly rapid turnover of capital stock for electricity generation.

The Kyoto agreement allows countries to bank unused emissions rights from one commitment period for use in the next. Should investments in research and development yield some pleasant surprises in the form of cleaner and more efficient technologies, banking will encourage the early adoption of these technologies in order to save unused emissions permits for future periods when the costs of emissions abatement may be higher.

In addition to banking across commitment periods, countries may bank certified emissions reductions obtained through the "clean development mechanism" discussed below. Countries may use emissions reductions achieved through this mechanism over the 2000-2007 period to assist in complying with their targets in the first commitment period. This provides an incentive for firms in industrial countries to begin investing in energy-efficient technologies in developing countries before 2008.

International Trading in Greenhouse Gas Emissions

Building on the benefits of the domestic trading program just described, the Administration proposed in Kyoto an international trading program for greenhouse gas emissions permits. The Kyoto agreement established the right of countries assigned emissions targets to meet their commitments by trading among themselves. This establishment of the right to trade provides the foundation for a trad-

ing regime among industrial countries, but leaves the details to be agreed upon later. Since it is easier to reduce emissions in some countries than others, and given that greenhouse gas emissions have equivalent climate effects regardless of their location, allowing global trading would achieve climate change objectives at lower cost. Such a global approach would ideally allow trading among all sources of greenhouse gases in participating countries and could incorporate opportunities to *remove* greenhouse gases from the atmosphere, for example by issuing emissions credits (which could then be sold to other firms) for reforestation projects.

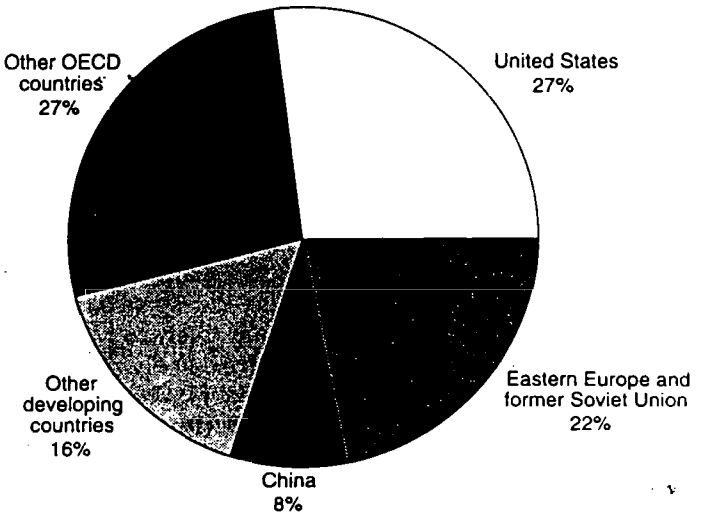
International trading could take place among firms that have been allocated permits through domestic trading programs. For countries that have no domestically tradable permits because they have opted for a command-and-control or a tax approach to controlling emissions, it may still be possible instead to arrange exchanges on a government-to-firm or government-to-government basis.

The setting of binding targets among all countries, together with international trade in permits, could in principle result in a global market price for permits for greenhouse gas emissions. For example, the permit price could be expressed in terms of dollars per ton of carbon equivalent emitted. Firms in all countries would reduce their emissions until the cost of further reductions exceeded this price, at which point they would buy additional permits. Large differences in both the patterns of energy use and the efficiency of energy technologies among countries imply that the cost savings from international permit trading would be large compared with a system without international trading. Put differently, even in comparison with a system with full domestic trading of emissions permits, international trading could substantially lower costs. Some models predict that the incremental cost of reducing CO_2 emissions may be as little as one-seventh of the cost of reductions from domestic trading alone. The gains from international trade in permits would be particularly large if developing countries were to participate.

The Importance of Developing-Country Participation

Negotiations leading up to the Kyoto agreement sought binding limits on greenhouse gas emissions among industrial nations. Developing countries have resisted committing themselves to binding limits on their emissions because of concern that to do so would severely constrain their economic growth, and because by far the greater part of accumulated greenhouse gases in the atmosphere is the result of past economic activity in the industrial countries (Chart 5-5). However, current forecasts project that greenhouse gas emissions from developing countries will surpass those from industrial countries around 2030, and even sooner if industrial countries are successful in limiting their emissions (Chart 5-6). Thus, eventual curbs on emissions from developing countries are essential in order to

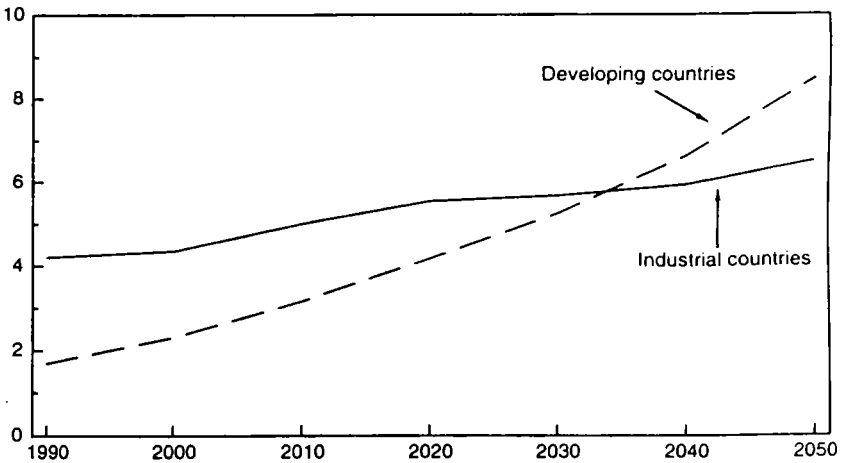
Chart 5-5 Cumulative World Emissions of Carbon Dioxide, 1950-95
Industrial countries are responsible for the vast majority of accumulated carbon dioxide in the atmosphere.



Note: Other OECD countries include the countries of the European Union, Australia, Canada, Iceland, Japan, New Zealand, Norway, Switzerland.
Source: Department of Energy.

Chart 5-6 Projected World Carbon Dioxide Emissions Without Kyoto Agreement
Around 2030, annual carbon dioxide emissions from developing countries are expected to surpass industrial countries' emissions.

Billion tons of carbon equivalent per year



Note: These projections are consistent with the Intergovernmental Panel on Climate Change IS92A global projection through 2100.
Source: Unpublished calculations by A. Manne, Stanford University and R. Richels, Electric Power Research Institute.

stabilize the amount of greenhouse gases in the atmosphere. Moreover, some of the least cost opportunities for reducing greenhouse gas emissions are in developing countries, because those countries now use energy relatively inefficiently. Moreover, those that are industrializing rapidly have greater scope to build their industry around cleaner and more efficient energy technologies and fuels than do mature economies whose capital stock is already in place.

Failure to involve developing countries in an international agreement limiting greenhouse gas emissions could lead to a more rapid rate of increase in emissions in those countries than would occur without any agreement at all. This "leakage" effect of emissions reductions could come about in any of several ways. As industrial countries reduce their use of fossil fuels in response to emissions controls, future world oil and coal prices are likely to be lower than they would be otherwise. This is likely to increase energy consumption in countries not bound to limit their emissions. U.S. industries are also concerned about their international competitiveness if some countries remain outside an international agreement, since factories in those countries will face lower costs for producing goods that take relatively large amounts of energy to manufacture. Some may be concerned that energy-intensive industries might choose to relocate to countries not subject to emissions constraints, although there is little evidence to suggest that this would pose a significant problem in most industries. For example, energy costs for manufacturing industries average just 2.2 percent of total costs.

Given the projected growth of developing countries' emissions, the Administration's position is to seek meaningful participation by key developing countries in the reduction of greenhouse gas emissions as a condition for the United States taking on binding emissions reductions. The President has indicated he will not submit the Kyoto agreement for Senate ratification until there is meaningful participation by key developing countries.

Joint Implementation and the Clean Development Mechanism

To encourage participation by developing countries in the climate change initiative even before they formally sign on for binding emissions limits, the President has proposed a program known as joint implementation. This program would provide incentives to developing countries to reduce their emissions of CO_2 and other greenhouse gases. The Kyoto agreement embraces the President's proposal in its designation of a "clean development mechanism" (CDM): U.S. companies that undertake projects that reduce greenhouse gas emissions in developing countries could count those reductions to meet their commitments. Institutionalizing key elements of joint implementation through this mechanism would encourage firms in the United States to transfer a larger volume of cleaner and more energy-efficient technology to developing countries, especially in the electric power

generating industry, while providing substantial cost savings to U.S. firms. It would also provide incentives to expand forests, which absorb CO_2. In addition to the CDM, the agreement allows industrial countries to undertake joint implementation projects with each other.

A key issue is how to ensure that credits are awarded for actual, additional emissions reductions, and not simply for projects that would have been carried out anyway. The Kyoto agreement requires that emissions reductions occurring through the CDM be certified to provide real, measurable, and long-term benefits related to the mitigation of climate change, and that the emissions reductions achieved are additional to any that would occur in the absence of these projects. Future negotiations will focus on developing the rules for certifying and enforcing projects undertaken through the CDM.

Promoting Clean and Efficient Energy Technology

The President's plan to reduce greenhouse gases commits new resources to energy research and programs to promote the wider use of cleaner and more energy-efficient technologies in the U.S economy. The emissions permit trading system for greenhouse gases is also likely to encourage more private research and innovation, as companies seek to lower the cost of meeting environmental targets.

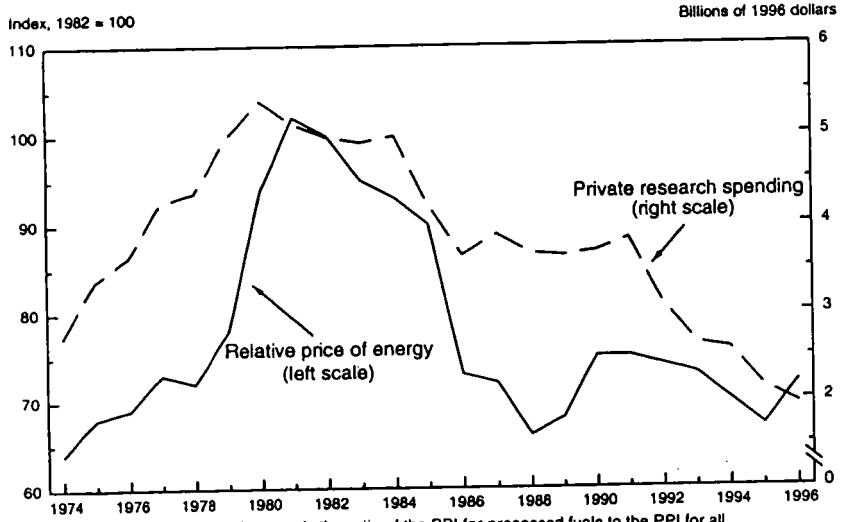
Government support for science and technology in general addresses an important market failure. Promising new technologies often fail to attract sufficient private sector interest if their technical risk is high and if they create economic and social benefits beyond what the investing firms can capture for themselves. Economic studies have shown that private firms, despite intellectual property protection, are able to appropriate only about half of the total economic benefits from their own research. This gap between social and private returns may be particularly large for research on cleaner and more efficient energy technology, when the environmental externalities associated with energy use have not been fully addressed by environmental and other regulatory policies.

The appropriability problem is not limited to basic research but frequently extends to precommercial research as well. Precommercial research is research that is close to yielding new products or processes, but still far enough away from commercialization that further development poses a substantial financial risk. New renewable energy industries (wind power, solar energy, and biomass energy, for example) may face particularly formidable constraints to commercialization. First-of-a-kind products often have high unit costs. High-volume production provides economies of scale, generates experience in manufacturing and operation, and opens new opportunities for incremental technological improvements—all of which may lead to lower costs.

The President's commitment to increase Federal support for new energy technology seeks to reverse a trend of declining national

investment in energy research (Chart 5-7). One reason investment in energy research has declined since the late 1970s is falling or stagnant energy prices, which reduced the economic incentive to develop new sources of energy and improve efficiency. In the 1990s it is primarily private sector energy research that has declined. Increasing government investment in energy research is likely to be complemented by more private research: public research on longer term, basic scientific studies can open up new, profitable opportunities for applied research and commercial development by the private sector. An increase in support for research that raises the rate of progress in developing cleaner and more efficient technologies would lower the costs of reducing greenhouse gas emissions.

Chart 5-7 **Energy Prices and Private Energy Research**
Energy prices and private investment in energy research have followed similar trends since the 1970s.



Note: The relative price of energy is the ratio of the PPI for processed fuels to the PPI for all intermediate materials.
Sources: Department of Energy and Department of Labor (Bureau of Labor Statistics).

The President's proposal also includes programs and tax incentives to encourage the wider adoption of existing technologies that can decrease greenhouse gas emissions. Of particular importance are technologies that reduce consumption of fossil fuels. In addition to encouraging clean and renewable energy sources, these programs will provide economic incentives and other forms of assistance (such as better information) for improving energy efficiency in industry, transportation, and homes. The President's plan to use Federal procurement policy to reduce greenhouse gas emissions is another way to increase market penetration of these technologies.

Until an emissions cap and trading system are in place, however, the economic incentive to use these technologies may be low, because at present the price of energy does not reflect the environmental cost of

CO_2 emissions. This environmental externality results in a market failure to make the most efficient use of new technologies that lower emissions. Many of these technologies are expected to be more profitable once a CO_2 emissions cap is in place and the environmental costs associated with energy use are more fully reflected in energy prices.

There is also evidence that many households and businesses fail to invest in some home and building improvements that appear profitable even at today's energy prices. More efficient home refrigerators and air conditioners, fluorescent lighting, and "low-E" glass for windows, for example, are available on the market and, by some accounts, offer potentially large energy and cost savings. By spending money now on these more efficient technologies, proponents argue, many consumers could quickly recoup their investments in the form of lower energy bills. But if such investments are in consumers' own economic interest, why don't they invest in them on their own? Insufficient knowledge and information may be a key factor: consumers may not be aware of new technologies that could reduce CO_2 emissions and save them money on energy bills, or may not be convinced of the economic benefits that could be realized from adopting them. Lack of up-to-date information on recent technological developments may also lead people to overestimate technical risks—they may doubt whether a new technology is as reliable as current methods, particularly if the new technology is not yet widely used.

On the other hand, even if a new technology is beneficial for many users, it may not be so for everyone. People differ in their willingness and ability to make investments today in order to realize savings in the future, especially if the initial expense is relatively large. In addition, some consumers may value a product for attributes other than its energy efficiency—for example, its convenience, size, or design. And not all consumers may achieve all of the promised energy savings, depending on the climate of the region where they live. These considerations reflect the great diversity of needs and preferences among businesses and households and help explain why new technologies may diffuse slowly over time.

Better information about the potential cost savings from improving energy efficiency may increase the use of technologies that already meet the market test—that is, that meet consumer standards for quality and dependability and offer real economic benefits. The Federal Government is working with the private sector to promote wider use of such technologies. For example, through the Green Lights program, the EPA provides technical information to private companies on the economic and environmental benefits of switching to new, fluorescent lighting systems. Energy Star is another EPA program, in which innovative products that use significantly less energy than older generation products are allowed to bear a special, readily identifiable label. More rapid diffusion of new emissions-saving technologies would make an important contribution toward meeting the goals of the Kyoto agreement.

Tab D:

Economists' statement on climate change, endorsed by over 2500 economists including eight Nobel Laureates

ECONOMISTS' STATEMENT ON CLIMATE CHANGE

Endorsed by Over 2500 Economists
including eight Nobel Laureates

I. The review conducted by a distinguished international panel of scientists under the auspices of the Intergovernmental Panel on Climate Change has determined that "the balance of evidence suggests a discernible human influence on global climate." As economists, we believe that global climate change carries with it significant environmental, economic, social, and geopolitical risks, and that preventive steps are justified.

II. Economic studies have found that there are many potential policies to reduce greenhouse-gas emissions for which the total benefits outweigh the total costs. For the United States in particular, sound economic analysis shows that there are policy options that would slow climate change without harming American living standards, and these measures may in fact improve U.S. productivity in the longer run.

III. The most efficient approach to slowing climate change is through market-based policies. In order for the world to achieve its climatic objectives at minimum cost, a cooperative approach among nations is required—such as an international emissions trading agreement. The United States and other nations can most efficiently implement their climate policies through market mechanisms, such as carbon taxes or the auction of emissions permits. The revenues generated from such policies can effectively be used to reduce the deficit or to lower existing taxes.

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January 3rd, 1997

Dear Colleague,

As you may know, representatives of the world's nations will convene in Kyoto in December, 1997 to negotiate an international agreement addressing the threat of global climate change due to greenhouse gas emissions. This presents a significant opportunity for the United States to exercise a leadership role in ensuring our long-term well-being. Conversely, a failure on the part of the U.S. government to put forward a well-reasoned position would be a major environmental, economic, and diplomatic setback.

As the climate debate unfolds, it is imperative that public policy be guided by sound economics rather than misleading claims put forward by special interest groups. For this reason, we invite you to join us in endorsing the attached non-partisan consensus statement on the economics of climate change.

Once this statement has been signed by a large number of economists, it will be widely disseminated to leaders in the public and private sectors, and to the general media. This effort is being coordinated by Redefining Progress, a non-partisan, non-profit public policy organization.

Attached please find an endorsement form for your consideration. This letter and endorsement form are being sent to the membership of the American Economic Association. Please feel free to circulate it to your colleagues in case they are not on the AEA mailing list.

We thank you for your prompt attention to this critical issue.

Sincerely,

Kenneth J. Arrow

Dale W. Jorgenson

Paul R. Krugman

William D. Nordhaus

Robert M. Solow

NOBEL LAUREATE SIGNATORIES TO ECONOMISTS' STATEMENT ON CLIMATE CHANGE

Kenneth Arrow (1972)
Stanford University

Gerard Debreu (1983)
University of California at Berkeley

John Harsanyi (1994)
University of California at Berkeley

Lawrence Klein (1980)
University of Pennsylvania

Wassily Leontief (1973)
New York University

Franco Modigliani (1985)
Massachusetts Institute of Technology (Emeritus)

Robert Solow (1987)
Massachusetts Institute of Technology

James Tobin (1981)
Yale University

ECONOMISTS' STATEMENT ON CLIMATE CHANGE

List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation
A. W. Coats	
Abbass Bozory	
Abdul Qayum	
Ahmad Afrasiabi	
Ajai Chopra	
Alan R. Winger	
Almudena Arcelus	
Amos Khasigian	
Andrea Dean	
Andrew Chritton	
Andrew Horowitz	
Andrew W. Weier	
Angela E. Chang	
Ann A. Dean	
Ann M. Watkins	
Annonymous	
Anthony Apostolides	
Anthony Barkume	
Arthur G. Ashbrook, Jr.	
Arturo R. Torres Jr.	
Arun Kumar Ghosh	
Austin Curwood Hoggatt	
Barbara Weinstein	
Barbara Y. Peters	
Benjamin Bridges	
Bernard Gordon	
Bernard Kemp	
Brian C. Jack	
Bruce Fallick	
Caren Grown	
Carlos Padilla	
Carlos Uliberri	
Carmine Gorga	
Charles D. Coleman	
Charles Ronald Ross	
Charles S. Maurice	
Chetan Sanghavi	
Chris Beacham	
Christian Ergen-Zucchi	
Chyongchiou Lin	
Clara Chu	
Clyde Tappwig	
Cornelia Strawser	
Craig Gallet	
D. Ward Mardfin	
Damon Wheichel	
Daniel G. Swanson	
Danny A. Bring	
David Ashmore	
David Buland	
David Burress	
David C. Campbell	
David C. Roberts	
David Calvin Gogerty	
David D. Hanig	
David L. Siskind	
David M. Eaves	
David R. Burnett	
David Reiffen	
David Sandler	
David Schenker	
Debojyoti Sarkar	
Deborah A. Senior	
Deenie Neff	
Delle Nadler	
Desiderius Vikor	
Dhez Woodworth	
Divid W. Riggs	
Donald E. Agthe	
Donald J. O'Hara	
Donald W. O'Connell	
Donald Wooten	
Douglass B. Lee	
Dr. Raynal Hammelton	
Drue Barker	
Dubravko Mihaljek	
Edgar J. Gordon	
Edward K. Smith	
Elias R. Ason	
Elliot A. Ponchick	
Elmer P. Lotshaw	
Eloy Mestre	
Eric Nauenborg	
Ernest C. Olson	
Eugene D. Straub	
Evamaria Uribe	
Evert Van Der Heide	
F. Brian Simmons, III	
Fereidoon P. Sioshansi	
Francois Melese	
Frank Canter	
Frank Leiber	

ECONOMISTS' STATEMENT ON CLIMATE CHANGE

List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation
Thesia I. Garner	
Thomas Foster	
Thomas M. Stanback, Jr.	
Thomson Whitin	
Tim Lefever	
Timothy D. Baker	
Timothy E. Mc Clive	
Timothy E. Sullivan	
Va Nee V. Van Vleck	
Valeo Schultz	
Van Lam	
Volher Wieland	
W. C. Brainard	
W. N. Turpin	
Willem J. Jansen	
William A. Masters	
William Crowell	
William Dellal	
William J. Weiskopf	
William Kahley	
William R. Belmont	
William S. Stine	
Yves Maroni	
Clark C. Abt	ABT Associates, Inc.
Gregory B Mills	ABT Associates, Inc.
Gunars Hauff Platais	ABT Associates, Inc.
Jacob Benus	ABT Associates, Inc.
Larry L. Orr	ABT Associates, Inc.
Leland Deck	ABT Associates, Inc.
Marty Makinen	ABT Associates, Inc.
Robert Kornfeld	ABT Associates, Inc.
Ulrich F.W. Ernst	ABT Associates, Inc.
Allen B. Ferguson	AFE, Inc.
Amy K. Taylor	Agency for Health Care Policy and Research
Chiou-nan Yeh	Alabama State University
Earl W. Adams	Allegheny College
Kenneth G. Ainsworth	Allegheny College
Stephen D. Casler	Allegheny College
Pamela Mobilia	Alpine PCS
Michael Stavy	Alternative Energy and EV's
Paul Thompson	AMBAC Indemnity
Riad Tabbarah	Ambassador of Lebanon to the U.S.
Daniel Bell	American Academy of Arts & Science
M. Abdul Shibli	American Economic Association
Paul Kahane	American Economic Association
Jay G. Chambers	American Institutes for Research

Name	Affiliation
Donald Rosenthal	American Management Systems
Tom Everding	American Medical Association
Alan G. Isaa	American University
Bruce H. Lubich	American University
Donald Bowles	American University
Howard M. Wachtel	American University
James H. Weaver	American University
Robin Hahnel	American University
Sue Headlee	American University
Karen Hallows	American University, Averett College
Ralph E. Beals	Amherst College
Richard C. Hoyt	Analytics
Samuel Gubins	Annual Reviews Inc.
Elbert V. Bowden	Appalachian State University
James Cavallo	Argonne National Laboratory
Lutz Hendricks	Arizona State University
Michael Lemmon	Arizona State University
Gary A. Latanich	Arkansas State University
Brian J. Cody	Arthur Andersen
Kevin J. O'Connor	Assistant Attorney General
Thomas White	Assumption College
Christopher J. Monroe	AT&T
Douglas G. Hobbs	AT&T
Jian Cao	AT&T
Kumiko Powell	AT&T
Gregory Naplorkowski	AT&T Laboratories
Louis T. Brewer	AT&T, Rtd.
Henry Thompson	Auburn University
John P. Sophocleus	Auburn University
Robert F. Hebert	Auburn University
Jurgen Brauer	Augusta State University. School of Business
Hiro Fukao	Aurthur D. Little
Patrick J. Kennon	Aviation Economics
Mark Tomass	Babson College
Stephen Silver	BADM, The Citadel
Judith A. Smrha	Baker University
Barbara Sherman Rolleston	Baldwin-Wallace College
Terence E. Byrne	Baltimore-Washington Financial Advisors
Leland S. Prussia	Bank of America Corporation
R. McFall Lamm, Jr.	Bankers Trust Co.
Maxwell Rhee	Banque Nationale de Paris
Mary Lashley Barcella	Barcella Associates
Dimitri Papadimitriou	Bard College
Shannon Mudd	Barente Group
Gopal Iyer	Baruch College
Theodore Joyce	Baruch College

ECONOMISTS' STATEMENT ON CLIMATE CHANGE

List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation
Ted Walther	Bates College
Steve Shamlle	Battelle
Katharine F. Wellman	Battelle Memorial Institute
Dave Anderson	Battelle-Northwest
David B. Belzer	Battelle-Northwest
Joseph A. McKinney	Baylor University
John Katharopoulos	BCBS of Michigan
Emie Nadel	BCI
Wayne A. Morra	Beaver College
James Lacey	Bell Labs
Steven G. Lanning	Bell Labs - Lucent Technologies
Roger Story	Bellcore
Kristina Weir	Bellevue Community College
Gary L. Hodgin	Belmont University
Mary M. Thompson	Belmont University
Warren Palmer	Beloit College
Marc Bendick, Jr.	Bendick & Egan Economic Consultants, Inc.
Bertrand LaNoue, O.S.B.	Benedictine College
Janet M. Thomas	Bentley College
Lucy Ackert	Berry College
Bassem Abou-Zeid	Bethel College
Phyllis Campbell	Bethel College
Miles O. Bidwell	Bidwell Associates Inc.
Edward A. Manfield	Binary Traders
Charles W. Bischoff	Binghamton University
Clifford D. Clark	Binghamton University
Dr. N.J. Wulwick	Binghamton University
Stanley H. Masters	Binghamton University
L. Aubrey Drewry, Jr.	Birmingham-Southern College
M. Iqbal Akhtar	Blackburn College
Bennett W. Golub	Blackrouk Financial Management
Edward Bloom	Bloom Research
Woo-Bong Lee	Bloomsburg University
Ronald L. Friesen	Bluffton College
Chong-en Bai	Boston College
Christopher Baum	Boston College
Donald J. White	Boston College
Frank M. Gollop	Boston College
Harold Petersen	Boston College
Joseph F. Quinn	Boston College
Kathleen Lang	Boston College
Marvin Kraus	Boston College
Paul Streeten	Boston College
Robert G. Murphy	Boston College
Andrew Weiss	Boston University
Carla Y. Willis	Boston University
David Weil	Boston University
Debraj Ray	Boston University
Eli Berman	Boston University
Ingo Vogelsang	Boston University
Jonathan Eaton	Boston University
Laurence J. Kotlikoff	Boston University
Shane J. Hunt	Boston University
Thomas McGuire	Boston University
Wei Yu	Boston University
William M. Capron	Boston University
Zvi Bodie	Boston University
Zvika Neeman	Boston University
William F. Samuelson	Boston University, School of Management
John Fitzgerald	Bowdoin College
Alan Day Haight	Bowling Green State University
Charles R. Chittle	Bowling Green State University
Harold L. Lunde	Bowling Green State University
Kyoo Kim	Bowling Green State University
Mark Kasoff	Bowling Green State University
Paul F. Hass	Bowling Green State University
Stephen Ziliak	Bowling Green State University
Felicia Yesari	BPBA-New York
Kalman Goldberg	Bradley University
Kevin M. O'Brien	Bradley University
Anne P. Carter	Brandeis University
Arthur Lewbel	Brandeis University
Gary H. Jefferson	Brandeis University
Rachel McCulloch	Brandeis University
Brian Kelly	Brian Kelly Inc.
Edward R. Fried	Brookings Institution
Margaret M. Blair	Brookings Institution
Nora Lustig	Brookings Institution
Robert Axtell	Brookings Institution
Robert E. Litan	Brookings Institution
Robert Solomon	Brookings Institution
William Dickens	Brookings Institution
Leo J. Raskind	Brooklyn Law School
Akio Yasuhara	Brown University
Louis Putterman	Brown University
Mark B. Schupack	Brown University
Michael Spagat	Brown University
David K. Ross	Bryn Maur College
Thomas Loo	Budget Comp.
Joel D. Fischer	Burnham Securities Inc.
Hasan MacNeil	Butte College
Bruce W. Kimzey	BYU-Hawaii, School of Busines

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List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation
Daniel M. Bernhofen	Clark University
John C. Brown	Clark University
Joseph Golec	Clark University
Rudy Yaksick	Clark University
Wayne B. Gray	Clark University
Fredric Menz	Clarkson University
J.K. Mullen	Clarkson University
Holley Ulbrich	Clemson University
Donald G. Freeman	Cleveland State University
John F. Burke Jr.	Cleveland State University
Jon D. Harford	Cleveland State University
Michael Bond	Cleveland State University
Myong-Hun Chang	Cleveland State University
Vijay K. Mathur	Cleveland State University
Nancy C. Wilson	Climate Institute
Peter J. Francis	CNA Corporation
H. A. Gemery	Colby College
Randy Nelson	Colby College
Tom Tietenberg	Colby College
David M. Sturges	Colgate University
Michael R. Haines	Colgate University
Oz Honkalehto	Colgate University
Robert W. Turner	Colgate University
Wayne A. Grove	Colgate University
Lawrence J. Frateschi	College of Du Page
Mary Goldschmid	College of Mount Saint Vincent
Lee H. Endress	College of Security Studies, Asia-Pacific Center
Marcia J. Frost	College of St. Benedict
James R. Ashley	College of St. Catherine
Miles B. Cahill	College of the Holy Cross
David H. Feldman	College of Willam and Mary
Eric R. Jensen	College of William and Mary
John S. Strong	College of William and Mary
Robert B. Archibald	College of William and Mary
Carol A. Dahl	Colorado School of Mines
Graham Davis	Colorado School of Mines
Wade E. Martin	Colorado School of Mines
Charles Revier	Colorado State University
John B. Loomis	Colorado State University
John R. McKean	Colorado State University
Kenneth C. Nobe	Colorado State University
Robert R. Keller	Colorado State University
Stephen Weiler	Colorado State University
Chris Mayer	Columbia Business School
Kenneth N. Kuttner	Columbia Business School
Orba Traylor	Columbia College

Name	Affiliation
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Elliot Zupnik	Columbia University
Giulio Pontecorvo	Columbia University
Harold W. Watts	Columbia University
Hugh Patrick	Columbia University
James W. Kuhn	Columbia University
Jay Pil Choi	Columbia University
Maurice Wilkinson	Columbia University
Richard R. Nelson	Columbia University
Roberto Perotti	Columbia University
Roger F. Murray	Columbia University
Ronald M. Schramm	Columbia University
Stefan H. Robock	Columbia University
Susan S. Wieler	Columbia University
Duncan K. Foley	Columbia University, Barnard College
Perry Mehrling	Columbia University, Barnard College
Rajiv Sethi	Columbia University, Barnard College
Andrew Haggard	Committee for Economic Development
Ronald S. Boster	Committee for Economic Development
Van Doorn Ooms	Committee for Economic Development
William J. Beeman	Committee for Economic Development
Robert Atallo	Comp. Resource Solutions
Jeffrey G. Woods	Concord College
Dick Nanto	Congressional Research Service
William A. Cox	Congressional Research Service
Spencer J. Pack	Connecticut College
Daniel W. Kennedy	Connecticut Labor Dept.
Stuart Harshbarger	Coopers and Lybrand
Ziad Ayash	Coopers & Lybrand
Habtu Braha	Coppin State College
Donald C. Cell	Cornell College
Gordon Urquhart	Cornell College
Imran Farooqi	Cornell College
Bill Rosen	Cornell University
Duane Chapman	Cornell University
Erik Thorbecke	Cornell University
Gary S. Fields	Cornell University
John H. Bishop	Cornell University
M. Gardner Clark	Cornell University
Robert C. Lind	Cornell University
Robert Gibbons	Cornell University
Robert H. Frank	Cornell University
Shankar Subramanian	Cornell University
Seymour Smidt	Cornell University, Johnson Graduate School
Hirsch S. Ruchlin	Cornell University Medical College
Michael D. Topper	Cornerstone Research

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March 24, 1997

Name	Affiliation
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Bruce Stram	Enron Corporation
Kenneth Acks	Env. Damage Valuation & Cost-Benefit News
Paul Holden	ERI
Robert Neal Peterson	ERS
Dennis Erickson	Erskine College
Kenneth P. Selden	Essential Economics, Inc.
Richard Castellana	Fairleigh Dickinson University
Steven A. Seelig	FDIC
Kevin Lansing	Federal Reserve Bank of Cleveland
Joseph Haimowitz	Federal Reserve Bank of Kansas City
Edward Lotterman	Federal Reserve Bank of Minneapolis
Richard M. Todd	Federal Reserve Bank of Minneapolis
Patricia Pollard	Federal Reserve Bank of St. Louis
Alexander David	Federal Reserve Board
Charles Siegman	Federal Reserve Board
Chunsheng Zhou	Federal Reserve Board
Dale W. Henderson	Federal Reserve Board
Dean F. Amel	Federal Reserve Board
Guy V.G. Stevens	Federal Reserve Board
Laura S. Rubin	Federal Reserve Board
Murat F. Iyigun	Federal Reserve Board
Randall Mariger	Federal Reserve Board
Steve Rhoades	Federal Reserve Board
Gerald D. Lomen	Federal Reserve Board of New York
George Budzeika	Federal Reserve Board of New York, Rtd.
Richard E. Ludwick, Jr.	Federal Trade Commission
Ohannes Hagopian	Felician College
Abdollah Ferdowsi	Ferris State University
Daniel Teferra	Ferris State University
Herbert E. Nell	Financial and Economic Strategies
Gabriel Torres	Fitch Investor Services
Benjamin Chinitz	Florida Atlantic University
Alison Butler	Florida International University
Maria Willumsen	Florida International Unversity
Charles E. Rockwood	Florida State University
James Cobbe	Florida State University.
Michael Slotkin	Florida Tech
Peter M. Ewen	Forcasts Department, APS
Dominick Salvatore	Fordham University
Jacqueline G. Coolidge	Foreign Investment Advisory Service
Betty F. Slade	Formerly Harvard Inst. for Intl. Development
Glenn G. Stevenson	Formerly Oak Ridge National Laboratory
Ronald G. Ridker	Formerly of The World Bank
Richard W. Stewart	Frontier Cooperative Herbs
Yury F. Ruban	Frontier Vision Technologies, Inc.

Name	Affiliation
Daniel A. Mizak	Frostburg State University
William J. Serow	FSU, Center for the Study of Population
Young J. Park	Fu Associates, Ltd.
Raul Moreno	Fundacion Nacional Para El Desarrollo
Kim M. Gardey	Gardey Investment Management
Anthony Negbenebor	Gardner Webb University
Frances Hammond	General Motors Corporation
Carrie A. Meyer	George Mason University
Chris G. Rodrigo	George Mason University
Steven C. Michael	George Mason University
Anita M. Benvignati	George Washington University
David C. Riber	George Washington University
Elinor H. Solomon	George Washington University
Eric Kodjo Ralph	George Washington University
Julian Silk	George Washington University
Mary Ann Baily	George Washington University
Stephen C. Smith	George Washington University
Vincy Fon	George Washington University
Warren Greenberg	George Washington University
Charles K. Ebinger	Georgetown University
Dale Murphey	Georgetown University
Daniel Kahn	Georgetown University
George J. Viksnins	Georgetown University
Ibrahim M. Oweiss	Georgetown University
James Tybout	Georgetown University
Jens Ludwig	Georgetown University
John Cuddington	Georgetown University
Mitch Kaneda	Georgetown University
Robert E. Moore	Georgia College & State University
Usha Nair	Georgia Institute of Technology
David L. Sjoquist	Georgia State University
Jorge Martinez-Vazquez	Georgia State University
Julie Hotchkiss	Georgia State University
Ronald G. Cummings	Georgia State University
Rubin Saposnik	Georgia State University
Peter G. Sassone	Georgia Tech
Richard J. Cebula	Georgia Tech
Brendan Cushing-Daniels	Gettysburg College
Katsuyuki Niiro	Gettysburg College
Ralph Chances	Gettysburg College
Janamitra Devan	Global Strategies Group
Randal G. Gunden	Goshen College
Katherine Henneberger	Goucher College
Mark Montgomery	Grinnell College
Claude Gruen	Gruen Gruen & Associates
Robert T. Tanimura	GTE Telephone Operations

ECONOMISTS' STATEMENT ON CLIMATE CHANGE

List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation
Lawrence Y. Fu	Illinois College
J. Lon Carlson	Illinois State University
L. Dean Hiebert	Illinois State University
Michael A. Nelson	Illinois State University
Michael C. Seeborg	Illinois Wesleyan University
Thomas E. McGinnis	Indiana State Government
Craig W. Holden	Indiana University
David Waterman	Indiana University
Eckhard Janeba	Indiana University
Fwu-Rang Chang	Indiana University
Herbert Kiesling	Indiana University
Janardhanan A. Alse	Indiana University
Joyce Man	Indiana University
Lloyd Orr	Indiana University
Mariannne V. Felton	Indiana University
Martin C. Spechler	Indiana University
Philip T. Powell	Indiana University
Phillip Saunders	Indiana University
Roy Gardner	Indiana University
Scott Smart	Indiana University
Clarence C. Morrison	Indiana University, Bloomington
Ashton I. Veramallay	Indiana University East
Shyam L. Bhatia	Indiana University Northwest
Arthur Mariel	Indiana University of Pennsylvania
Robert J Stonebrakon	Indiana University of Pennsylvania
Roger W. Schmenner	Indiana University School of Business
Lawrence J. Haber	Indiana-Pudue at Fort Wayne
Thomas L. Guthrie	Indiana-Pudue at Fort Wayne
Robert Weiss	Industrial Electrotechnology Laboratory
Roy B. Helfgott	Industrial Relations Counselors Inc.
Charles Marston	Infinity Inc.
Thomas P. Rothrock	Info Tech Inc.
Bruce McKinlay	Information Systems Group
Jon Christianson	Inst. for Health Services Research
Geoffrey Carliner	Institute for International Economics
Robert J. Muscat	Institute for Policy Reform
Richard Webb	Instituto Cuanto
Charles Richter	Inter-American Development Bank
Michael A. Gomez	Inter-American Development Bank
Michael Gavin	Inter-American Development bank
Orlando A. Reos	Inter-American Development Bank
Alan McInnes	Internal Revenue Service
Joseph Mc Grewe	Internal Revenue Service
Peter G. Balash	Internal Revenue Service
Agnes R. Quisumbing	International Food Policy Research Institute
Dean Jolliffe	International Food Policy Research Institute
Stephen A. Vosti	International Food Policy Research Institute
Nazrul Islam	International Inst. for Advanced Studies
Adolfo Barajas	International Monetary Fund
Adrienne Cheasty	International Monetary Fund
Alphecca Muttardy	International Monetary Fund
Caroline Van Ryckeghem	International Monetary Fund
David T. Coe	International Monetary Fund
Dev Kumar Kar	International Monetary Fund
Elaine Buckberg	International Monetary Fund
Ernesto Hernández-Catá	International Monetary Fund
Geert J. Almekinders	International Monetary Fund
George Iden	International Monetary Fund
Gian Maria Milesi-Ferretti	International Monetary Fund
Gregory C. Dahl	International Monetary Fund
Gustavo Canonero	International Monetary Fund
James E. Blalock	International Monetary Fund
Jeromin Zettelmeyer	International Monetary Fund
John E. Lelmone	International Monetary Fund
Kevin L. Ross	International Monetary Fund
Lorenzo L. Perez	International Monetary Fund
Malcom D. Knight	International Monetary Fund
Mark R Stone	International Monetary Fund
Michael G. Papaioannou	International Monetary Fund
Michael P. Leidy	International Monetary Fund
Nicholas Tsaveas	International Monetary Fund
Patricia A. Reynolds	International Monetary Fund
Peter B. Clark	International Monetary Fund
Rakia Moalla-Felini	International Monetary Fund
Richard Stillson	International Monetary Fund
Sunil Sharma	International Monetary Fund
Thomas Rumbaugh	International Monetary Fund
Teshiro Nishizawa	International Monetary Fund
Vikram Haksar	International Monetary Fund
Wayne E. Lewis	International Monetary Fund
William L. Hemphill	International Monetary Fund
Zeljko Bogetic	International Monetary Fund
Jonathan Levin	International Monetary Fund, Rtd.
Robert F. Lundy	Interstate Commerce Commission, Rtd.
Roger Williams	INVEST
David Hennessy	Iowa State University
J. Peter Mattila	Iowa State University
John A. Miranowski	Iowa State University
Peter Orazem	Iowa State University
Stanley R. Johnson	Iowa State University
William Merrill	Iowa State University
Cynthia Haciemun	Iowa Wesleyan College

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List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation
Theodore Palivos	Lousiana State University
Howard Baetser, Jr.	Loyola College
James Konow	Loyola Marymont University
Bruce Vanderporten	Loyola University, Chicago
George Kaufman	Loyola University, Chicago
Marc Douglas Hayford	Loyola University, Chicago
Robert Carow	Loyola University, Chicago
Dan C. Messerschmidt	Lynchburg College
D. Sykes Wilford	M.D. Bankers Trust
Marshall Pomer	Macroeconomic Institute
Emily Sun	Manhattan College
John F. Tomer	Manhattan College
Bruce Carpenter	Mansfield University
Joan E. Gadsby	Market Media International Corporation
James Tober	Marlboro College
David E. Clark	Marquette University
David L. Marshall	Marshall & Associates
Harlan M. Smith, II	Marshall University
Mark A. Thompson	Marshall University
Amy M. Diduch	Mary Baldwin College
Amata	Marygrove College
Calvin Timmerman	Maryland Public Service Commission
Steven Payson	Marymont University
Lyle Nelson	Mathematica Policy Research
Merrile Sing	Mathematica Policy Research
Walter Corson	Mathematica Policy Research
Karen Akerhielm	Mathtech Inc.
Ramsey Nguon Lay	McDonnell Douglas Aerospace West
David Wyss	McGraw Hill
Anthony Pennington-Cross	McGraw-Hill
Susan M. Lund	McKinsey & Company
B. David Collier	Medical College of Wisconsin
Charles H. Andrews	Mercer University
C.W. Blowens	Metro-Dade County Planning Department
David J. O'Hara	Metropolitan State University
O. Homer Erekson	Miami Univerisity
Raymond Gorman	Miami University
Robert L. Conn	Miami University
William K. Hutchinson	Miami University
William R. Hart	Miami University
Peter Eckstein	Michigan AFL-CIO
H. William Rockwell, Jr.	Michigan Dept. of Natural Resources
Corinne M. Krupp	Michigan State University
Daniel R. Talhelm	Michigan State University
Harry J. Holzer	Michigan State University
James L. Doumen	Michigan State University
John P. Hoehn	Michigan State University
Kenneth D. Boyer	Michigan State University
Mordechai Kreinin	Michigan State University
Norman P. Obst	Michigan State University
Paul L. Menchik	Michigan State University
Paul Segerstrom	Michigan State University
Richard T. Baillie	Michigan State University
Robert J. La Londe	Michigan State University
Scott M. Swinton	Michigan State University
Stephen A. Woodbury	Michigan State University
W. Paul Strassmann	Michigan State University
Paul A. Nelson	Michigan Technological University
Atanu Saha	Micronomics Inc.
Bichaka Fayissa	Middle Tennessee State University
Reuben Kyle	Middle Tennessee State University
John Craven	Middlebury College
Yoshi Fukasawa	Midwestern State University
Alec R. Levenson	Milken Institute
Kurt R. Schaefer	Miller Freeman Inc.
Ross Miller	Miller Risk Advisors
Marion Ross	Mills College
Patrick A. Taylor	Millsaps College
Kevin Richardson	Minute Maid Company
Paul W. Grimes	Mississippi State University
Robert O. Weagley	Missouri University
Alberto Bisin	MIT
Carl Kaysen	MIT
Donald Lessard	MIT
E. Cary Brown	MIT
Eli Shapiro	MIT
Evsey D. Domar	MIT
Franklin M. Fisher	MIT
George W. Rathjens	MIT
Jorn Steffen Pischke	MIT
M. A. Adelman	MIT
* Paul Krugman	MIT
Paul Smoke	MIT
*, ** Robert Solow	MIT
Robin Wells	MIT
Scott Stern	MIT
Susan Athey	MIT
Tim Riddiough	MIT
William C. Wheaton	MIT
Alan M. Strout	MIT, Rtd.
B. Wernerfelt	MIT, Sloan School of Management
Erik Brynjolfsson	MIT, Sloan School of Management

ECONOMISTS' STATEMENT ON CLIMATE CHANGE

List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation
Lori Leachman	Northern Arizona University
Richard J. Dowen	Northern Illinois University
Todd Knoop	Northern Illinois University
Virginia Wilcox-Gok	Northern Illinois University
Young C. Kim	Northern Illinois University
Gary E. Clayton	Northern Kentucky University
Martin G. Giesbrecht	Northern Kentucky University
Tom Cate	Northern Kentucky University
Hillar D. Neumann, Jr.	Northern State University, South Dakota
R. Stephen Elliott	Northwestern State University
Alan M. Taylor	Northwestern University
Boaz Moselle	Northwestern University
Burton A. Weisbrod	Northwestern University
Deborah Lucas	Northwestern University
Mark A. Satterthwaite	Northwestern University
Michael Wallerstein	Northwestern University
Todd Pulvino	Northwestern University
Donald P. Jacobs	Northwestern University, J.C. Kellog Schoool
Sr. Beth Anne Tercek	Notre Dame College
Liang-rong Shiau	NSU
John Tepper Marlin	NYC Comptroller's Office
Eileen R. Kaufman	NYC Dept of Design & Construction
Larry M. Blair	Oak Ridge Associated Universities
C. J. Austermiller	Oakland Community College
Kevin J. Murphy	Oakland University
A. T. Aburachis	Oannon University
David L. Cleeton	Oberlin College
Hirschel Kasper	Oberlin College
James Whitney	Occidental College
Micheal K. Tamada	Occidental College
Robert L. Moore	Occidental College
Edward H. Clarke	Office of Management & Budget
Joseph R. Mason	Office of the Comptroller of the Currency
Robert DeYoung	Office of the Comptroller of the Currency
William O. Shropshire	Oglethorpe University
Frederick Church	Ohio Legislature Budget Office
Alan Randall	Ohio State University
Amy Jocelyn Glass	Ohio State University
Belton M. Fleisher	Ohio State University
Brent Sohngen	Ohio State University
Elian Khalil	Ohio State University
Eric Fisher	Ohio State University
Hassan Y. Aly	Ohio State University
Herbert Parnes	Ohio State University
Jay L. Zagorsky	Ohio State University
Jingang Zhao	Ohio State University
Mario J. Miranda	Ohio State University
Nancy Ettlinger	Ohio State University
Nelson C. Mark	Ohio State University
Peter Howitt	Ohio State University
Richard A. Tybout	Ohio State University
Robert J. Caswell	Ohio State University
Stephen G. Cecchetti	Ohio State University
Chulho Jung	Ohio University
Kurt A. Schwabe	Ohio University
James V. Koch	Old Dominion University
Paul R. Koch	Olivet Nazarene University
Vartkes L. Broussalian	OMB, Washington, Rtd.
Rohit Sah	Oppenheimer Funds, Inc.
Carol Horton Tremblay	Oregon State University
Emery N. Castle	Oregon State University
Joe Kerkvliet	Oregon State University
Laura S. Connolly	Oregon State University
Ronald A. Oliviera	Oregon State University
Bronwyn H. Hall	Oxford University, UK
Jacques J. Polak	P. Jacobson Foundation
Richard Ottinger	Pace Law School
Michael Szenberg	Pace University
Bruce McWilliams	Pacific Institute
Marlen Miller	Pacific Lutheran University
Norris A. Peterson	Pacific Lutheran University
Rachel Nugent	Pacific Lutheran University
John A. Jaksch	Pacific Northwest National Laboratory
Joseph M. Roop	Pacific Northwest National Laboratory
Michael J. Scott	Pacific Northwest National Laboratory
H. Joe Story	Pacific University
Philip J. Ruder	Pacific University
Loren A. Lee	Palomar College
Teresa L. C. Laughlin	Palomar College
Craig Paxton	Paxton Analysts
Brandt Witte	Peace Corps
Daniel A. Underwood	Peninsula College
Colin Polsky	Penn. State Univ., Earth System Science Center
Mark D. Agee	Pennsylvania State University
Ali Abderrezak	Pennsylvania State University
Ann Fisher	Pennsylvania State University
Barry N.	Pennsylvania State University
Chidem Kurdas	Pennsylvania State University
Donald J. Epp	Pennsylvania State University
Gary Bolton	Pennsylvania State University
Jacob DeRooy	Pennsylvania State University
James D. Rodgers	Pennsylvania State University

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March 24, 1997

Name	Affiliation
Bernard Rose	Rocky Mountain College
Kenna Taylor	Rollins University
Ron Balman	Roosevelt University
Dale Bremmer	Rose - Hulman Institute of Technology
Stephen Smith	Rose State College
Marijeh Sabi	Russell Sage College
A. Myrick Freeman III	Rutgers University
Bruce Mizrach	Rutgers University
Carlos Seiglie	Rutgers University
Edmund M. Tavernier	Rutgers University
Horace J. De Podwin	Rutgers University
Leslie E. Small	Rutgers University
Marlene Kim	Rutgers University
Michael A. Crew	Rutgers University
Michael K. Taussig	Rutgers University
Richard W. Johnson	Rutgers University
Robert H. Patrick	Rutgers University
Marjorie W. Munson	Rutgers University, Douglass College
William H. Wrean	Sacajawea & Company
Lucjan Orlowski	Sacred Heart University
Alannah Orrison	Saddleback College
Kenneth G. Woodward	Saddleback College
Hong Y. Park	Saginaw Valley State University
Charles Henning	SAIC
Gilbert Becker	Saint Anselm College
Reza Ramazani	Saint Michael's College
Thampy Mammen	Saint Norbert College
Dorothy Ryan Siden	Salem State College
Chee Y. Thum	Salomon Brothers Inc.
Adam Gifford, Sr.	San Diego State University
Douglas B. Stewart	San Diego State University
James Gerber	San Diego State University
S. Grossbay-Shechtman	San Diego State University
Dluchi O. Nnachi	San Francisco Juvenille Court
Betty J. Blecha	San Francisco State University
Joanna Moss	San Francisco State University
R. Newby Schweitzer	San Francisco State University
Yea-Mow Chen	San Francisco State University
Douglas F. Greer	San Jose State University
Thomas Drennen	Sandia National Laboratories
Helen Popper	Santa Clara University
Michael Kevane	Santa Clara University
R. D. Norton	Sarkisian
Edward Alban	Savannah State University
John Watters	SBC Communications
Frank D. Weiss	School of Advanced International Studies

Name	Affiliation
Patricia Dillon	Scripps College
Jere W. Clark	SCSC
M. Louise Curley	Scudder, Stevens & Clark
Allen S. Bellas	Seattle University
Vinay Datar	Seattle University
William L. Weber	SEMO State University
Jerry Jenkins	Sequoia Institute
Henry C. F. Arnold	Seton Hall University
Tony Loviscek	Seton Hall University
Alan G. Myers	SFWS
Michael J. Chapman	Shearman & Sterling
Thomas H. Sheenan, Jr.	Sheenan International
Daneil A. Pavsek	Shenandoah University
Signe L. Sherman	Sherman Holdings
Kirk E. Vandezande	Simon Fraser University
Sharon Pang	Skadden, Arps, Slate, Meahr & Flom
Deborah Haas-Wilson	Smith College
Roger T. Kaufman	Smith College
L. Scott Muller	Social Security Administration
Michael V. Leonesio	Social Security Administration
Carlos A. Benito	Sonoma State University
Stephen D. Lewis	Sonoma State University
Robert G. McGillivray	Sound Economics
Thomas Mitchell	South Illinois University
Elizabeth Granitz	Southampton College
Christopher R. Mann	Southeast Michigan Council of Govts.
Kenneth Chinn	Southeastern Oklahoma State University
Scott Bellamy	Southern Arkansas University
Paul Shuler	Southern California College
David Lui	Southern California Edison
Donald Elliott	Southern Illinois University
Jim Musumeci	Southern Illinois University
Julius Horvath	Southern Illinois University
Paul Trescott	Southern Illinois University
S. Grosskopf	Southern Illinois University
Stanford L. Levin	Southern Illinois University
R.W. Hafer	Southern Indiana University
J. Carter Murphy	Southern Methodist University
Thomas Osang	Southern Missouri University
Thomas Dalton	Southern University at New Orleans
C. E. Chang	Southwest Missouri State University
E. Dale Wasson	Southwest Missouri State University
Anne R. Hornsby	Spelman College
Bernice de Gaines Scott	Spelman College
Kenneth N. Hamilton	Spring Hill College
Brian K. Stalhr	Sprint

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ECONOMISTS' STATEMENT ON CLIMATE CHANGE

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Name	Affiliation
Stephen Golub	Swarthmore College
Roger C. Dower	Sycom Enterprises
A. Dale Tussing	Syracuse University
Bernard Jump	Syracuse University
Donald H. Dutkowsky	Syracuse University
Michael Wasylenko	Syracuse University
David I. Goldeberg	Systematic Forecasting, Inc.
Faith Breen	Systems Resource Management
Dana Stevens	Takashi Corporation
Cindy Houser	TAMIU
William L. Beaty	Tarleton College
Thomas D. Legg	TD Legg Financial Economics
Robert E. Lucore	Teamsters Union
Michael J. Ileo	Technical Associates, Inc.
Charles P. Hall	Temple University
Charlotte Phelps	Temple University
J. Jay Choi	Temple University
Thomas E. Getzen	Temple University
Seisel Jonakin	Tennessee Tech. University
Whewon Cho	Tennessee Tech. University
Lonnie L. Jones	Texas A & M University
Wade L. Griffin	Texas A& M University
Amy P. Thurow	Texas A&M University
C. Richard Shumway	Texas A&M University
Farshid Vahid	Texas A&M University
James H. Ullmer	Texas A&M University
Javier Gimeno	Texas A&M University
John R. Moroney	Texas A&M University
Julian E. Gaspar	Texas A&M University
Manzoor E. Chowdhury	Texas A&M University
Noh-Sun Kwark	Texas A&M University
Rajiv Sarin	Texas A&M University
Ronald C. Griffin	Texas A&M University
Thomas D. Jeitschko	Texas A&M University
Frank Giesber	Texas Lutheran University
Richard E. Quandt	The Andrew W. Mellon Foundation
Kenneth T. Wise	The Brattle Group
Paul R. Carpenter	The Brattle Group
Peter Fox-Penner	The Brattle Group
Peter Fox-Penner	The Brattle Group
G.R. Guralnik	The Business Group, Inc.
Donald E. Campbell	The College of William & Mary
A. Doris Capistrano	The Ford Foundation
Bernard Wasow	The Ford Foundation
Henry E. Cole	The Future Group International
Gerald Kraft	The GSK Group, Ltd.

Name	Affiliation
Ronald H. Miller	The Hudson Group
Thomas E. O'Hare	The Intertich Group
Gina Livermore	The Levin Group
David C. Stapleton	The Lewin Group
Linz Audain	The Mandate Corporation
William G Rhoads	The Nature Conservancy
Martin Duffy	The Perseus Group
Hiroshi Kawamura	The United Nations
Larry Willmore	The United Nations
Fernando Losada	The Weston Group
Peter C. Moll	The World Band
A. Mead Over, Jr.	The World Bank
Andrew Steer	The World Bank
Carter Brandon	The World Bank
Charles C. Griffin	The World Bank
David Dollar	The World Bank
Delbert Fitchett	The World Bank
Estelle James	The World Bank
Gianni Zanini	The World Bank
Gunnar S. Eskeland	The World Bank
Herman Cesar	The World Bank
Hideo Akabayashi	The World Bank
Humayun Tai	The World Bank
Inderuit Singh	The World Bank
J. Michael Finger	The World Bank
Jacques Van der Gaag	The World Bank
John Kellenberg	The World Bank
John Williamson	The World Bank
Keith E. Hansen	The World Bank
Loerene Yap	The World Bank
Manuela Ferro	The World Bank
Maria Freire	The World Bank
Mark W. Leiserson	The World Bank
Martha De Melo	The World Bank
Martin Ravallion	The World Bank
Maurice Schiff	The World Bank
Moshe Syrquin	The World Bank
Nobuhiko Fuwa	The World Bank
Pedro Belli	The World Bank
Robert Armstrong	The World Bank
Robert Hunt	The World Bank
Saji Thomas	The World Bank
Stefan G. Koeberle	The World Bank
Timothy King	The World Bank
Yi Chen	The World Bank
Yin-kann Wen	The World Bank

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List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation
Robert M. Williams	UCLA
Stuart O. Schweitzer	UCLA
Tom K. Lieser	UCLA
Trudy Ann Cameron	UCLA
Wei-Yin Hu	UCLA
Werner Z. Hirsch	UCLA
Brad Cornell	UCLA, Anderson School of Business
Bhagwan Chowdhry	UCLA, Anderson School of Management
David R. Bell	UCLA, Anderson School of Management
M. J. Brennan	UCLA, Anderson School of Management
Marvin Lieberman	UCLA, Anderson School of Management
Jose` De La Torre	UCLA, Anderson School of Mgmt.
Richard H. Sander	UCLA, School of Law
Georgios Karras	UIC
Bill Lord	UMBC
Nathaniel Wollman	Uniersity of New Mexico
Ella K. Hensley	Union College
J. Douglas Klein	Union College
Therese McCarthy	Union College
Todd A. Burgman	Union College
Dr. Faruk G. Sabet	United Nations
Gary W. Grizzle	United Parcel Service
Herbert Traxler	United States PHS
John Mark Lindrall	Univ. of Phoenix, Southern CA campus
Stanley Long	Univ. of Pittsburgh, Penn. State Univ.
James J. Heckman	Univeristy of Chicago
Richard Bryant	Univeristy of Missouri-Rolla
Gautam Vora	Univeristy of New Mexico
Richard W. Stratton	University of Akron
Harris Schlesinger	University of Alabama
Nancy S. Barrett	University of Alabama
Walter S. Misiolek	University of Alabama
Robert A. McLean	University of Alabama, Birmingham
Seung-Dong Lee	University of Alabama, Birmingham
John F. Schnell	University of Alabama, Huntsville
William S. Brown	University of Alaska - SE
Todd R. Smith	University of Alberta, Canada
Alberta H. Charney	University of Arizona
David A. King	University of Arizona
Edward E. Zajac	University of Arizona
Eric Monke	University of Arizona
Gordon Tullock	University of Arizona
James C. Cox	University of Arizona
John L. Wilson	University of Arizona
Leslie S. Stratton	University of Arizona
Lester D. Taylor	University of Arizona
Mark Zupan	University of Arizona
Richard Newcomb	University of Arizona
Roger W. Fox	University of Arizona
Ronald J. Vogel	University of Arizona
Willard T. Carleton	University of Arizona
Gary Ferrier	University of Arkansas
William P. Curington	University of Arkansas
Michael Sher	University of Auckland
David W. Stevens	University of Baltimore
Esra Bennathan	University of Bristol, UK
Aaron S. Edlin	University of California, Berkeley
Anne M. Libby	University of California, Berkeley
Anthony Fisher	University of California, Berkeley
Ben F. Vaughan, IV	University of California, Berkeley
Clair Brown	University of California, Berkeley
Clark Kerr	University of California, Berkeley
David Romer	University of California, Berkeley
Frank E. Trinkl	University of California, Berkeley
Garland L. Brinkley	University of California, Berkeley
Gary Charness	University of California, Berkeley
** Gerard Debreu	University of California, Berkeley
Glenn A. Woroch	University of California, Berkeley
Gordon Rausser	University of California, Berkeley
Gregory Grossman	University of California, Berkeley
Hal R. Varian	University of California, Berkeley
Jeffrey S. Petersen	University of California, Berkeley
Jerome Siebert	University of California, Berkeley
John M. Letiche	University of California, Berkeley
Larry S Karp	University of California, Berkeley
Lee S. Friedman	University of California, Berkeley
Mark Rubinstein	University of California, Berkeley
Maurice Obstfeld	University of California, Berkeley
Miguel Cantillo	University of California, Berkeley
Oliver E. Williamson	University of California, Berkeley
Peter Berck	University of California, Berkeley
Richard B. Norgaard	University of California, Berkeley
Robert M. Anderson	University of California, Berkeley
Sylvia Lane	University of California, Berkeley
Theodore E. Keeler	University of California, Berkeley
David J. Teece	University of California, Berkeley, Haas School
** John C. Harsanyi	University of California, Berkeley, Haas School
Pablo T. Spiller	University of California, Berkeley, Haas School
Stephen Penman	University of California, Berkeley, Haas School
Richard H. Holton	University of California, Berkeley, Haas School
Richard Meese	University of California, Berkeley, Haas School
Daniel Rubinfeld	University of California, Berkeley Law School

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Name	Affiliation	Name	Affiliation
Francis Tannian	University of Deleware	John B. Braden	University of Illinois
Lawrence P. Donnelley	University of Deleware	Robert Resek	University of Illinois
Pamela C. Brown	University of Deleware	Robert W. Gillespie	University of Illinois
Pamela J. Smith	University of Deleware	Thomas S. Ulen	University of Illinois
Donald Pemberton	University of Detroit, Mercy	Walter W. McMahon	University of Illinois
Maurice Tsai	University of Evansville	George Rosen	University of Illinois, Chicago
David Denslow	University of Florida	Houston H. Stokes	University of Illinois, Chicago
Elias Dinopoulos	University of Florida	Richard F. Kosobud	University of Illinois, Chicago
Eugene Brigham	University of Florida	William F. Maloney	University of Illinois, Urbana
Ira Horowitz	University of Florida	William F. Malowey	University of Illinois, Urbana
Jay R. Ritter	University of Florida	David J. Balan	University of Illinois, Urbana Champaign
John F. Scoggins	University of Florida	Koji Taira	University of Indiana
Max R. Langham	University of Florida	Benjamin Wilner	University of Iowa
Richard E. Suttor	University of Florida	Calvin D. Siebert	University of Iowa
Sanford V. Berg	University of Florida	Gerald Nordquist	University of Iowa
Tracy R. Lewis	University of Florida	Joel Horowitz	University of Iowa
Andy Keeler	University of Georgia	John M. Brooks	University of Iowa
P. Mather Lindsay	University of Georgia	S. Y. Wu	University of Iowa
Steve Turner	University of Georgia	Thomas F. Pogue	University of Iowa
W. J. Florkowski	University of Georgia, Griffin	De-Min Wu	University of Kansas
Paul Callaghan	University of Guam	Joseph Sicilian	University of Kansas
Bharat Kolluri	University of Hartford	Neal Becker	University of Kansas
Demetrios Giannaros	University of Hartford	Donald J. Mullineaux	University of Kentucky
Farhad Rassekh	University of Hartford	James Stoker	University of Kentucky
Rao Singamsetti	University of Hartford	Yoonbai Kim	University of Kentucky
Chung H. Lee	University of Hawaii	Gonyung Park	University of La Verne
David McClain	University of Hawaii	John Vahaly	University of Louisville
James Moncur	University of Hawaii	Anthony Lanyi	University of Maryland
Louis A. Rose	University of Hawaii	Arvind Panagariya	University of Maryland
Richard E. Peterson	University of Hawaii	Christopher K. Clague	University of Maryland
Sumner La Croix	University of Hawaii	Douglas Meade	University of Maryland
David L. Hammes	University of Hawaii, Hilo	Erik Lichtenberg	University of Maryland
Denise Eby Konan	University of Hawaii , Manoa	John H. Cumberland	University of Maryland
A. Reza Hoshmand	University of Hawaii, West Oahu	John W. Dorsey	University of Maryland
A. Marvasti	University of Houston	Karla Hoff	University of Maryland
D. Andrew Austin	University of Houston	Lee E. Preston	University of Maryland
Janet Kohlhase	University of Houston	Maureen Cropper	University of Maryland
Steven G. Craig	University of Houston	Paul A. Weinstein	University of Maryland
Roger H. Coupal	University of Idaho	Peter Cramton	University of Maryland
Stephen Devadoss	University of Idaho	R. Betancourt	University of Maryland
Anil K. Bera	University of Illinois	Robert Costanza	University of Maryland
Donald W. Paden	University of Illinois	Suzi C. Kerr	University of Maryland
Eliezer B. Ayal	University of Illinois	Theodore C. Kariotis	University of Maryland
George G. Pennacchi	University of Illinois	Phillip Weitzman	University of Maryland UNW College
Gerrit Knaap	University of Illinois	Branch Ben	University of Massachusetts
Hans J. Brems	University of Illinois	Donald W. Katzner	University of Massachusetts

ECONOMISTS' STATEMENT ON CLIMATE CHANGE

List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation
Barry M. Popkin	University of North Carolina, Chapel Hill
David J. Ravenscraft	University of North Carolina, Chapel Hill
Michael Luger	University of North Carolina, Chapel Hill
Robert Gallman	University of North Carolina, Chapel Hill
Teresa L. Kauf	University of North Carolina, Chapel Hill
Richard A. Zuber	University of North Carolina, Charlotte
Andrew C. Brod	University of North Carolina, Greensboro
Donald R. Escarraz	University of North Dakota
Fikret Ceyhun	University of North Dakota
Michael Nieswiadomy	University of North Texas
Micheal A. McPhasa	University of North Texas
Steven G. Thorpe	University of Northern Iowa
Charles K. Wilber	University of Notre Dame
Jeffrey H. Bergstrand	University of Notre Dame
Ralph Chami	University of Notre Dame
Richard G. Sheehan	University of Notre Dame
Robert E. Florence	University of Notre Dame
James C. Hartigan	University of Oklahoma
Zhen Zhu	University of Oklahoma
Shuanglin Lin	University of Omaha
Bruce A. Blonigen	University of Oregon
James P. Ziliak	University of Oregon
Paul B. Simpson	University of Oregon
Raymond Mikesell	University of Oregon
Robert E. Smith	University of Oregon
Stephen Haynes	University of Oregon
Alan Heston	University of Pennsylvania
Andrew Postlewaite	University of Pennsylvania
Arthur L. Bloomfield	University of Pennsylvania
Herbert S. Levine	University of Pennsylvania
** Lawrence R. Klein	University of Pennsylvania
Morris Hamburg	University of Pennsylvania
Patricia M. Danzon	University of Pennsylvania
Paul E. Fischer	University of Pennsylvania
Petra E. Todd	University of Pennsylvania
Daniel Levinthal	University of Pennsylvania, Wharton School
David Cummins	University of Pennsylvania, Wharton School
Elizabeth E. Bailey	University of Pennsylvania, Wharton School
Franklin Allen	University of Pennsylvania, Wharton School
Richard C. Marston	University of Pennsylvania, Wharton School
William G. Whitney	University of Pennsylvania, Wharton School
Alvin E. Roth	University of Pittsburgh
Daniel Berkowitz	University of Pittsburgh
Edward Sussna	University of Pittsburgh
Gene W. Gruver	University of Pittsburgh
Jerome C. Wells	University of Pittsburgh
John Kagel	University of Pittsburgh
Josephine E. Olson	University of Pittsburgh
Kevin Sontheimer	University of Pittsburgh
Michael H. Spiro	University of Pittsburgh
Steve Husted	University of Pittsburgh
Steven F. Rushen	University of Pittsburgh
Evaldo A. Cabarrouy	University of Puerto Rico
Kate Stirling	University of Puget Sound
Lorenzo Garbo	University of Redlands
John P. Burkett	University of Rhode Island
S. Chon Rhee	University of Rhode Island
Stephen Swallow	University of Rhode Island
Jonathan Wight	University of Richmond
Peter W. Schuhmann	University of Richmond
Robert Dolan	University of Richmond
Florian Zettelmeyer	University of Rochester
James A. Kahn	University of Rochester
Jeffrey S. Banks	University of Rochester
Lionel W. McKenzie	University of Rochester
Per Krusell	University of Rochester
Eric Hanushek	University of Rochester, Walli[illegible] Institute
Yhi-Min Ho	University of Saint Thomas
Rosalie Liccardo Pacula	University of San Diego
Man-Lui Lau	University of San Francisco
Mike Lehmann	University of San Francisco
Ed Scahill	University of Scranton
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Oliver G. Wood, Jr.	University of South Carolina
Randolph C. Martin	University of South Carolina
Samuel L. Baker	University of South Carolina
William S. Rawson	University of South Carolina
William T. Moore	University of South Carolina
Dennis A. Johnson	University of South Dakota
Eila Hanni	University of South Florida
John C. Briggs	University of South Florida
John W. Rowe, Jr.	University of South Florida
K. Gyimah-Brempong	University of South Florida
R. Mark Wilson	University of South Florida
Thomas N. Chirikos	University of South Florida
Catherine S. Elliott	University of South Florida, New College
Frederick R. Strobel	University of South Florida, New College
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ECONOMISTS' STATEMENT ON CLIMATE CHANGE

List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation
Norman R. Cloutier	University of Wisconsin, Parkside
Richard H. Keehu	University of Wisconsin, Parkside
Ahdol Sooti	University of Wisconsin, Platteville
Lawrence Weiser	University of Wisconsin, Stevens Point
Thomas D. Crocker	University of Wyoming
Mark D. Soskin	Universtiy of Central Florida
John D. Bitzan	Upper Great Plains Transportation Institute
Gerhard N. Rostvold	Urbanomics Research Associates
Christine Williams	USG
Amit Batabyal	Utah State University
Carl Lundgren	Valmarpro Forecasting
Andrea Maneschi	Vanderbilt University
C. Elton Hinshaw	Vanderbilt University
Fred M. Westfield	Vanderbilt University
Gian S. Sahota	Vanderbilt University
Malcolm Getz	Vanderbilt University
Rudolph C. Blitz	Vanderbilt University
Stephen Buckles	Vanderbilt University
Geoffrey A. Jehle	Vassar College
Phyllis W. Isley	Vermont Law School
N. Laopodis	Villa Julie College
Kishor Thanawala	Villanova University
Wen Mao	Villanova University
Amy H. Dalton	Virginia Commonwealth University
Eleanor C. Snellings	Virginia Commonwealth University
John H. Bowman	Virginia Commonwealth University
Thomas J. Meeks	Virginia State University
Allan Mandelstamm	Virginia Tech
Catherine Eckel	Virginia Tech
Djavad Salehi-Isfahani	Virginia Tech
George W. Norton	Virginia Tech
Glen H. Mitchell	Virginia Tech
Mark Stegeman	Virginia Tech
Nicholas Tideman	Virginia Tech
Vijay Singal	Virginia Tech
Vernon O. Roningen	VORSIM
Christopher J. O'Leary	W. E. Upjohn Institute
Jonathan Peters	Wagner College
Donald W. Walls	Walls & Associates
Lisa Daniels	Washington College
Art Goldsmith	Washington & Lee University
Bruce Herrick	Washington & Lee University
John C. Winfrey	Washington & Lee University
Ernst W. Stromsdorfer	Washington State University
Gareth P. Green	Washington State University
Robert Rosenman	Washington State University

Name	Affiliation
Bruce Petersen	Washington University
Marcus Berliant	Washington University
Wilhelm Neuefeind	Washington University
Dennis L. Lambert	Washington University, School of Medicine
R. W. La Hote	Washtenaw Community College
Kenneth G. McColn	Waterford International
Yong U. Glasure	Wayland Baptist University
Doris Geide-Stevenson	Weber State University
John Mukum Mbaku	Weber State University
Sarah Tinkler	Weber State University
James Burtle	WEFA Group
Jeffrey F. Werling	WEFA Group
Virendra Singh	WEFA Group
Marshall Goldman	Wellesley College
Gary Yohe	Wesleyan University
John P. Bonin	Wesleyan University
Joyce Jacobsen	Wesleyan University
Lori Bollinger	Wesleyan University
Mamie W. Mueller	Wesleyan University
Clifford B. Hawley	West Virginia University
Douglas W. Mitchell	West Virginia University
Jerald J. Fletcher	West Virginia University
Kern O. Kymn	West Virginia University
Peter V. Schaeffer	West Virginia University
Stratford M. Douglas	West Virginia University
Walter C. Labys	West Virginia University
Susan K. Kask	Western Carolina University
James A. Yunker	Western Illinois University
Vaman Rao	Western Illinois University
Annette N. Brown	Western Michigan University
Bassam E. Harik	Western Michigan University
Donald L. Alexander	Western Michigan University
Emily P. Hoffman	Western Michigan University
Usree Bandyopadhyay	Western Michigan University
Werner Sichel	Western Michigan University
Dennis R. Murphy	Western Washington University
John R. Wagner	Westfield State College
Maria K. Wrotniak	Westminster College
Gordon Weil	Wheaton College
James Halteman	Wheaton College
John A. Walgreen	Wheaton College
James F. Shepherd	Whitman College
Samuel Webb	Wichita State University
Charles Waldauer	Widener University
Beth A. Wilson	Willamette University
Don Negri	Willamette University

ECONOMISTS' STATEMENT ON CLIMATE CHANGE

List of Economists Who Have Endorsed to Date

March 24, 1997

NAME	AFFILIATION
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Peter Gordon	University of Southern California
Richard H. Day	University of Southern California
Timothy N. Cason	University of Southern California
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Lewis R. Gale, IV	University of Southwest Louisiana
Charles M. Gray	University of St. Thomas
Demos P. Hadjiyanis	University of St. Thomas
Marsha Blumenthal	University of St. Thomas
Paul R. Casperson	University of St. Thomas
Amy Farmer	University of Tennessee
Charles B. Garrison	University of Tennessee
Jean Gauger	University of Tennessee
John W. Mayo	University of Tennessee
Jonathan D. Rubin	University of Tennessee
Matthew N. Murray	University of Tennessee
Peter M. Bearse	University of Tennessee
Sidney L. Carroll	University of Tennessee
Thomas R. Sadler	University of Tennessee
E. Bruce Hutchinson	University of Tennessee, Chattanooga
William J. Crowder	University of Texas
Brian M. Trinque	University of Texas, Austin
Charles C. Holt	University of Texas, Austin
Chrys Dougherty	University of Texas, Austin
David Kendrich	University of Texas, Austin
David Scoones	University of Texas, Austin
Don Fullerton	University of Texas, Austin
Dwight Steward	University of Texas, Austin
Geoffrey T. Andron	University of Texas, Austin
Paul W. Wilson	University of Texas, Austin
Ray Marshall	University of Texas, Austin
Stephen L. McDonald	University of Texas, Austin
Tracy Hofer	University of Texas, Austin
Charles Lackey, Jr.	University of Texas, Brownsville
Wim P.M. Vijverberg	University of Texas, Dallas
Jose A. Pagan	University of Texas, Pan American
John Merrifield	University of Texas, San Antonio
David E. Keefe	University of the Pacific
Michael Ballot	University of the Pacific
Walter C. Wagner	University of the Pacific
Johannes Overbeek	University of the Virgin Islands
Alan H. Gleason	University of Toledo
C. R. Winegarden	University of Toledo
John Murray	University of Toledo
Bobbie L. Horn	University of Tulsa
John Karikari	University of Tulsa

NAME	AFFILIATION
Gail Blattenberger	University of Utah
Kenneth P. Jameson	University of Utah
Lance Girton	University of Utah
Mark Glick	University of Utah
R. Thayne Robson	University of Utah
Thomas N. Maloney	University of Utah
Abbas Alnasrawi	University of Vermont
Alfred L. Thimm	University of Vermont
Michael Sesnowitz	University of Vermont
Charles A. Holt	University of Virginia
Jane Ihrig	University of Virginia
John Elder	University of Virginia
John K. Whitaker	University of Virginia
Mark R. Eaker	University of Virginia
Michael G. Rukstad	University of Virginia
John Treble	University of Wales
Dan Jacoby	University of Washington
Gardner Brown	University of Washington
Haideh Salehi-Esfahani	University of Washington
J. Lawarree	University of Washington
Kathryn Dewenter	University of Washington
Robert Varadi	University of Washington
William Beyers	University of Washington
Abbas A. Taheri	University of Wisconsin Center, Fox Valley
Darwin Wassink	University of Wisconsin, Eau Claire
Maria DaCosta	University of Wisconsin, Eau Claire
Wayne Carroll	University of Wisconsin, Eau Claire
Sayeed Payesteh	University of Wisconsin, Fond du Lac
Thomas S. Nesslein	University of Wisconsin, Green Bay
Glenn Knowles	University of Wisconsin, LaCrosse
Donald A. Nichols	University of Wisconsin, Madison
James Andreoni	University of Wisconsin, Madison
James D. Schilling	University of Wisconsin, Madison
Kenneth D. West	University of Wisconsin, Madison
Patricia Hallinan	University of Wisconsin, Madison
Arik Levinson	University of Wisconsin, Madison
James D. Shilling	University of Wisconsin, Madison
Martin David	University of Wisconsin, Madison
Raghar Oygard	University of Wisconsin, Madison
W. A. Brock	University of Wisconsin, Madison
David J. Bernstein	University of Wisconsin, Milwaukee
Markos J. Mamalakis	University of Wisconsin, Milwaukee
Sol Shalit	University of Wisconsin, Milwaukee
M. Kevin McGee	University of Wisconsin, Oshkosh
Nancy J. Burnett	University of Wisconsin, Oshkosh
Dennis A. Kaufman	University of Wisconsin, Parkside

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List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation
Herbert Giwtes	University of Massachusetts
Irving Gershenberg	University of Massachusetts
James K. Kindahl	University of Massachusetts
James T. Campen	University of Massachusetts
Nancy Folbre	University of Massachusetts
Norman D. Aitken	University of Massachusetts
Paul M. Brown	University of Massachusetts
Andres Torres	University of Massachusetts, Boston
David Terkla	University of Massachusetts, Boston
Joann Stewart	University of Massachusetts, Boston
David M. Kemme	University of Memphis
K. K. Fung	University of Memphis
Anphonse G. Holtmann	University of Miami
Bryan W. Roberts	University of Miami
David C. Mauer	University of Miami
David Letson	University of Miami
Kerry Anne McGeary	University of Miami
Alan V. Deardorff	University of Michigan
Albert Park	University of Michigan
Christine Papajohn	University of Michigan
Edward Gramlich	University of Michigan
F. Thomas Juster	University of Michigan
Frank Thompson	University of Michigan
J. Kmenta	University of Michigan
James N. Morgan	University of Michigan
Jeffrey K. Mackie-Mason	University of Michigan
Jonathan A. Parker	University of Michigan
Merritt B. Fox	University of Michigan
Michael R. Moore	University of Michigan
Michael Wellman	University of Michigan
Paul N. Courant	University of Michigan
Richard A. Hirth	University of Michigan
Robert Stern	University of Michigan
Steven T. Vass	University of Michigan
Terry L. Roe	University of Michigan
Warren C. Whatley	University of Michigan
Wolfgang F. Stolper	University of Michigan
Yan Chen	University of Michigan
David Weinstein	University of Michigan Business School
Sugato Bhattacharyya	University of Michigan Business School
Mark J. Perry	University of Michigan, Flint
N. N. Reddy	University of Michigan, Flint
Bryan Dowd	University of Minnesota
C. Ford Runge	University of Minnesota
Edward Coen	University of Minnesota
Edward Foster	University of Minnesota

Name	Affiliation
G. Edward Schuh	University of Minnesota
Grant Haner	University of Minnesota
Jared Creason	University of Minnesota
Jay S. Coggins	University of Minnesota
Jerrold M. Peterson	University of Minnesota
John A. Nyman	University of Minnesota
Leonid Hurwicz	University of Minnesota
Mahmood A. Zaidi	University of Minnesota
Margaret Peteraf	University of Minnesota
Pareena Lawrence	University of Minnesota
Philip M. Raup	University of Minnesota
Robert T. Kudrle	University of Minnesota
Roger Feldman	University of Minnesota
Timothy J. Kehoe	University of Minnesota
Vernon W. Ruttan	University of Minnesota
Arne Kildergaard	University of Mississippi
Norman K. Womer	University of Mississippi
Chyi-Ing Lin	University of Missouri
Donald J. Schilling	University of Missouri
Floyd K. Harmston	University of Missouri
Nicholas Kalaitzandonakes	University of Missouri
Robert J. Bevins	University of Missouri
Shawn Ni	University of Missouri
W. Whitney Hicks	University of Missouri
Philip B. Thompson	University of Missouri, Rolla
Douglas Dalenberg	University of Montana
John Duffield	University of Montana
Michael Kupilik	University of Montana
Craig R. MacPhee	University of Nebraska
E. Wesley F. Peterson	University of Nebraska
Gordon Karels	University of Nebraska
Lilyan E. Fulginiti	University of Nebraska
Roger F. Riefler	University of Nebraska
Richard K. Perrin	University of Nebraska, Lincoln
Ronald M. Cronovich	University of Nevada
Ricardo Gazel	University of Nevada, Las Vegas
Dwayne Wrightsman	University of New Hampshire
W. David Bradford	University of New Hampshire
Edward A. Downe	University of New Haven
Robert Rainish	University of New Haven
Christine Sauer	University of New Mexico
Geoffrey J. Bannister	University of New Mexico
K. Gawande	University of New Mexico
Max D. Bennett	University of New Mexico
Arja Turunen-Red	University of New Orleans
Alfred J. Field Jr.	University of North Carolina, Chapel Hill

ECONOMISTS' STATEMENT ON CLIMATE CHANGE

List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation
Peter S. Menell	University of California, Berkeley, Law School
Robert D. Cooter	University of California, Berkeley, Law School
Robert D. Cooter	University of California, Berkeley Law School
David F. Layton	University of California, Davis
John E Roemer	University of California, Davis
Klaus Nehring	University of California, Davis
Lovell S. Jarvis	University of California, Davis
Peter H. Lindert	University of California, Davis
Robert Smiley	University of California, Davis
Thomas Mayer	University of California, Davis
Barrie R. Nault	University of California, Irvine
David Brownstone	University of California, Irvine
Dennis J. Aigner	University of California, Irvine
Kenneth A. Small	University of California, Irvine
Michelle R. Garfinkel	University of California, Irvine
Peter Navarru	University of California, Irvine
Aziz Khan	University of California, Riverside
Jang-Ting Guo	University of California, Riverside
Keith C. Knapp	University of California, Riverside
Keith Griffin	University of California, Riverside
R. Robert Russell	University of California, Riverside
Steven Helfand	University of California, Riverside
Victor D. Lippit	University of California, Riverside
Takeo Hoshi	University of California, San Deigo
Alex Kane	University of California, San Diego
Allan Timmermann	University of California, San Diego
Christopher Woodruff	University of California, San Diego
Joel Watson	University of California, San Diego
John Conlisk	University of California, San Diego
Joseph Grunwald	University of California, San Diego
Lawrence B. Krause	University of California, San Diego
Michael Willoughby	University of California, San Diego
Richard T. Carson	University of California, San Diego
Richard W. Ruppert	University of California, San Diego
Elliot Marseille	University of California, San Francisco
Harold S. Luft	University of California, San Francisco
Charles D. Kolstad	University of California, Santa Barbara
Doug Steigerwald	University of California, Santa Barbara
Lloyd J. Mercer	University of California, Santa Barbara
Robert T. Deacon	University of California, Santa Barbara
Stephen J. DeCanio	University of California, Santa Barbara
William S. Comanor	University of California, Santa Barbara
Alan Richards	University of California, Santa Cruz
Daniel Friedman	University of California, Santa Cruz
Lori Kletzer	University of California, Santa Cruz
Menzie D. Chinn	University of California, Santa Cruz

Name	Affiliation
Michael M. Hutchison	University of California, Santa Cruz
Richard B. Howarth	University of California, Santa Cruz
Catherine Y. Co	University of Central Florida
Andres Rodriguez	University of Chicago
David Hummels	University of Chicago
Gale D. Johnson	University of Chicago
James D. Fearon	University of Chicago
Lars Peter Hansen	University of Chicago
Mary Jean Bowman	University of Chicago
Milton Harris	University of Chicago
Stefan Krieger	University of Chicago
Thomas Sargent	University of Chicago
Uzma Qureshi	University of Chicago
Claire Friedland	University of Chicago, George J. Stigler Center
Cass D. Sunstein	University of Chicago, Law School
Austan Goolsbee	University of Chicago, School of Business
Lars A. Stole	University of Chicago, School of Business
Timur Kuran	University of Chicago, School of Business
Dennis Hanseman	University of Cincinnati
Wolfgang Mayer	University of Cincinnati
Naci Mocan	University of Colorado
Bernard Udis	University of Colorado, Boulder
Charles De Bartolome	University of Colorado, Boulder
Charles W. Howe	University of Colorado, Boulder
Keith E. Maskus	University of Colorado, Boulder
Kenneth R. Beauchemin	University of Colorado, Boulder
Mark Cronshaw	University of Colorado, Boulder
Paul Stutsman	University of Colorado, Boulder
Robert K. Davis	University of Colorado, Boulder
Robert McNown	University of Colorado, Boulder
Russell R. Wermers	University of Colorado, Boulder
Daphne Greenwood	University of Colorado, Colorado Springs
Michael J. Mueller	University of Colorado, Colorado Springs
Arthur W. Wright	University of Connecticut
C. P. Hallwood	University of Connecticut
Lanse Minkler	University of Connecticut
Peter Barth	University of Connecticut
Susan Randolph	University of Connecticut
Walter Dolde	University of Connecticut
John Rapp	University of Dayton
George R. Parsons	University of Delaware
Kenneth A. Lewis	University of Delaware
Laurence Seidman	University of Delaware
Russell F. Settle	University of Delaware
Stacie E. Beck	University of Delaware
David E. Black	University of Deleware

ECONOMISTS' STATEMENT ON CLIMATE CHANGE

List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation
Edward K. Hawkins	The World Bank, Rtd.
Enrique Lerdau	The World Bank, Rtd.
George C. Maniatis	The World Bank, Rtd.
Philip J. Glaessner	The World Bank, Rtd.
Ralph H. Hofmeister	The World Bank, Rtd.
Theodore Lang	Thomas Lane & Associates
Michael H. Thomson	Thomson Econometrics
James W. Thomson	Thomson Investing
Richard Skolnik	Tiffin University
Nayyer Hussain	Tougaloo College
B. Michael Gilbar	Town of Hanover, New Hampshire
Chang Min Kong	Towson State University
George C. Georgiou	Towson State University
William Ingram	Tradewinds Realty
Bruce Vermeulen	Training & Development Corp.
Andrew J. Gold	Trinity College
Ward S. Curran	Trinity College
William Breit	Trinity University
David Gillette	Truman State University
Jane Sung	Truman State University
Seymour Patterson	Truman State University
Werner Sublette	Truman State University
Carsten Kowalczyk	Tufts Univeristy
David M. Garman	Tufts University
Gilbert Metcalf	Tufts University
Jonathan Harris	Tufts University
Joseph A. DiMasi	Tufts University
Neva Goodwin	Tufts University
Thomas A. Downes	Tufts University
Dahlia Remler	Tulane University
David Hotchkiss	Tulane University
David Malueg	Tulane University
Eamon M. Kelly	Tulane University
Irving H. LaValle	Tulane University
Jonathan B. Pritchett	Tulane University
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Gampat Ramesh	U.N. Development Program
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James L. Mudge	U.S.A.I.D.
Jerre A. Manarolla	U.S.A.I.D.
Michael Crosswell	U.S.A.I.D.
Liliana E. Pezzin	U. S. Agency for Health Care Policy & Research
Arden K. Sansom	U. S. Army Corps of Engineers
Frank D. Campbell	U. S. Army Trade Analysis

Name	Affiliation
Marshall Reinsdorf	U. S. Bureau of Labor Statistics
Adam A. Sokoloski	U. S. Bureau of Land Management
Marc Rubin	U. S. Bureau of the Census
Anthony C. Homan	U. S. Consumer Product Safety Commission
Elliot Levy	U. S. Department of Commerce
H. Kemble Stokes, Jr.	U. S. Department of Commerce
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Christian Ehemann	U. S. Dept. of Commerce, Bureau of Economic
Paul D. Gayer	U. S. Dept of Health and Human Services Rtd.
Monroe Burk	U. S. Foreign Service
Michael E. C. Ely	U. S. Foreign Service, Rtd.
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William McNaught	U. S. General Acounting Office
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James M. Russell	U. S. Treasury Department
Willilam B. Trautman	U. S. Treasury Department
Lawrence D. Krohn	UBS Securities
Donald Shoup	UCLA
Hilary Sigman	UCLA
Jack Hirshleifer	UCLA
John G. Riley	UCLA
John J. McCall	UCLA
Mohan Penubarti	UCLA
Paul M. Ong	UCLA
Rebecca Menes	UCLA

ECONOMISTS' STATEMENT ON CLIMATE CHANGE

List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation
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Patricia Hughes	St. Cloud State University
Micheal St. John	St. John & Associates
Daniel Finn	St. John's University
Sara Gordon	St. John's University
Ralph A. Terregrossa	St. Johns University
Linda R. Rudolph	St. Lawrence University
Robert A. Blewett	St. Lawrence University
Sarah A. Stevens	St. Lawrence University
Kathleen N. Gillespie	St Louis University, School of Public Health
Andrea T. Williams	St. Mary's College of California
Joan Underhill Hannon	St Mary's College of California
Theodore Tsukahara, Jr.	St. Mary's College of California
Gary Scott	St. Mary's University
Roy E. Robbins	St. Mary's University
Herbert Kessel	St. Michael's College
David Emery	St. Olaf College
David W. Schodf	St Olaf College
Paul Wojick	St. Olaf College
Rebecca Judge	St. Olaf College
Xum Z. Pomponio	St. Olaf College
John J. Donohue	Stanford Law School
William F. Baxter	Stanford Law School
A. Michael Spence	Stanford University
Anne O. Krueger	Stanford University
Auner Greif	Stanford University
B. Douglas Bernheim	Stanford University
Bert G. Hickman	Stanford University
Bruce F. Johnston	Stanford University
Ciaran S. Phibbs	Stanford University
Ezra Solomon	Stanford University
Henry M. Levin	Stanford University
Hung-po Chao	Stanford University
John Earle	Stanford University
Karine Nyborg	Stanford University
*,** Kenneth J. Arrow	Stanford University
Lawrence J. Lau	Stanford University
Martin Carnoy	Stanford University
Mordecai Kurz	Stanford University
Myra H. Strober	Stanford University
Rosamond Naylor	Stanford University
Scott Rozelle	Stanford University
Victor R. Fuchs	Stanford University
Jeffrey Williams	Stanford University, Food Research Institute
Pan A. Yotopoulos	Stanford University, Food Research Institute

Name	Affiliation
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Gerald M. Meier	Stanford University, School of Business
Thomas Hellman	Stanford University, School of Business
Andrea Shepard	Stanford University, School of Business
Jeremy Bulow	Stanford University, School of Business
Patricia Bowles	State Education
Gregory Vitale	State of Iowa
Khosrow Khojasteh	State of Iowa
Bernard Brown	State of New Jersey
Richard Fryman	State University of West Georgia
Siegfried G. Karsten	State University of West Georgia
William C. Schaniel	State University of West Georgia
James E. Mallett	Stetson University
Ranjini Thaver	Stetson University
Richard H. Wood, Jr.	Stetson University
Richard M. O'Conor	Stockholm School of Economics
Hossein S. Kazemi	Stonehill College
Raymond A. Pepin	Stonehill College
Jeffrey H. Rohlfs	Strategic Policy Research
Karen Nelson	Streamline Training & Documentation
Shahruz Mohtadi	Suffolk University
Jonathan Sunshine	Sunshine and Associates
Betty C. Daniel	SUNY, Albany
Jim H. Wyckoff	SUNY, Albany
Kajal Lahiri	SUNY, Albany
Terrence Kinal	SUNY, Albany
John S. Nader	SUNY at Delhi
Edward C. Kokkelenberg	SUNY, Binghamton
Manas Chatterji	SUNY, Binghamton
Robert L. Basmann	SUNY, Binghamton
Richard M. Romano	SUNY, Broome
Frederick G. Floss	SUNY, Buffalo
Murray Brown	SUNY, Buffalo
Thomas Romans	SUNY, Buffalo
David Ring	SUNY, College at Oneonta
Edward I. Beck	SUNY, College at Oneonta
Amar K. Paral	SUNY, Fredonia
William H. Foeller	SUNY, Fredonia
David A. Martin	SUNY, Geneseo
Roman A. Ohrenstein	SUNY, Nassau College
Peter Vukasin	SUNY, New Paltz
Wade L. Thomas	SUNY, Oneonta
William P. O'Dea	SUNY, Oneonta
Michael A. Stoller	SUNY, Plattsburgh
Warren L. Fisher	Susquehanna University
Larry E. Westphal	Swarthmore College

ECONOMISTS' STATEMENT ON CLIMATE CHANGE

List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation
James F. Kasting	Pennsylvania State University
Jeffrey K. Lazo	Pennsylvania State University
Lawrence L. Blacchi	Pennsylvania State University
Norman R. Swanson	Pennsylvania State University
Philip A. Klein	Pennsylvania State University
Thomas A. Gresik	Pennsylvania State University
Tim Considine	Pennsylvania State University
William J. Wheele	Pennsylvania State University
Elizabeth T. Hill	Pennsylvania State University, Mont Alto
M.M. Shahjahan	PEPCO
Morton Zeman	Perimeter Adult Learning & Services
Peter L. Bernstein	Peter L. Bernstein, Inc.
Yoon Kim	Phoenix, Inc.
James Lehman	Pitzer College
Sailaja Raparla	Point Systems Solutions, Inc.
Hans Lofgren	Policy Research Institute
Jane Venohr	Policy Studies, Inc.
Eleanor Brown	Pomona College
Frank C. Wykoff	Pomona College
James D. Likens	Pomona College
Michael Kuehlwein	Pomona College
Stephen V. Marks	Pomona College
Giles H. Burgess Jr.	Portland State University
Harold G. Valter	Portland State University
Helen Youngelson-Neal	Portland State University
John F. Walker	Portland State University
Myron B. Katz	Portland State University
Thomas P. Potiowsky	Portland State University
Robert Kirchner	Potomac Electric Power Company
Peter Merrill	Price Waterhouse
Burton Malkiel	Princeton University
Elizabeth C. Bogen	Princeton University
Gregory Chow	Princeton University
Maria Hanratty	Princeton University
Timothy Van Zandt	Princeton University
Albert O. Hirschman	Princeton University, Inst. for Adv. Studies
John P. Lewis	Princeton University, Woodrow Wilson School
Kenneth Rogoff	Princeton University, Woodrow Wilson School
Mark Watson	Princeton University, Woodrow Wilson School
Michael Rothschild	Princeton University, Woodrow Wilson School
R. Thomas Burge	Proctor & Gamble Pharmaceuticals
Curt Mueller	Project Hope
David Zalewski	Providence College
Mary Jane Lenon	Providence College
YJ Yoon	Public Choice Center
Evan White	Public Utility Commision of Oregon

Name	Affiliation
Antonio L. Rosado	Puerto Rico Economist Association
Dan Kovenock	Purdue University
George R. Averiit	Purdue University
Gerald E. Shively	Purdue University
Hedayeh Samavati	Purdue University
James C. Moore	Purdue University
Janet S. Netz	Purdue University
John M. Connor	Purdue University
Larry De Boer	Purdue University
Patrick McCarthy	Purdue University
Paul L. Farris	Putnam, Hayes & Barlett, Inc.
George R. Hall	Quinnipiac College
Trish Kelly	R. J. Bates
Rex J. Bates	RainForest ReGeneration
Robert L. Randall	RAND
Dana Goldman	RAND Corp..
Julia Lowell	RAND Corp.
Sheila Nataraj Kirby	RAND Corp.
William Dow	Randolph Macone College
C. Barry Pfitzner	Randolph-Macon Woman's College
Antoinette J. Criss	RDP Consulting Group
Eugenio Diaz-Bonilla	Red Oak Research
Richard B. Parker	Reed College
Carl M. Stevens	Reed Consulting Group
Heidi Brown	Regional Science Research Corp
Benjamin H. Stevens	Regis College
H. Michael Coiner	Regis College
Mary J. Oates	Rehabilitation Services, Inc.
Robert L. Lessne	Rensselaer Polytechnic Institute
Donald F. Vitaliano	Research Triangle Institute
Gary Zarkin	Research Triangle Institute
Katherine B. Heller	Research Triangle Institute
Sheila A. Martin	Resource Decisions
Marvin Feldman	Resources for the Future
Dallas Burtraw	Rhode Island College
Alema Karim	Rice University
Dagobert L. Brito	Rice University
Gordon W. Smith	Rice University
Kei-Mu Yi	Richard Stockton College of New Jersey
Melaku Lakew	Ricks College
Kirk D. Gifford	Rider University
Henry J. Frank	Ripon College
Paul J. Schoofs	Robert W. Baird & Co. Incorporated
Clare W. Zempel	Rochester Institute of Technology
Michael J. Vernarelli	Rock Creek Research, Inc.
Albert Keidel, III	

ECONOMISTS' STATEMENT ON CLIMATE CHANGE

List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation
Ernst R. Berndt	MIT, Sloan School of Management
** Franco Modigliani	MIT, Sloan School of Management
Dale W. Larson	Mitsubishi Research Institute
Michael H. Lee	Montana Public Service Commission
Phillip LeBel	Montclair State University
William Gissy	Morehouse College
Michael Rollins	Mount Holyoke College
Frank Zamowski	Mount St. Mary's College
Arthur J. Raymond	Muhlenberg College
George Heitmann	Muhlenberg College
Rohini P. Sinha	Muhlenberg College
Martin Milkman	Murray State University
Seid Y. Hassan	Murray State University
Brian Thomas	MWD
Brian Crumb	NACT
C. Stuart Callison	Nathan Associates, Inc.
Gary L. French	Nathan Associates, Inc.
John Varley	Nathan Associates, Inc.
Abraham J. Fallick	National Association of Business Ecomonists
Brian J. Ostrom	National Center for State Courts
Gerald C. Berg	National Defense University
Robert W. Beckstead	National Defense University
Alan J. Daskin	National Economic Research Associates Inc.
David Tabak	National Economic Research Associates Inc.
Leonardo Giacchino	National Economic Research Associates Inc.
Li-Lan Cheng	National Economic Research Associates Inc.
Marci Kramer Mayer	National Economic Research Associates Inc.
Robert Petersen	National Economic Research Associates Inc.
Stephen E. Usher	National Economic Research Associates Inc.
Carolyn Dewa	National Opinion Research Center
Ted R. Miller	National Public Services Research Institute
Chris Wise-Mahr	National Science Foundation
Robert Schmidt	National University
Bill Gates	Naval Postgraduate School
David Whipple	Naval Postgraduate School
Joseph DaBoll-Lavoie	Nazareth College
Edward A. Schroeder, IV	Nazareth College of Nazareth
Joyce Gleason	Nebraska Wesleyan University
Richard McGahey	Neece, Cator & McGahey
Richard L. Kaluzny	New Jersey Division of Taxation
David T. Geithman	New Jersey Institute of Technology
Eliot Orton	New Mexico State University
Robert Heilbroner	New School for Social Research
Willi Semmler	New School for Social Research
Alex L Yufa	New York City Economic Dev. Corp.
Sidney Friend, Jr.	New York City Police Department

Name	Affiliation
Carol L. Osler	New York Federal
William J. Lawrence	New York Institute of Technology
Sonya Komreich	New York State Dept. of Labor, Ind.
Janusz A. Ordover	New York Univeristy
Adam Przeworski	New York University
Amy Ellen Schwartz	New York University
Dick Netzer	New York University
Edward Wolff	New York University
Holger C. Wolf	New York University
Jacob A. Toby	New York University
Jess Benhabib	New York University
Joshua Ronen	New York University
Lawrence White	New York University
Lewis A. Kornhauser	New York University
Paul Wachtel	New York University
Rita Maldonado-Bear	New York University
Roy Radner	New York University
W. Van Der Klaauw	New York University
Walter W. Haines	New York University
** Wassily Leontief	New York University
William J. Baumol	New York University
Robert A. Kavesh	New York University, Stern School
Thomas A. Pugel	New York University, Stern School
Mark J. Lawless	NFPA International
Thomas A. Foulkes	NHTI
Stanton A. Warren	Niagara University
Yuzo Kumasaka	NLI Research Institute
Blair T. Bower	NOAA Consultant
Carol A. Jones	NOAA Damage Assesment Center
Gregory N. Price	North Carolina A&T University
Lawrence B. Morse	North Carolina A&T University
Ryoichi Sakano	North Carolina A&T University
Darren L. Frechette	North Carolina State University
Duncan M. Holthausen	North Carolina State University
Fanis Tsoulouhas	North Carolina State University
Michael B. McElroy	North Carolina State University
Samim Cilem	North Carolina State University
J. Carl Poindexter	North Carolina State University
Allen Vander Muelen	North Central College
Thomas M. Love	North Central College
Lynn Schneider	North Georgia College & State University
Watson Collins	Northeast Utilities
Barbara M. Fraumeni	Northeastern University
Gustav Schachter	Northeastern University
John Adams	Northeastern University
Kamran M. Dadkhah	Northeastern University

ECONOMISTS' STATEMENT ON CLIMATE CHANGE

List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation
Shawky El Toukhy	ITA of New Jersey
Elia Kacapyr	Ithaca College
M. Raquibuz Zaman	Ithaca College
Marc Bilodeau	IUPUI
Jannette M. Barth	J.M. Barth & Associates, Inc.
Andrew Kohen	James Madision Univerisity
Joanne M. Doyle	James Madision University
Ehsan Ahmed	James Madison University
J. Barkley Rosser, Jr.	James Madison University
William C. Wood	James Madison University
Kevin Stokes	Jefferson Community College
Ronald Swanstrom	Jefferson High School
Edward J. Jorgenson	Jet Propulsion Laoboratory
Lawrence R. Cima	John Carroll University
Thomas A. Sears	John F. Kennedy University
Carl F. Christ	Johns Hopkins University
Christopher D. Carroll	Johns Hopkins University
Cristino R. Arroyo	Johns Hopkins University
David G. Fernandez	Johns Hopkins University
Isaiah Frank	Johns Hopkins University
Louis J. Maccini	Johns Hopkins University
W. Max Corden	Johns Hopkins University
Douglas W. Copeland	Johnson County Community College
Nan L. Wilson	Johnson County Community College
Zohreh M. Niknia	Johnson County Community College
Milton Russell	Joint Institute for Energy and Environment
Joseph A. Swanson	Joseph Swanson & Co.
Kenneth A. Reinert	Kalamazoo College
Amir Tavakkol	Kansas State University
Andrew Barkley	Kansas State University
Patrick Gormely	Kansas State University
Richard L. D. Morse	Kansas State University
Robert B. Borges	Kansas State University
Roger Trenary	Kansas State University
Steve Hamilton	Kansas State University
Pierre Carasso	Kayne Anderson
Carol M. Condon	Kean College of New Jeresey
Youn-Suk Kim	Kean College of New Jersey
Alexander S. Kelso, Jr.	Kelso International
Penelope B. Prime	Kennesaw State University
Richard J. Kemt	Kent State University
Arthur D. Chesler	Kentucky Wesleyan College
Kottayam V. Natarajan	King Co. Dept. of Natural Resources
Hamid Hosseini	King's College
Zachary Rolnik	Kluwer Publishers
Wan Ho Cho	Korean Consulate

Name	Affiliation
John P. Brown	KPMG Economic Consulting Services
Richard A. Boykin	KPMG Economic Consulting Services
Steven D. Felgran	KPMG Economic Consulting Services
Stephen E. Baldwin	KRA Corporation
Jon Haveman	Krannert School of Management
David H. Robinson	La Salle University
Dr. Mark J. Ratkus	La Salle University
James C. Haefner	Labelon Corporation
Dwayne S. Breger	Lafayette College
Howard Bodenhorn	Lafayette College
James DeVault	Lafayette University
Jeffrey O. Sundberg	Lake Forest College
Richard F. Dye	Lake Forest College
Robert A. Baade	Lake Forest College
William Maskoff	Lake Forest College
Rolando A. Santos	Lakeland College
Judith Markland	Landmark Strategies
Thomas W. Langford	Langford & Associates
Christopher J. Pleatsikas	Law & Economics Consulting Group
Steven Stoft	LBNL
Hui-Liang Tsai	Lebanon Valley College
J. Richard Aronson	Lehigh University
Thomas Hyclak	Lehigh University
Todd A. Watkins	Lehigh University
Eban Goodstein	Lewis & Clark College
James H. Grant	Lewis & Clark College
Shaomin Huang	Lewis Clark State College
Hal Sider	Lexecon Inc.
Jeffery T. Collins	Lincoln Memorial University
Vishwanath Tirupattur	Lincoln National
Randy R. Grant	Linfield College
Stpehen M. Lewarne	LMCL Corp
Douglas A. Wion	Lock Haven University
Michael Edesess	Lockwood Financial Group
Gang Feng	Lockwood Trade Journal Co. Inc.
John T. Evans	Long Island University
P. M. Rao	Long Island University
Ranbir Varma	Long Island University
Brian R. Horrigan	Loomis, Sayles & Co.
Steven Booth	Los Alamos National Laboratory
Verne W. Loose	Los Alamos National Laboratory
Robby C. Winters	Los Angeles City College
Nancy L. Sidener	Louisiana Council for Economic Education
Steven J. Prince	Louisiana Scholars' College
John M. Church	Louisiana State University Law Center
Marc C. Chopin	Louisiana Tech

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List of Economists Who Have Endorsed to Date

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Name	Affiliation
Peter C. Mayer	Guam Power Authority
Louis D. Johnston	Gustavus Adolphus College
Herbert W. Fraser	H. W. Fraser Associates
Ahmad Faruqui	Hagler Bailly
Harold A. Cohen	Hal Cohen, Inc.
Robert E. Dansby	Halcyon Inc.
John Haldi	Haldi Associates, Inc.
Elizabeth J. Jensen	Hamilton College
Hilke Kayser	Hamilton College
Burke Burright	Hamon Systems Center
Robert Charles Graham	Hanover College
Samuel S. Chun	Harvard Business School
Thomas K. McCraw	Harvard Business School
Randall Bluffstone	Harvard Inst. for International Developement
Bruce R. Bolnick	Harvard Inst. for International Development
Clifford Zinnes	Harvard Inst. for International Development
Clive S. Gray	Harvard Inst. for International Development
David C. Cole	Harvard Inst. for International Development
Glenn P. Jenkins	Harvard Inst. for International Development
Jeffrey D. Sachs	Harvard Inst. for International Development
Jeffrey Vincent	Harvard Inst. for International Development
John Luke Gallup	Harvard Inst. for International Development
Amartya Sen	Harvard University
Andrew Metrick	Harvard University
Brian Hall	Harvard University
Cheol Soo Park	Harvard University
Claudia Goldin	Harvard University
* Dale Jorgenson	Harvard University
David Laibson	Harvard University
Dwight H. Perkins	Harvard University
James K Hammitt	Harvard University
Jerry R. Green	Harvard University
John R. Meyer	Harvard University
John Y. Campbell	Harvard University
Lawrence Katz	Harvard University
Lester E. Gordon	Harvard University
Martin L. Weitzman	Harvard University
Michael Whinston	Harvard University
Nathan Keyfitz	Harvard University
Oliver Hart	Harvard University
Raymond Vernon	Harvard University
Robert Dorfman	Harvard University
Roswell G. Townsend	Harvard University
Steven Shavell	Harvard University
Tilman Slembeck	Harvard University
Christopher Jencks	Harvard University, Kennedy School of Govt.
David T. Ellwood	Harvard University, Kennedy School of Govt.
Edward A. Parson	Harvard University, Kennedy School of Govt.
F. M. Scherer	Harvard University, Kennedy School of Govt.
Jose Antonio Gomez-Ibanez	Harvard University, Kennedy School of Govt.
Mun S. Ho	Harvard University, Kennedy School of Govt.
P. Timothy Bushnell	Harvard University, Kennedy School of Govt.
Richard F. Garbaccio	Harvard University, Kennedy School of Govt.
Robert Stavins	Harvard University, Kennedy School of Govt.
William Spitz	Harvard University, Kennedy School of Govt.
Robert H. Mnoouin	Harvard University, Law School
W. Kip Viscusi	Harvard University, Law School
Abram Bergson	Harvard University, Littauer Center
Rashi Fein	Harvard University, Medical School
David Hemenway	Harvard University, School of Public Health
Maurine A. Haver	Haver Analytics
Shelley M. Mark	Hawaii, Dept of Bus. Econ. Devel & Tourism
Vincent A. Fulmer	Hawthorn College
Hilda Kahne	Heller School, Brandeis University
David E. Ervin	Henry A. Wallace Institute
Michael MacCully	High Point Univerisity
Michael McCully	High Point University
Stephen L. Zabor	Hiram College
Ugur Aker	Hiram College
James E. Metzger	Histecon Associates Inc.
Takatoshi Ito	Hitotsubashi University, International
Matthew K. Loke	HMSA
Jacob Weissman	Hofstra University
Walter E. Hoadley	Hoover Institution
Robin Klay	Hope College
Linda Marie Dynan	Hospital Research and Education Trust
Chuck Nwaka	Howard University
Cleveland A. Chandler	Howard University
Sung Kwack	Howard University
C. Elisabeth Pittman	HPA, Inc.
L. Douglas Lee	HSBC Washington Analysis
Mark Shroder	HUD (for identification only)
David T. Hulett	Hulett & Associates
Daniel M. Ihara	Humboldt State University
Saeed Mortazavi	Humboldt State University
Steven Hackett	Humboldt State University
Tim Yeager	Humboldt State University
Taisuji Hayakawa	IADB
Michael C. Barth	ICF Kaiser
Robert Tokle	Idaho Sate University
Rob P. Vos	IDB
Mylene Kherallah	IFPRI

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ECONOMISTS' STATEMENT ON CLIMATE CHANGE

List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation
Anne Bunton	Cottey College
Alice Tepper Marlin	Council on Economic Priorities
Lenore H. Burckel	Cowers TM
Naomi Chesler	CPE
Joseph M. Phillips	Creighton Unviersity
Roberto Riley	Critical Decisions Group
P. Hartland-Thunberg	CSIS
Albert I. A. Bookbinder	CUNY
Ashok Vora	CUNY
Hugo M. Kaufmann	CUNY
Irving Stone	CUNY
Joseph Berechman	CUNY
Ki-Ho Kim	CUNY
Lawrence Jay Kaplan	CUNY
Robert Kaestner	CUNY, Baruch College
Yehuda L. Klein	CUNY, Brooklyn College
V. Petratos	CUNY, C. S. I.
Howard Chernick	CUNY, Hunter College
Harvey Gram	CUNY, Queens College
Peter Ellbott	CUNY, Queens College
Zadia H. Feliciano	CUNY, Queens College
Peter Chow	CUNY, The City College
Paul G. Althaus	CUNY, York College
Dennis E. Logue	Dartmouth College
John A. Menge	Dartmouth College
M. O. Clement	Dartmouth College
Michael M. Knetter	Dartmouth College
Sang-Seung Yi	Dartmouth College
Sheri L. Aggarwal	Dartmouth College
C. Louise Nelson	Davidson College
David W. Martin	Davidson College
George Szejner	DC Superior Court
Gary D. Lemon	De Pauw University
Peter Meenan	Deloitte & Touche LLP
Richard Sciacca	Deloitte & Touche LLP
Calvin A. Hoerneman	Delta College
Craig Walker	Delta State University
Pete Morton	Denver University
Adolph E. Mark	DePaul University
Animesh Ghoshal	DePaul University
Bala Batavia	DePaul University
Michael Marschoun	DePaul University
Woods Bowman	DePaul University
Eric R. Nelson	Development Alternatives, Inc.
Martha O. Blaxall	Development Alternatives, Inc.
Greig Harvey	DHS Associates

Name	Affiliation
Gordon S. Bergsten	Dickinson College
Leo Brand	Director, Standard & Poor
Cono Casella	Dowlire Colege
William M. Boal	Drake University
Andrew Venzilli	Drexel University
Bijou Y. Lester	Drexel University
Shawkat Hammoudeh	Drexel University
Vibhas Madan	Drexel University
Carol Mansfield	Duke University
E. Roy Weintraub	Duke University
Ed Tower	Duke University
Mark Y. An	Duke University
Martin Bronfenbrenner	Duke University
Philip J. Cook	Duke University
Pietro Peretto	Duke University
Wesley A. Magat	Duke University
Richard Henning	E. Elgar Publishers
C. A. Christofides	East Stroudsburg University
P. Neelakantan	East Stroudsburg University
Seewoonundun Bunjun	East Stroudsburg University
Perm S. Mann	Eastern Connecticut State University
Harold D. Nordin	Eastern Illinois University
James E. Payne	Eastern Kentucky University
Thomas G. Watkins	Eastern Kentucky University
Richard A. Yoder	Eastern Mennonite University
Adrian J. Lottie	Eastern Michigan University
Michael G. Vogt	Eastern Michigan University
Thomas W. Bonsor	Eastern Washington University
Hugh Richards	ECON
Frederic B. Jennings, Jr.	Econologistics
Richard A. Baum	Economic Analysis
Kenneth R. Button	Economic Consulting Services Inc.
Geoffrey H. Moore	Economic Cycle Research Institute
Jared Bernstein	Economic Policy Institute
Kenneth R. Dunmore	Economic & Policy Studies
John A. Laitner	Economic Research Associates
Paul F. White	Economic Research Services, Inc.
Steve Holland	Economics Institute
An-Sik Min	Edinboro University of Pennsylvania
Rudi W. Schadt	Edwin L. Cox School of Business, SMU
Robert J. Eggert	Eggert Economic Enterprises
Eli Ginzberg	Eisenhower Center, Columbia University
E. Somanathan	Emory University
Jeffrey A. Rosenweig	Emory University
Richard F. Muth	Emory University
Robert Catlett	Emporia State University

ECONOMISTS' STATEMENT ON CLIMATE CHANGE

List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation
Robert Wassmer	Cal State Sacramento
James M. Payne	Calhoun Community College
Tsong-Yue Lai	California State University
Malcom Dole, Jr.	California Air Resources Board
Seymour Goldstone	California Energy Commission
Lionel J. Lerner	California Energy Commission, Rtd.
Charles R. Plott	California Insitute of Technology
Lance E. Davis	California Institute of Technology
Phillip Fanchon	California Polytechnic State University
James Ahern	California Polytechnic University
Franklin Y. Ho	California State Polytechnic University
A. R. Gutowsky	California State University
Anil K. Puri	California State University
Daniel R. Blake	California State University
Don R. Leet	California State University
Eduardo M. Ochoa	California State University
Eric J. Solberg	California State University
Madhu S. Mohanty	California State University
Michael Perelman	California State University
Neil Garston	California State University
Tom C. Geurts	California State University
Donald J. Oswald	California State University, Bakersfield
Robert G. James	California State University, Chico
Suleman A. Moosa	California State University, Chico
Scott Houser	California State University, Fresno
Paul D. Staudohar	California State University, Hayward
Robert S. Ozaki	California State University, Hayward
Marion S. Beaumont	California State University, Long Beach
Micheal J. Farrell	California State University, Long Beach
John A. Tomaske	California State University, Los Angeles
H. Dieter Renning	California State University, Stanislaus
Mary Fair Berglund	California Transportation Commission
Young J. Park	California University of Pennsyvania
Julie Elston	Caltech
John P. Tiemstra	Calvin College
Scott V. Parris	Cambridge University Press
Pierre Canac	Cameron School of Business
John M. Courington	Cameron University
Yu-Mong Hsiao	Campbell University
Andrew C. Givens	Cardinal Energy Service, Inc.
Dickson K. Smith	Cardinal Strich College
George H. Lamson	Carleton College
Stephen H. Strand	Carleton College
Allan H. Meltzer	Carnegie Mellon University
Chris L Telmer	Carnegie Mellon University
George Loewenstein	Carnegie Mellon University
Lester B. Lave	Carnegie Mellon University
Mark S. Kamlet	Carnegie Mellon University
Russell Sheldon	Carnegie Mellon University
Shyam Sunder	Carnegie Mellon University
Amresh Hanchate	Case Western Reserve University
Bo Carlsson	Case Western Reserve University
Robert E. Schill	Castleton State College
Robert K. Arnold	CCSCE
Robert Deuson	Center for Disease Control
Stephen T. Parente	Center for Health Affairs
Zbigniew Bochniarz	Center for Nations in Transition, Univ. of
Carol Moore	Center for Naval Analysis
Jan Ondrich	Center for Policy Research, Syracuse University
Sidney Weintraub	Center for Strategic and Intl. Studies
James Reschovsky	Center for Studying Health System Change
Paul B. Ginsburg	Center for Studying Health System Change
Brian Peterson	Central College
Richard Glendening	Central College
N. Wayne Jordan	Central Florida Community College
Paul Natke	Central Michigan University
Baird Allen Brock	Central Missouri State University
Bruce K. Johnson	Centre College
David A. Anderson	Centre College
Robert E. Martin	Centre College
Michael J. Walsh	Centre Financial Products Ltd.
Raymond Sfeir	Chapman University
Deloris R. Wright	Charles River Associates
Philip K. Vealecer Sr.	Charles River Associates
Robert J. Lamer	Charles River Associates
Gladys A. Dejesus	Chowan College
Koenraad M. Driessens	Christensen Associates
Laurence D. Kirsch	Christensen Associates
Laurits R. Christensen	Christensen Associates
Samuel Cutting	Christensen Associates
Philip Schoech	Christiansen Associates
Rita C. Sweeney	Christiansen Associates
Kookshin Ahn	Chung-Ang University, Seoul
Jarl R. Hellemaln-Ashfield	Church of God
Frederick Schroeder	Cigna Financial Advisors, Inc.
Alfred Eisenpreis	City Innovation
Alfred Keisenpress	City Innovation
Gordon Alexander	City of Austin, Texas
Greg Hill	City of Seattle
Paul A. Zak	Claremont Graduate School
Mark Haggerty	Clarion University
Attiat F. Ott	Clark University

ECONOMISTS' STATEMENT ON CLIMATE CHANGE

List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation
Lorraine M. Connell	
M. G. Zephirin	
M. S. Noorzoy	
Marianne Ferber	
Mark D. Henson	
Mark W. Rider	
Marnie Shaul	
Martin J. Wyand	
Martin Muhleisen	
Martine Duchatelet	
Mary McNally	
Maud Naroll	
Michael Adler	
Michael Rabbitt	
Mike Denning	
Milton A. Wolf	
Milton Garnet James	
Milton Moss	
Mingliang Zhang	
Nancy H. Wilson	
Nicholas Komninos	
Nizar Jetha	
Nora Piore	
Norman Nierenberg	
Omar Azfar	
P. Michael Laub	
Pat Markovich	
Patricia Godoy-Kain	
Patrick Karani	
Paul Boyce	
Peter F. Freund	
Peter M. Emerson	
Peter Siegelman	
Peter Zadrozny	
Philip A. Dillaber	
Philip E. Franklin	
Piljoo Yum	
Priya Shyamsundar	
R.R. Rhomberg	
Rafael Montalvo	
Ralph N. Calkins	
Ralph W. Pfouts	
Raymond A. Miller	
Raymond L. Guarnieri	
Rebecca A. Havens	
Rene Bernier	
Richard B. Goode	
Richard Gomez	
Richard Hooley	
Richard J. Claycombe	
Richard L. Ruth	
Richard Nichols	
Richard Raymond	
Richard Sabatino	
Richard Weckstein	
Richard Young	
Rick Mines	
Robert A. Rennie	
Robert C. Young	
Robert D. Stevens	
Robert Dennis	
Robert Hawkins	
Robert L. Steiner	
Robert L. Wood, Jr.	
Robert Myers	
Robert T. Mott	
Robert V. Bishop	
Robert V. Bishop	
Roberto Chang	
Rod E. Jensen	
Rogene A. Buchholz	
Roger D. Little	
Roger Mann	
Rose Jochnowitz	
Rudolph W. Hardy	
S. Scanlon Romer	
Saul L. Smith	
Scott Goldsmith	
Sergio Pereira Leite	
Serim Huh	
Shannon R. Brown	
Shimon Awerbuch	
Souleyman Gueye	
Stahis S. Panagides	
Stella Swetnick	
Stephen Altheim	
Stephen H. Zeller	
Stephen Parkoff	
Steven Yamarik	
Teresa Sala-Ruede	
Terrence P. Smith	
Theodore Borek	

Sponsored By:

ECONOMISTS' STATEMENT ON CLIMATE CHANGE

List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation
Frank Lerman	
Frank W. Gery	
Fred Morser	
Gary Anders	
Gary Watts	
George A. Jouganlos	
George E. Michel	
George Fox	
George L. Perry	
George R. Feiwel	
Gerald A. Pollack	
Gerald T. O'Mara	
Gertrude Schroeder	
Gilbert R. Coleman	
Gordon Irlam	
Gordon K. Douglass	
Gregory L. Rosston	
Gretchen McClain	
H. Lynn Miller	
Harold L. Bryant	
Henry B. McFarland	
Herbert S. Wong	
Howard Gensler	
Hugh Franks	
Irma T. de Alonso	
Irving W. Cheskin	
J. Herbert Burkman	
J. L. Bascunana	
Jack Beebe	
Jacob C. Hurwitz	
Jacques J. Kozub	
James A. Lew	
James Duprey	
James E. Clark	
James E. Glassman	
James L. Hamilton	
James Trask	
Jan Parker	
Jay V. Groves	
Jay Zamilkau	
Jeff Bond	
Jeffrey M. Rhodes	
Jessica Gordon Nembhard	
Jiehjou Joe Wu	
John Dean Gaffey	
John H. Wells Jr.	
John Hayes	
John J. Hisnanick	
John J. Soladay	
John M. Hackett	
John Maher	
John McFarland	
John Navratil	
John P. Shelton	
John R. Moore	
John R. Norsworthy	
John R. Stewart, Jr.	
John S. Coleman	
John Stein	
John Van Dewater	
Jon Manger	
Jonathan Willner	
Joseph E. Bowring	
Joseph F. Shaw	
Joseph Froomkin	
Joseph P. Cain	
Joseph V. Cartwright	
Juan A. Villeta-Trip	
Jules N. LaRocque	
Julie-Anne M. Cronin	
Jurg Niehans	
Karen Van Nuys	
Karl De Schweinitz	
Karl Driessen	
Karl E. Sagner	
Katherine K. Yunker	
Kathleen Short	
Kathleen V. McNally	
Keith Waehrer	
Ken Beier	
Kenan Ogelman	
Kent R. Nilsson	
Kent Sims	
Kevin J Klyan	
Kishore Kulkarni	
Kuo Tseng	
Lawrence F. Mansfield	
Lawrence Thurston	
Leah J. Smith	
Lee Cohen	
Leibert Benet Wallerstein	
Li-Teh Sun	

ECONOMISTS' STATEMENT ON CLIMATE CHANGE

List of Economists Who Have Endorsed to Date

March 24, 1997

Name	Affiliation	Name	Affiliation
James S. Hanson	Willamette University		
Elizabeth Brainerd	Williams College		
Matthew Hyle	Winona State University		
David Peterson	Wisconsin Department of Revenue		
Marcus Boggs	Wishview Press		
E. B. Gendel	Woodbury University		
Michael J. Radzicki	Worcester Polytechnic Institute		
Paul Faeth	World Resources Institute		
Robert Repetto	World Resources Institute		
Norman S. Anon	Wright State University		
Rishi Kumar	Wright State University		
Thomas Traynor	Wright State University		
Steven C. Agee	XAE Corporation		
Robert O. Zimmerman	Xavier University		
Henry Hansmann	Yale Law School		
Katherine O'Regan	Yale School of Management		
Paul W. MacAvoy	Yale School of Management		
Barry Nalebuff	Yale University		
Dirk Bertemann	Yale University		
** James Tobin	Yale University		
Jody Sindelar	Yale University		
Joel Waldfogel	Yale University		
L. G. Reynolds	Yale University		
Lynne Bennett	Yale University		
M. J. Peck	Yale University		
Robert Evenson	Yale University		
T. Paul Schultz	Yale University		
* William Nordhaus	Yale University		
Gustav Ranis	Yale University, Economic Growth Center		

Tab E:

A Short Primer on Externalities and Public Goods

A Short Primer on Externalities and Public Goods

Overview on externalities

A negative externality is a cost that one person or company imposes on another. For example, if your home furnace emits soot that soils your neighbors' laundry, you have imposed an externality on your neighbor. A key element of the externality is that the person imposing the cost does not bear the full (social) cost of the activity. In the case of the dirty furnace, the homeowner bears the costs of fuel and furnace maintenance, but escapes the cost of dealing with the soiled laundry. It is worth noting that externalities need not be bad; a positive externality confers a benefit on someone who did not have to pay for it. For example, if your yard's graceful trees and colorful flowers offer your neighbors a fine view, you have conferred on them a positive externality: they would be willing to pay something for the view, but it is not feasible (it would cost too much) to charge them for it. Left to itself, the free market will produce too little of a positive externality (like a pleasing landscape) and too much of a negative externality (like pollution).

The economists' term for this is **market failure** -- indicating the existence of external costs or benefits for which it is not feasible to compensate or charge those who bear the costs or enjoy the benefits. Economists have long recognized the role of externalities: Marshall (1898) introduced the concept of externalities, and Pigou (1920) incorporated the concept into welfare economics, introducing the distinction between private and social cost. Pigou also devised one of the classic responses to a negative externality. For example, assume that homeowners will emit too much soot if they do not have to bear all the costs of what they do. Pigou's solution was to levy a charge equal to the difference between marginal social cost and marginal private cost (see figure 1)-- thus forcing the homeowner to "internalize" the full social costs of her actions.

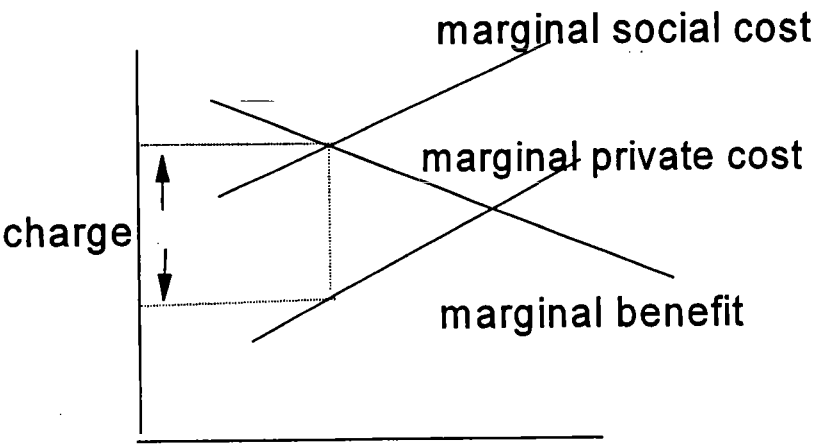

Figure 1: Pigouvian charge

Overview on public goods

A public good is one that must be provided in the same amount to all affected consumers. National defense is a public good: the amount of national defense I receive in no way diminishes the amount you receive. We may value it differently, but we all get the same amount. Moreover, there is no way for me to deny you the same amount that I get. A free market will provide too little of a public good, because there is no incentive for any individual to reveal the true value to him or her of the public good. The usual solution is for governments to provide public goods, although that leaves the problem of deciding on a common level.

A pure public good has both of the properties referred to above: nonrivalry and nonexcludability (Samuelson 1954, 1955).[1] Nonrivalry means that additional consumers do not have to compete with each other to use the good and therefore drive up its cost: the marginal cost of an additional individual using the good is zero. Nonexcludability means that the marginal cost of exclusion -- of stopping an individual from enjoying the good -- is prohibitive. Public goods thus permit **free riding.** Lighthouses, for example, are public goods: when lighthouse services are provided to one person, others may enjoy the same services without cost.

International public goods

The atmosphere is an international public good, in that atmospheric concentrations are the result of combined actions by all countries. That means that if one country's greenhouse gas reductions thwart global warming, all countries benefit.

Since different countries will be affected differently by climate change, the benefits of avoiding greenhouse warming will also differ from country to country. Further, some actions will simultaneously affect local atmospheric conditions (providing local public goods) and greenhouse concentrations. For example, actions that reduce urban driving improve local air quality and at the same time reduce greenhouse gas emissions.[2]

Property rights

Adam Smith's insight on the invisible hand of the marketplace (1776) remains the basis of welfare economics. Stated in modern form, it says that if each producer and consumer maximizes his own private net benefits, then markets that allow trading among all producers and all consumers will result in a socially optimal allocation of resources. Here, socially optimal means Pareto optimal, in that resources cannot be reallocated so as to make one person better off without at the same time making someone else worse off.

Environmental problems most often occur when well-defined property rights do not exist (Coase 1960). This may occur because the rights have not been comprehensively assigned (a person may hold title to a piece of land, but no one holds title to the air that circulates over it); because the rights are not exclusive; because the rights are not transferable

(a farmer who could not transfer his land would lack some incentive to preserve its fertility); or because the rights are not secure, thus encouraging the owner to exploit the resource while it is still under his control (Hanley, Shogren, and White 1997).

The absence of property rights for many environmental resources forms the justification for most government intervention in the environment.

Assigning property rights to the atmosphere is particularly difficult, however, since this would require the agreement of many sovereign states. Tradable greenhouse emission permits, discussed below, can be thought of as an attempt to resolve the problem by explicitly assigning property rights to greenhouse emissions.

Establishing property rights for emissions is not the same thing as considering the climate system itself as a public good. The Framework Convention on Climate Change refers to the climate system (not the atmosphere) as a "common concern of humankind." Atmospheric concentrations are the net result of emissions plus the contributions and effects of other factors such as the oceans, forests, and agricultural activity. Establishing property rights over emissions does not provide guidance for the consideration of these other influencing factors. Thus, establishing property rights for the atmosphere is only one of the mechanisms necessary to regulate climate change.

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Notes

1.For counter examples to the received wisdom, see Coase (1960). After Samuelson seminal articles in 1954 and 1955, Kneese (1962, 1964) extended the treatment of externalities with a series of articles in which he showed that an effluent charge would efficiently allocate the costs of clean up. See Baumol and Oates (1988) for a proof.

2.Although there may also be trade-offs: reductions in gases that contribute most to local pollution may sometimes be achieved at the expense of increased emissions of greenhouse gases.

Tab F:

Opportunities for Low-Cost Reductions Abroad

Opportunities for Low-Cost Reductions Abroad

The Framework Convention on Climate Change (FCCC) says that "policies and measures to deal with climate change should be cost effective." Because greenhouse gas (ghg) emissions anywhere in the world have the same effect on the atmosphere, reducing a unit of emissions is equally valuable wherever it occurs.

Countries vary by two orders of magnitude in emissions of greenhouse gases per unit of gdp. At the low end are the poorest countries of sub-Saharan Africa: Rwanda, Burundi, Mali, Chad, and so on. These are pre-industrial economies that still rely on animal and human power supplemented by wood and crop wastes, rather than commercial fuels. The OECD countries lie in the middle of this range. Within the OECD, countries with low population density, an abundance of fossil fuels, a cold climate, or large average dwelling size use more energy per unit of gdp. Thus, Canada, Australia, and the US top the OECD list. China has the most carbon-intensive economy. Other countries with high greenhouse emissions per unit of gdp include India, Indonesia, Egypt, Mexico, Venezuela, Hungary, and South Africa. All these countries are all in the middle stages of industrialization, and most have large coal or oil reserves.

Many of these less developed countries (LDCs) and economies in transition (EITs) offer low-cost opportunities for reducing carbon emissions, for two reasons:

- *Energy Efficiency.* Many LDCs and EITs are less energy efficient than OECD countries.

  Non-annex I countries use two and a half times as much energy per unit of gdp as Annex I countries. This manifests in all sectors of the economy, and in many individual end-uses of energy. Many investments in energy efficiency would quickly pay for themselves, yielding negative-cost reductions.

  - Chinese coal-fired boilers are only 2/3 as efficient as US boilers. A recent World Bank study concluded that China could reduce its carbon emissions by 15 percent from its projected 2020 levels through zero- and negative-cost energy efficiency improvements. About 70 percent of these improvements would come as a result of market-oriented restructuring, with the remainder from particular technical projects.

  - Russian cities spend large parts of their budgets on heat and heat subsidies; the city of Cheliabinsk, for example, spends more money on heat and heat subsidies than on health care.

- *High rates of growth and investment.* Because of their high growth rates, developing countries have an advantage over the OECD in their ability to meet their reduction targets by installing new, carbon-efficient plants rather than by retrofitting existing plants.

  Non-annex 1 countries accounted for only 18 percent of world gdp in 1994 -- and only $790 in gdp per head, as against $12,200 for Annex 1. At the same time non-annex gdp

was growing at 5 percent annually (1990 to 1994), as against 1.2 percent for Annex 1. This has important implications for growth and investment.

When a power company in an OECD country considers building a new plant, it weighs the total cost of building a new natural gas plant against only the variable cost continuing to operate its existing coal plants. Unless coal prices jump, or the existing plant is in poor repair, only a large rise in coal prices will justify scrapping the old coal plant. When a power company in an LDC considers building a new plant, however, it weighs the total cost of building a new natural gas plants against the total cost of building a new coal plant. Here, only a small rise in coal prices could justify the decision to build a gas plant.

Joint implementation and trading

Joint implementation and international trading of carbon emission rights can help reduce emissions cost-effectively. Joint implementation could include switching from high-carbon to low-carbon fuels, investments in renewable energy projects, and the protection and expansion of forests as carbon sinks. The underlying idea is simple. If country A can reduce carbon emissions more cheaply than country B, B can buy greenhouse gas reductions from A by, for example, investing in tree-planting in A, or investing in new low-carbon energy sources in A.

Joint Implementation can serve other useful purposes besides reducing the cost of meeting greenhouse commitments: the opening of overseas markets, wider dissemination of advanced technologies, and improvements in local air quality.

Evidence for cost-effectiveness of trading and JI

Every economic study has found that trading and JI would lower costs worldwide. Barrett (1992), for example, stabilizing emissions country-by-country could cost the EU 50 times as much as stabilizing emissions for the EU as a whole. OECD's GREEN model shows that the costs of abatement vary among regions of the globe by a factor of 20 (Burnieux et al., 1992). GREEN also indicates that even with reach region reaching its stabilization target at least cost, allowing trade between regions would lower worldwide compliance costs by another factor of two. The Battelle Laboratory's Second Generation Model (SGM) shows similar results, as do virtually all other economy-energy-carbon models now used to inform the debate.

Examples of successful JI projects

The FCCC continues to consider including JI as a way for signatories to meet their obligations. In the meantime, the US government and the World Bank, among others, have embarked on projects with JI characteristics.

World Bank. The Global Environment Facility (GEF) of the World Bank funds projects to demonstrate the effectiveness of interfuel substitution and technology innovation in reducing greenhouse emissions.

In Poland, the Coal to Gas Conversion (CTG) Project encourages coal-to-gas conversions in medium-sized boilers where concessional financing is necessary to meet acceptable rates of return. The GEF will divide the $50 million cost with local sources.

In Mexico, the GEF encourages the replacement of incandescent lamps with fluorescent lamps in the cities of Guadalajara and Monterrey. This is forecast to reduce carbon emissions by 118,000 tons annually, sulfur oxides by 3000 tons annually, and nitrogen oxides by 208 tons annually.

The World Bank has also proposed a Carbon Investment Fund (CIF) to act as a market intermediary. The fund, on behalf of its investors, would undertake JI-type projects and sell the resulting carbon offsets to make a profit. Such a fund could improve on the efficiency of today's bilateral JI pilot projects by reducing transaction and search costs, providing efficient administration, and pooling risk.

United States. Since its foundation in 1993, the US Initiative on Joint Implementation (USIJI) has accepted 28 project proposals in 12 countries, helping US firms tap the potential outside the OECD for low-cost carbon reductions. These projects cover fuel switching, renewables, afforestation, and reforestation.

In the Czech Republic, The Bynov Heating Plant project in the city of Decin will switch the Bynov District Heating Plant from brown coal to natural gas, and at the same time improve the efficiency of the distribution system. In this project, the US Center for Clean Air Policy is collaborating with three US electric utilities and the City of Decin. Of the total capital investment of $1.5 million, local officials will finance 60 percent, with US utilities expected to make significant contributions. The Washington-based environmental group World Resources Institute (WRI) will be responsible for monitoring and analysis. The project aims to offset 12,800 tons of CO2 per year. In addition the project aims to substantially improve local air quality in a city whose peak SO2 level is 10 times higher than the health standards set by the World Health Organization (WHO), by removing 96 tons of SO2, and 3 tons of particulates.

The Biomass Cogeneration Project in India aims to demonstrate the feasibility of firing boilers at rural sugar mills with bagasse (sugar cane waste) during the 8-month crushing season, and with another renewable fuel during the four-month off-season. The project includes replacing existing boilers and installing cogeneration equipment, including high-pressure multi-fuel boilers, high-efficiency condensing extraction turbines, and advanced pollution control equipment.

In Costa Rica, the Klinki Forestry Project arranges with farmers to plant Klinki trees, specifically developed for their carbon-fixing ability. Farmers in Costa Rica plant trees to offset emissions of schools, individual homes, and small businesses in the United States, who contract with the project sponsors. Participating farmers, who sign a 40-year contract, receive tree seedlings, technical assistance, and a cash payment. The trees yield a high-grade industrial wood, suitable for utility poles and plywood, both of which continue to store carbon. The government of Costa Rica guarantees the reductions for 20 years, and will verify the extraction and storage of carbon. Project sponsors estimate that this method sequesters 16 tons of carbon per acre planted,

at a cost of only $5 per ton to sequester carbon this way.

In Malaysia, the Massachusetts-based New England Electric Power has joined with Rakyat Berjaya SDN, a Malaysian forest products company to improve forest management techniques on 1400 hectares forest land. Three forestry research institutes are monitoring the results. Project sponsors estimate that it will sequester 300,000 to 600,000 tons of carbon.

In the first JI-like project, the US independent power producer Alternative Energy Systems (AES) joined forces with local groups in Guatemala to plant forests there, offsetting carbon emissions from power projects AES was constructing elsewhere. AES teamed with CARE to identify local partners in Guatemala; World Resources Institute (WRI) monitored the results.

In Paraguay, AES joined forces with the Nature Conservancy to preserve tropical forests, and to demonstrate that a JI project could also benefit biodiversity.

A project in Costa Rica has replaced fossil-fuel burning power sources with a 20 MW wind farm which is expected to reduce carbon emissions by 72,000 tons over 15 years.

A project in Russia planted 506 hectares of trees and is expected to reduce carbon concentrations by 35,000 tons over 60 years.

Other projects, in various stages of implementation, include:

A large forest management project in progress in Bolivia combines forest regeneration and protection with the promotion of sustainable forest-product enterprises to reduce atmospheric carbon by an estimated 14.5 million tons over 30 years.

Also in Bolivia, the Rural Solar Electrification Project will finance and install photovoltaic collectors, with auxiliary equipment, in 400 homes in the Oruro and Chuquisaca Departments, which are not serviced by the national grid. The project is intended to test the feasibility of photovoltaic electricity generation in a dispersed rural setting. If successful, this would lead to a larger project, of which the major US partner is GPU International (the independent power producer subsidiary of a large East-coast utility).

In Sri Lanka, the Solar Electric Light Company (SELCO) of Washington DC will help finance the distribution and installation of solar photovoltaic collectors in 812,000 homes, to provide power for lighting, radio, and television. This will reduce carbon emissions by displacing kerosene lamps for lighting, and diesel generators that now power other small appliances.

A project in Russia will improve heating efficiency in Zelenograd by installing new heat exchangers, pumps, and control equipment. This project can reduce carbon emissions by 440,000 tons over 30 years.

Other countries. Several EU members have embarked on JI projects.

- In 1996, the Netherlands set aside US $51 million for JI projects in 6 countries: Bhutan, Czech Republic, Ecuador, Hungary, and Uganda.

- Norway funds a coal-to-gas conversion project in Poland, through the World Bank and the GEF. Norway has another JI project with Mexico.

- Australia is planning two JI projects in the south Pacific region, focusing on energy efficiency and renewables.

- Germany has 7 JI projects, in the Czech Republic, Indonesia, Jordan, Latvia, Portugal, and the Russian Federation. These focus on fuel switching, energy efficiency, and renewables.

In addition, at least 7 other countries have included Joint Implementation in their national action plans: Canada, Costa Rica, Japan, Denmark, Finland, Iceland, and Sweden. The group of potential host countries continues to grow. Projects have been launched or proposed in 17 countries. Thirty-two projects have received approval from both host and sponsor governments. On the US list alone, Bolivia, all 7 countries of Central America, Chile, Pakistan, and South Africa have all signed statements of their intent to cooperate with the United States.

Tab G:

"Cap and Trade" Emissions Trading Programs: A Mechanism to Achieve Emission Reductions Cost Effectively

"Cap and Trade" Emissions Trading Programs: A Mechanism to Achieve Emission Reductions Cost Effectively

The United States has successfully used a "cap-and-trade" emissions trading program as a tool to reduce the sulfur dioxide emissions which cause acid rain. This program has met the environmental goal while substantially lowering compliance costs, compared to other approaches. This paper explains the use of emissions trading by providing an introduction, a summary of how the Acid Rain Program works, an explanation of why the U.S. supports an international greenhouse gas emissions trading system for greenhouse gases, and some preliminary thoughts about how a domestic greenhouse gas emissions trading system would help the U.S. to meet the commitments envisioned by the Kyoto Protocol.

Introduction to Emissions Trading

- "Cap-and-trade" emissions trading programs have proved to be a successful and flexible approach to reducing pollution and lowering the cost of achieving emission reductions

- "Cap-and-trade" programs establish a legally binding limit on total emissions -- a legally-binding target -- providing the basis of environmental accountability.

- The target amount is divided into "allowances" and distributed (by an allocation system or by auction) to specific sources. These "allowances" can then be bought or sold. In the case of the U.S. acid rain program, the target was divided into one-ton "allowances" and allocated to electric utilities.

- Regulated sources are able to buy or sell allowances as needed to tailor their compliance strategies to reflect their own least cost approaches and adjust to changes in technology or market conditions. A source facing low compliance costs can "over-control" and sell extra allowances. A source facing high control costs can buy allowances.

- An effective system of tradeable permits achieves the environmental objective at the lowest possible cost. The crucial point is that tradeable permits allow firms to undertake reductions in the most efficient means possible. If one firm is able to reduce emissions at low cost, while another firm finds it difficult to reduce emissions, the first firm will be able to sell permits to the second firm -- reducing the overall cost of achieving the environmental objective.

Summary of the U.S. Experience with the Acid Rain Program

The Clean Air Act of 1990 established a "cap-and-trade" system for reducing the sulfur dioxide emissions responsible for acid rain. The first phase of emission reductions began in 1995 when 263 Phase I units were required to reduce their emissions by approximately 30 percent, on average, from 1980 levels of emissions. The second phase of the program begins in the year 2,000 and will require an average reduction of almost 50 percent from 1980 levels for

almost all electric utility units. During the first three years of Phase I, the utilities have reduced their emissions well beyond required limits. These "extra" reductions are being made now and "banked" in anticipation of the more stringent requirements taking effect in 2000, since the "banked" allowances can be used to reduce the cost of compliance with Phase II. As a result of allowance trading and banking, full compliance costs are now expected to be less than half of what the government estimated the program would cost in 1990.

The major steps needed to implement the Acid Rain Program are discussed in more detail in the next section, and highlighted below:

- Congress set the national cap (emission limit);
- Congress authorized EPA to allocate allowances (authorizations to emit SO2) to each utility unit (boiler or turbine) according to legislative formulas;
- EPA developed draft regulations, incorporated public comment, and published final regulations
- Utilities determine their own compliance strategy, measure and report emissions, and conduct allowance trades;
- EPA collects, verifies, and publishes emissions data, records official allowance trades, and conducts annual compliance;
- Congress required automatic penalties for excess emissions

Acid Rain Program Implementations Steps

1. *Congress set the national cap (emission limit).* The Clean Air Act specifies that the goal of the Acid Rain Program is to reduce national emissions of SO2 by 10 million tons. For the electric utility industry (which accounted for 2/3 of the national SO2 emissions in 1980), a reduction of 8.5 million tons (or almost 50 percent) will be required to reach the annual cap of 8.95 million tons by 2010. Phase I of the Program requires only the 263 largest and highest emitting boilers to reduce their emissions approximately 30 percent during the years 1995-1999, while Phase II of the Program (which begins in 2000) will require participation from approximately 2,000 units across the country.

2. *Congress authorized EPA to assign emission limits (allocate allowances) to each utility unit according to legislative formulas.* Within the 8.95 million ton cap, Congress authorized EPA to allocate "allowances" (one allowance is the authorization to emit one ton of SO2) to the 2,000 affected utility units. If the allowances had been grandfathered using emission baselines, then a 50 percent emission reduction would have been required at every unit. Instead, EPA used a fuel utilization baseline and set a performance standard emission rate to assign allowances. In other words, higher emitting units in the base year were assigned steeper emission reductions (their

"assigned number of allowances" were much lower than 50 percent of their base year emissions), while some of the lower emitting units in the base year were assigned enough allowances to fully cover their base year emissions (plus room for growth in many cases). After using these basic formulas to allocate allowances to each of the 2,000 utility units, EPA made a further adjustment to ensure that the national total would result in no more than 8.95 million tons of annual emissions.

EPA was authorized to withhold 2.8 percent of each unit's allowances to create a pool of allowances for auction for the benefit of new units, which were not assigned allowances. After soliciting bids from the private sector, EPA selected the Chicago Board of Trade to actually conduct this annual auction. The revenue raised from these auctions is returned (proportionately) to the utility companies. It is important to note that these are not extra allowances, but are set aside from within the national limit. The auction served the important function of providing an early price signal to the market. After the first year, the allowance market has emerged with private brokers facilitating almost all allowance trades, and now only a small fraction of traded allowances are purchased through the EPA auction held by CBOT. EPA still holds the auctions each year and publishes the results because Congress required them under the legislation.

3. *Utilities determine their own compliance strategy, measure and report emissions, and conduct trades.* Some utilities installed "scrubbers," post-combustion technology installed in the stack to capture and essentially eliminate sulfur from the emissions into the atmosphere. Under the Acid Rain Program, scrubbers have become more efficient at removing sulfur and also more cost-effective. Other utilities have switched to lower sulfur fuels, for example by switching to lower sulfur coal or from coal to natural gas, or by blending coals to produce a lower average sulfur fuel. Low sulfur coal turned out to be less expensive then predicted at the beginning of the program, largely because transportation costs dropped under deregulation of the railroads. Nevertheless, the innovation in compliance strategies and the lower cost can be attributed to the flexibility utilities are accorded in choosing their own (lowest cost) emission reduction strategies.

Utilities are also required to install and maintain continuous emission monitors (CEMs), or alternative emission measurement equipment at each source. One of the most important features of the monitoring system established under the Acid Rain Program is the automated data collection and reporting -- computer systems were installed along with the measurement equipment to capture hourly emissions data and to provide reports in an EPA-specified standard format. Utilities are responsible for conducting quality assurance testing on the monitors, according to daily, quarterly, and annual testing procedures, and to report both the quality assurance data and the emissions data to EPA quarterly.

Of course, this means that each power company itself has computerized access to its own emission reports, and thus can decide if and when to trade allowances - either to sell "extra" allowances the particular unit won't need, or to buy allowances if the unit will exceed its starting allowance budget. Many of these "trades" are internal to one company which owns more than one unit (since EPA started tracking allowance trades in 1994, over 50 million allowances have been traded from one private account to another). Some utilities go to other companies to buy or

sell allowances. More than 15 million allowances have been traded to date from one corporate entity to another. Among these private trades, 68 percent are between utilities and brokers, while only 10 percent are traded directly from one utility company to another (and many of these utility-utility trades may also involve private brokers who facilitate the direct transaction without taking title to the allowances). EPA tracks only official allowance trades which utilities (and brokers) want recorded officially (i.e. so that the utility can have the allowances for compliance with its emission reduction requirements); brokers and utilities are free to trade allowances outside the official EPA tracking system. However, the change in ownership of a traded allowance must be recorded in EPA's tracking system before it can be used by a source to cover emissions for compliance purposes.

4. *EPA collects, verifies, and publishes emissions data, records official allowance trades, and conducts annual compliance.* EPA spends most of its resources tracking, verifying, and publishing emissions data. EPA designed the standard electronic format for the quarterly emission reports, and processes approximately 1,700 files every three months. EPA uses its standard mainframe program to automatically check for certain data errors, and to provide feedback reports back to each utility to improve the quality of their reports. EPA then publishes quarterly summary reports, and carefully verified annual emission reports within a few months of receiving the data. These reports are the basis of the emissions data used to deduct the proper number of allowances from each utility account at the end of each year. EPA also has resources devoted to assisting the utilities with their monitoring hardware and software questions, and has implemented a program of field audits in cooperation with EPA Regional and State employees who visit the utilities and check the monitors directly.

Utilities and/or brokers carry out an allowance trade by filling out a simple one page form which identifies the buyer, the seller, and the allowances to be transferred. EPA does not collect the price for these official transactions -- the "public" price data is made available through the private sector, where the private sector brokers publish price information but keep the identity of the buyers and sellers confidential. EPA checks the allowance transfer form for proper authorization, and processes the trade by entering the data into a computer system which completes the transfer of allowances from one account to another, usually within 24 hours of receiving the form. EPA is planning on developing an electronic method for utilities to enter their requests.

About 100 people in Federal and State nationwide implement this program. EPA employs about 50 people in Headquarters to administer the SO2 allowance program and to develop and administer programs to address NOx and greenhouse gases : 25 to assist with monitoring or emissions data verification; 10 to manage the permitting, allowance trading, and annual compliance process; and the remainder to work on program evaluation, environmental assessment, and development of new programs focusing on NOx and greenhouse gas emissions. The other 50 people work in our EPA Regional offices or the State Agencies, working more directly with sources, particularly in providing assistance with meeting the monitoring requirements and conducting field audits.

5. *Congress required automatic penalties for excess emissions.* A utility must hold enough allowances to cover its emissions at the end of each year; if a utility's emissions were to exceed its annual allowances, then the Clean Air Act specifies that the utility must both provide an "offset" by authorizing EPA to automatically deduct the excess emissions from the utilities' next annual allocation and also by requiring the utility to automatically pay a financial penalty of $2,000 (adjusted for inflation) per ton of excess emissions. The $2,000/ton of excess emissions was intended to be approximately three times the expected cost of compliance with the program. With the current price of allowances at $100, and the inflation-adjusted penalty set currently at $2,500/ton, the penalty is currently about 25 times the cost of compliance. During the first two years of the program, 100 percent of the affected utilities are in compliance with their emission reduction requirements.

Acid Rain Program Results

When the Clean Air Act legislation was developed in 1990, a typical "command and control ("policies and measures") program, which would have required each electric utility boiler to install standard pollution control technology, was estimated to cost about $5 billion annually. To achieve the same level of emissions reductions using a "cap-and-trade" emissions trading program (which would allow electric utilities to choose the most cost effective approach for each boiler) was estimated in 1990 to cost about $4 billion annually. Once the program actually became effective, pollution control costs dropped dramatically, and with trading, the U.S. Government Accounting Office has since estimated that the SO_2 program is costing about $2 billion annually.

This dramatic drop in the nationwide cost of compliance is also reflected in the allowance price. In 1990, estimates of the likely permit price ranged from $200 up to over $1,000 (the higher end of the range was produced by industry analysts, who may not have been fully disinterested, and did not reflect all the institutional details of the final SO_2 program). The attached chart tracks the price of allowances, and shows that the current price of allowances is approximately $115.

The U.S. has already experienced significant emission reductions under the first phase of the control program: by 1995, the U.S. experienced a 30 percent drop in national SO_2 emissions from 1980. The attached chart shows that Phase I utilities have reduced their emissions 30 percent beyond the required limits (note the significant 3 million ton drop from 1994 to 1995 -- a 40 percent reduction attributed to the first year of the SO_2 trading program).

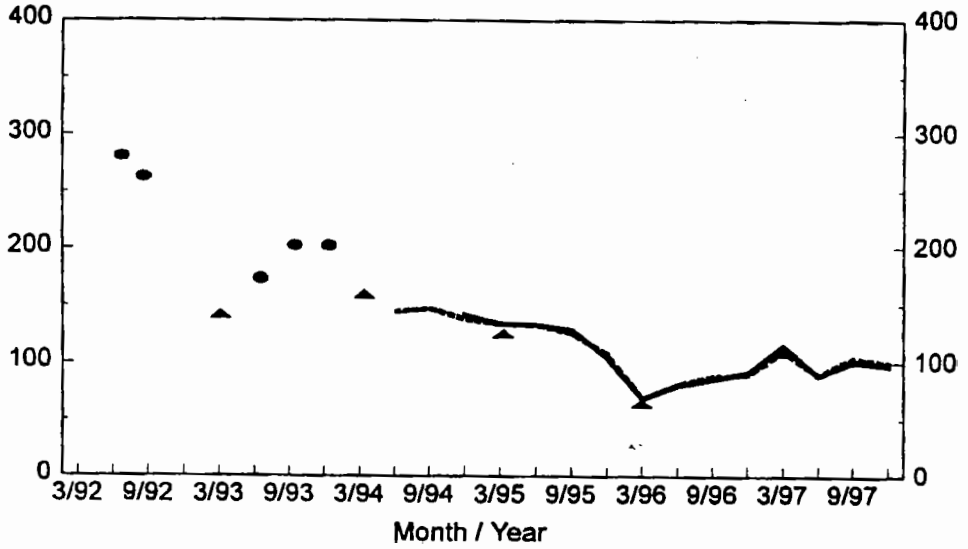
In addition to the significant reduction in emissions, the U.S. has experienced dramatic drops in acidic deposition in some of the most sensitive regions of the country. EPA will continue to study the environmental impacts of the program.

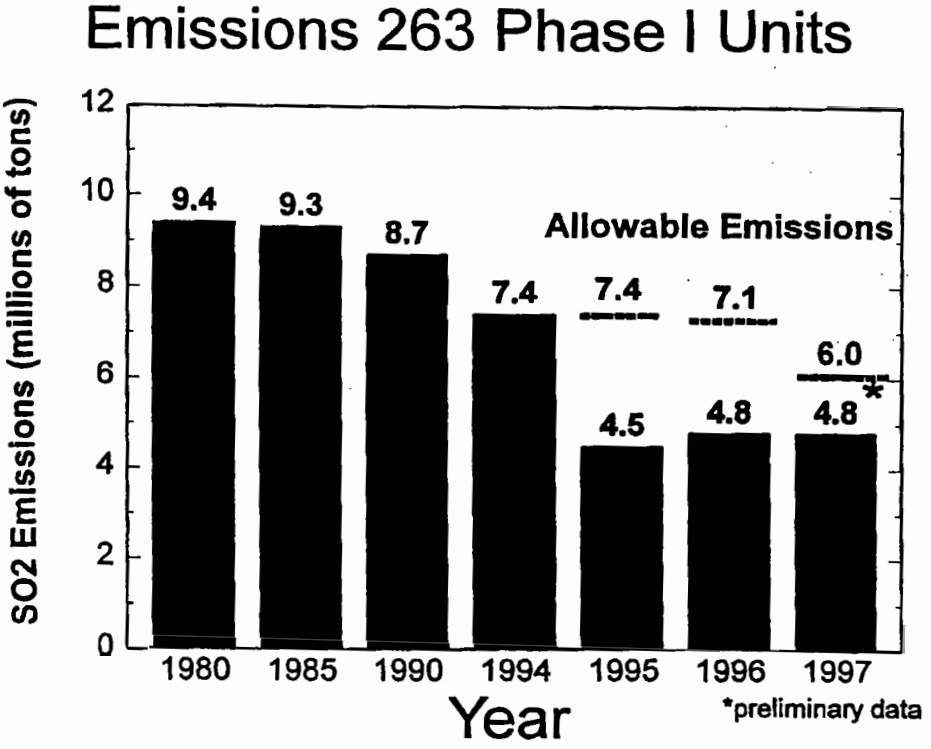
Conclusion

The U.S. government believes that the dramatic emission reductions and cost savings

realized by the emissions trading system under the Acid Rain Program can be applied to other appropriate environmental problems. Creation of an international greenhouse gas emissions trading system must be founded upon accurate, verifiable emissions measurement and reporting. Such an international emissions trading system can be designed to provide the certainty and flexibility needed to encourage the private sector to take economically efficient actions to reduce their greenhouse gas emissions. In particular, international emission trading will stimulate innovative and lower cost approaches to reducing greenhouse gas emissions, including the development of new technologies. New technologies and other low cost approaches to reduce greenhouse gas emissions will enable countries to achieve even greater emission reduction in the future.

Figure 1. SO2 Allowance Prices in US$





Tab H:

Non-Climate Benefits of the Kyoto Agreement (to be revised)

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Non-Climate Benefits of US participation in the Kyoto Agreement

I. Ancillary Emissions Reductions

The Kyoto agreement will lead to ancillary reductions in emissions that contribute to local air pollution, e.g., NOx, and VOCs. NOx, for example, is a combustion by-product that contributes to ground-level ozone and fine particulate formation. Thus to the extent that carbon emissions are reduced through reductions in fuel use, NOx emissions will also fall. In addition, NOx emissions per unit energy are also greater from coal, a carbon-intensive fuel, so that substitution of natural gas for coal, as well as reductions in fuel use, will also result in reductions in NOx.

We here treat the ancillary reductions in emissions of these gases as reducing the costs of meeting the new national ambient air quality standards (NAAQS). EPA estimated the costs of meeting the new NAAQS in 2010 to be $9.6 billion per year for ozone, and $37 billion per year for particulate matter. (These cost estimates may not be additive.)

A key question in estimating cost savings is whether carbon emissions reductions would avoid NAAQS related control measures. NAAQS related control costs would be avoided only if carbon-reduction strategies also reduced emissions that contribute to ozone and PM, *and* these ancillary emissions reductions were included in State Implementation Plans (SIPs) in a way that avoided the adoption of specific new control measures. SIPs that "demonstrate attainment" with the new NAAQS by specific dates that vary with air quality will be due in 2003 for ozone and 2005 for particulate matter. To date EPA has accepted in SIPs only those emission reductions that result from legally enforceable State actions. Thus EPA acceptance of emissions reductions from lower vehicle use resulting from higher fuel prices would be precedent setting, although it is apparently within the Agency's discretion. Since most of the control measures associated with attainment of the NAAQS entail sunk costs, cost savings may be reduced if controls to reduce carbon emissions occurred after, say, 2005, as may well be the case.

This note addresses ancillary reductions resulting from both reductions in fuel use and fuel switching based on the (incomplete) existing literature. It concludes that these ancillary benefits would range into the billions of dollars per year, given a carbon price of about $100/ton. Assuming fuel price increases, reduced vehicle use might reduce Nox and VOC emission control costs by $.15 billion in the short run to $.5 billion in the long run.

I. Utilities and Point Sources.

This analysis relies on information from EPA that supercedes information from EIA. EIA had provided us with an estimate of Nox emissions reductions from electric utilities as a result of a $100/ton carbon tax. EIA estimate is 1.6 million tons of Nox emissions per year nation-wide

from both fuel use and fuel switching. This estimate is an overstatement because it uses a baseline that neglects both the recent PM/ozone standards and EPA's recently proposed OTAG SIP call to reduce Nox. We believe that this overstatement is substantial because the estimated Nox reduction is approximately the reduction of 1.6 million summertime tons of Nox expected as a result of EPA's recently proposed OTAG Nox SIP call.

EPA supplied data on February 4 about two sets of air emissions reductions by pollutant (Nox, PM2.5, PM10, VOC and SO2), by sector and by State. The reductions are both from a baseline of partial attainment with the old NAAQS; EPA promulgated new NAAQS in July 1997.[1] The first set of reductions is for partial attainment of the new NAAQS, (it is unclear whether this is the new PM standard or the new ozone standard). The second set of reductions is for a $40/ton price of "CO2" (I presume but have not confirmed that this is a price of carbon not carbon dioxide). The appropriate baseline depends in part on the timing of the NAAQS implementation relative to the likely timing of a carbon cap and trade system. We believe that the Administration's policy is to support a carbon cap and trade program to be implemented in 2008. Therefore an appropriate baseline is partial attainment of the new NAAQS, given the preceeding discussion about SIP deadlines.

EPA has not supplied data on emissions reductions attributible to a carbon price given a baseline of partial attainment with the new NAAQS. To approximate such an estimate we assumed that the reductions from the $40/ton case from a baseline of partial attainment of the old NAAQS, less the reductions from the partial attainment of the new NAAQS given the same baseline, gives the reductions that would result from the $40/ton case given a baseline of partial

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For each type of emissions (Nox VOCs etc.,) we calculated the imputed reduction from the $40/ton policy given the baseline of partial attainment of the new NAAQS, under the additivity assumption. (When this approach yielded negative numbers we assumed a zero.) We then summed across all pollutants, sectors and States. For SO2, which we treated separately because of its lower abatement costs, the sum was .57 million tons, while for NOX+VOCs+PM2.5 it was .7 million tons.

For SO2, EPA had estimated an average cost/ton of $580 for the reductions achieved under a prospective 60 percent utility SO2 cap and trade program (in additional to the Phase II Title IV program). A marginal cost may be more appropriate, but no estimate is available. Applying this average cost per ton to the estimated SO2 emissions reductions gives cost savings of $.3 billion per year.

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[1] The baseline is partial attainment as opposed to full attainment of the old NAAQS because Los Angeles and some other cities have trouble meeting the old NAAQS.

For the other pollutants, EPA estimated average costs/ton of $1300 for the OTAG Nox cap, and $1500 for industrial boilers covered under the OTAG Nox cap. Both estimates are average costs, not marginal costs which were significantly higher. Therefore we use $2000/ton for nationwide estimates, as opposed to those limited to the OTAG region. Given this value per ton we calculate cost savings of $1.4 billion for the $40/ton case.

Aggregate cost savings are $1.7 billion/year from point sources.

Annual Ancillary Utilities Emission Reductions: Tons and Cost Avoided
Table 1

Carbon Permit Prices	SO_2 Cost Savings (billions)	Nox, VOCs and PM2.5 Cost Savings (billions)	Total Savings (billions)
$40/ton	$0.3	$1.4	$1.7

To put these estimated cost savings in perspective, the EPA's Regulatory Impact Assessment for the NAAQS uses $3,200/ton of NOx as an estimate of average control cost for specified measures in this full attainment scenario (see p. 9-15). The EPA also used a figure of $10,000/ton that for the incremental cost of the emissions reductions needed to reach full attainment of the new NAAQS, from a baseline of partial attainment.

Thus a $40/ton carbon price might yield cost savings of $1.7 billion per year.

II. Vehicles

NOx and VOC emission reductions from motor vehicles may come from more fuel efficient engines, reduced use, or changes in fleet composition. EPA estimates that 2010 Clean Air Act baseline NOx emissions from mobile sources (including motor vehicles and nonroad emissions sources) in ozone nonattainment areas will be 970 million tons; motor vehicle emissions nation-wide will be 7637 million tons.

Annual Ancillary Emission Reductions: Tons and Cost Avoided
Mobile Sources
Table 2

Area	Thousand tons/year					Cost Avoided per year (billions)	
	NOx	VOCs	Total Emissions	Emissions Reduced		Short Run	Long Run
				SR	LR		
Nation-wide[2]	7,637	5,834	13,400	270	940	$.3 [3] to $.8	$.9 to $2.8
Nonattainment areas[4]	1,433	841	2,300	50	160	$.15[5]	$.5

Note: Short run (SR) and long run (LR) emissions reductions reflect different price elasticities of demand; the long-run presumes vehicle fleet turn-over.

One recent study suggests that fuel price increases lead to reductions in carbon that are much larger than reductions in other emissions.[6] Several estimates for four metropolitan areas in California indicate that fuel taxes of $0.50 per gallon lead to Nox emissions reductions about 40 percent as large as carbon emission reductions. Reductions in VOCs are slightly larger, but for simplicity we ignore this difference. Given these relationships, we can posit a fuel price increase necessary to achieve a carbon emissions reduction, and then scale the Nox and VOC emissions reductions accordingly.

Our point of departure is the price hike needed to meet the Kyoto agreement. If the Kyoto agreement led to a domestic cap and trade system for carbon it might raise gasoline prices by $100/ ton of carbon, or $0.26 / gallon of refined petroleum products in the absence of

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[2]Reflects Clean Air Act Baseline, and so does not exclude emission reductions to meet the NAAQS. Sum of nonroad and motor vehicle emissions.

[3] At $1000/ton and $3,000/ton.

[4]Reflects Partial Attainment Scenario baseline. Sum of mobile and non-road emissions.

[5]These reductions are valued at $3,200/ ton because they are exclusively in nonattainment areas.

[6]See *Transportation Pricing Strategies for California: An Assessment of Congestion, Emissions, Energy and Equity Impacts*, California Environmental Protection Agency, November 1996

international permit trading. This is approximately a 20 percent price increase. Given a demand elasticity (short-run estimates are around .25, long run estimates as high as .9) consumption should fall by 5 percent in the short run and 18 percent in the long-run. Using the scaling factor of .4 from the California study, Nox and VOC emissions reductions would be 2 percent in the short run and 7 percent in the long run. Applying these percentages to the baseline emissions reported in Table 2 above, the reductions in the short run are 270 and 50 thousand tons per year nationally and in nonattainment areas respectively. Reductions in the long-run are 940 and 160 thousand tons per year nationally and in nonattainment areas respectively. Reductions for smaller fuel price increases are available by assuming that these benefits are proportional to the fuel price increase.

For simplicity we do not distinguish between the control costs avoided for VOCs and Nox. VOC emissions in EPA's NAAQS RIA were assumed to be controllable at an average marginal cost of $10,000/ton, but identified measures had an average incremental cost of $4000/ton, i.e., above the comparable figure of $3,200 for NOx. We ignore this difference and value both VOCs and Nox at $3200/ton in nonattainment areas and $1000 to $3000 in attainment areas. This range of values is likely to be conservative for nonattainment areas; the extent of conservatism for nation-wide reductions is not clear. Thus the cost avoided from mobile source emissions reductions may be about a half billion dollars per year, given a carbon price of $100/ton.

Congestion Related Benefits From Fuel Price Increases

The Kyoto agreement will reduce emissions from carbon by about 27 percent (100/137=.73). To the extent that these emissions reductions are achieved through fuel price increases, there will be a reduction in the use of motor vehicles, and there may be resulting increases in traffic congestion.

One recent study suggests that fuel price increases would lead to significant reductions in traffic delays.[7] Several estimates for four metropolitan areas in California indicate that fuel taxes of $0.50 per gallon in 1991 would have led to reductions in delay of about 7 percent.

A recent report funded by the Department of Transportation put the costs of congestion, relative to free-flowing traffic, at nearly $60 billion in 1994, up from less than $40 billion in 1986.[8] These costs reflect both the dollar value of delays to motorists, and the additional fuel consumption from congestion, although only about a tenth of the total estimated costs are fuel-related.

Thus a $100/ton carbon tax would lead to a $0.25/gal fuel tax, and reductions in congestion related delays of about 3.5 percent in the four California cities. If extrapolated nation-wide, reductions in congestion related delays, including the fuel savings, would be worth about $2 billion per year.

These estimates exclude the reductions in inconvenience that travelers would experience as a result of being able to begin trips closer to their preferred travel time. Such reduced inconvenience may be as valuable as the reductions in delay.

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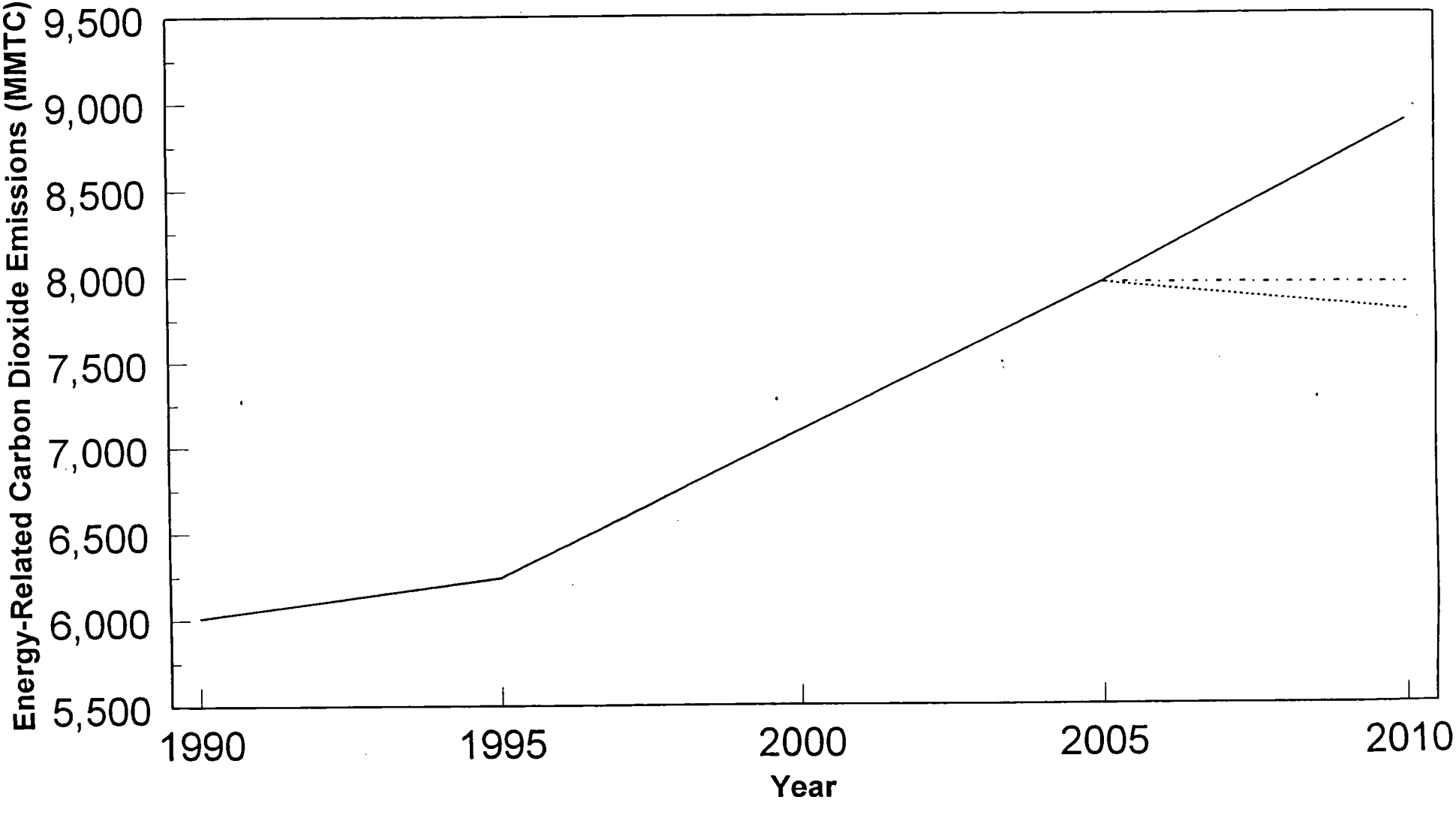
[7] See *Transportation Pricing Strategies for California: An Assessment of Congestion, Emissions, Energy and Equity Impacts*, California Environmental Protection Agency, November 1996

[8] *Urban Roadway Congestion --1982 to 1994* Texas Transportation Institute, Texas Department of Transportation, and the Federal Highway Administration, August 1997

Tab I:

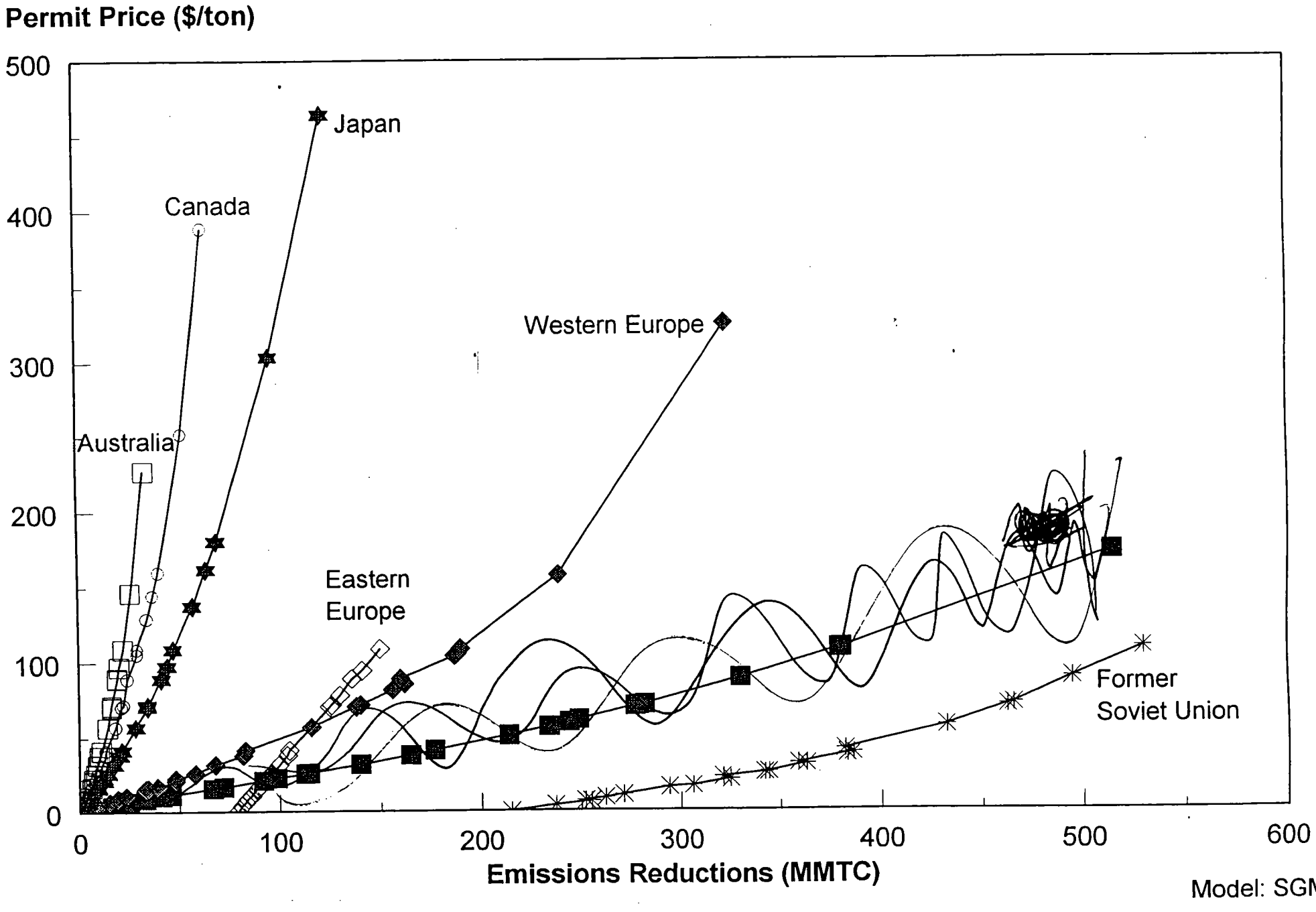
Background Charts

Trend in Global Energy-Related CO_2 Emissions

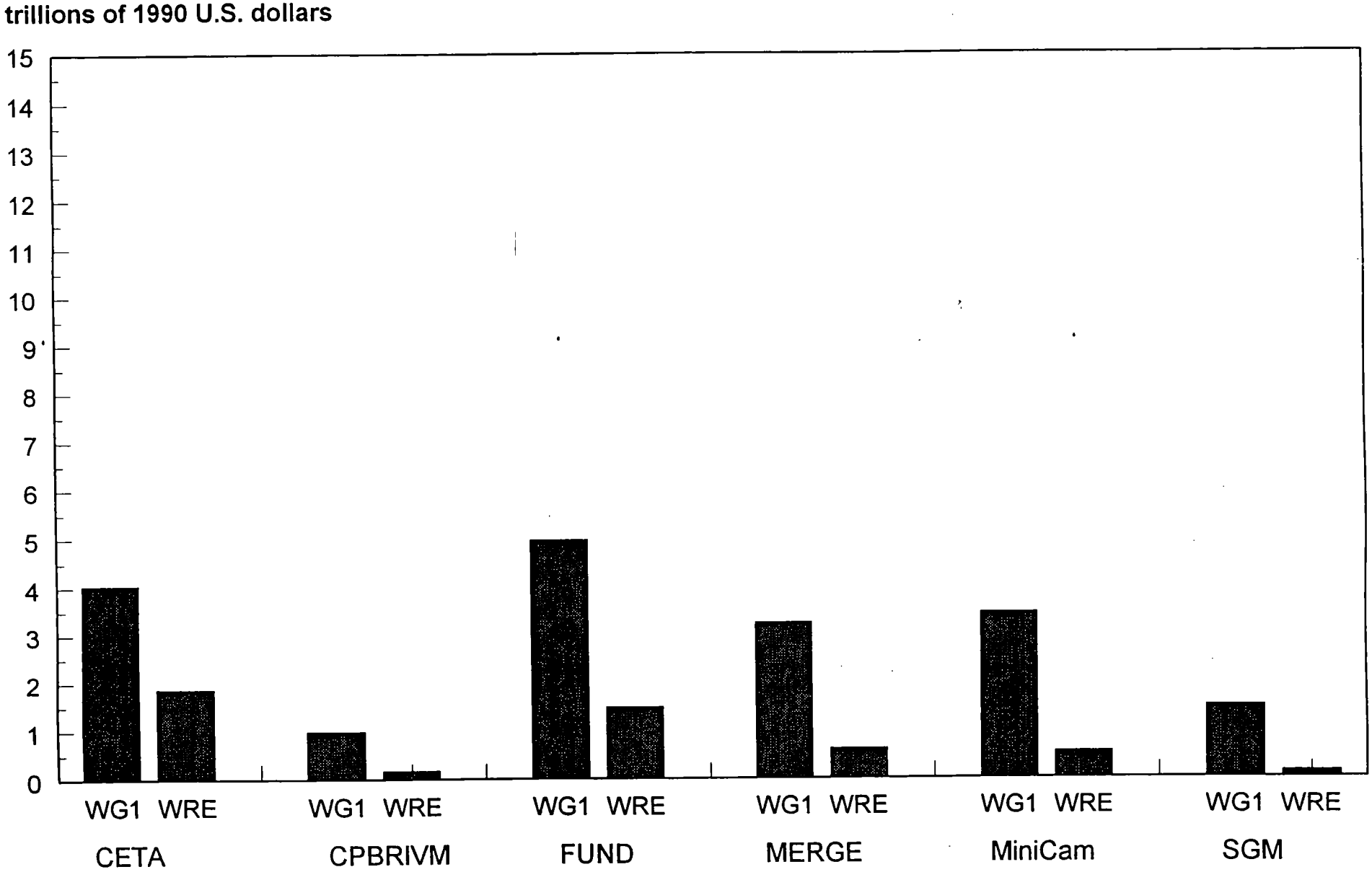


Sources: EIA IEO97 and AEO98

2010 Annex I Marginal Abatement Cost Curves for Energy-Related CO_2



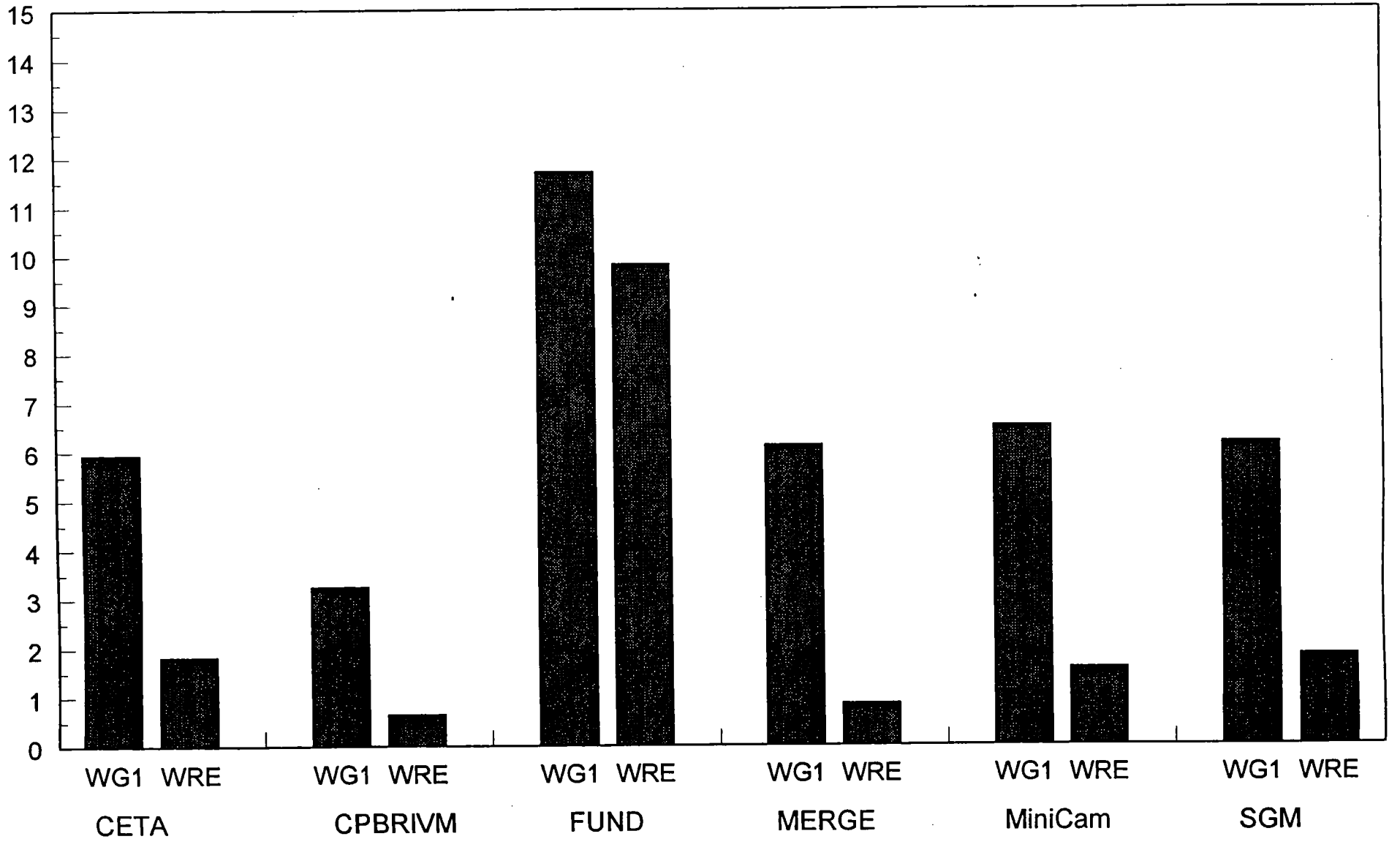
Cost to OECD, of Stabilizing CO2 Concentrations at 550ppmv, with International Trading



Source: EMF-14

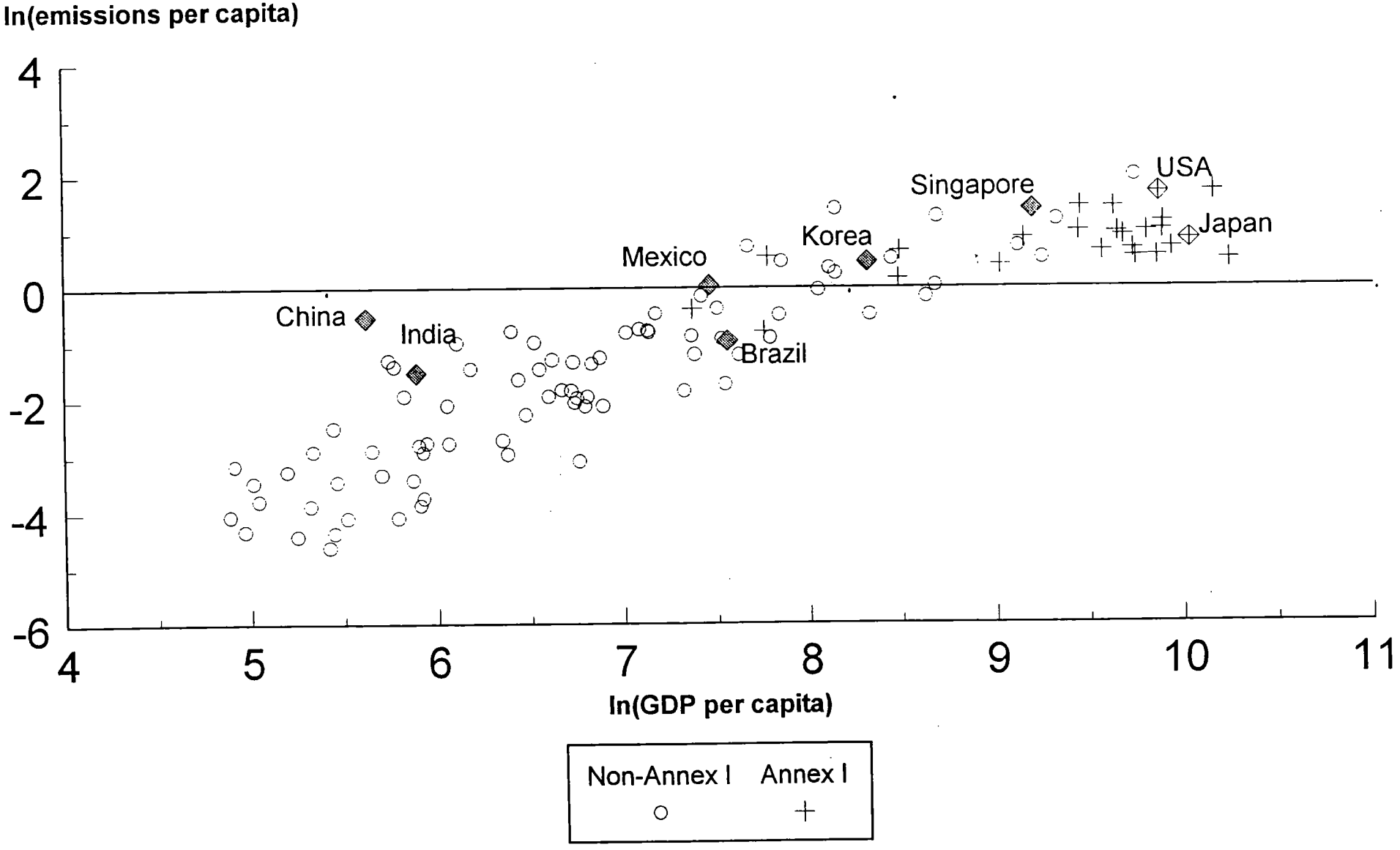
Cost to OECD, of Stabilizing CO2 Concentrations at 550ppmv, without International Trading

trillions of 1990 U.S. dollars



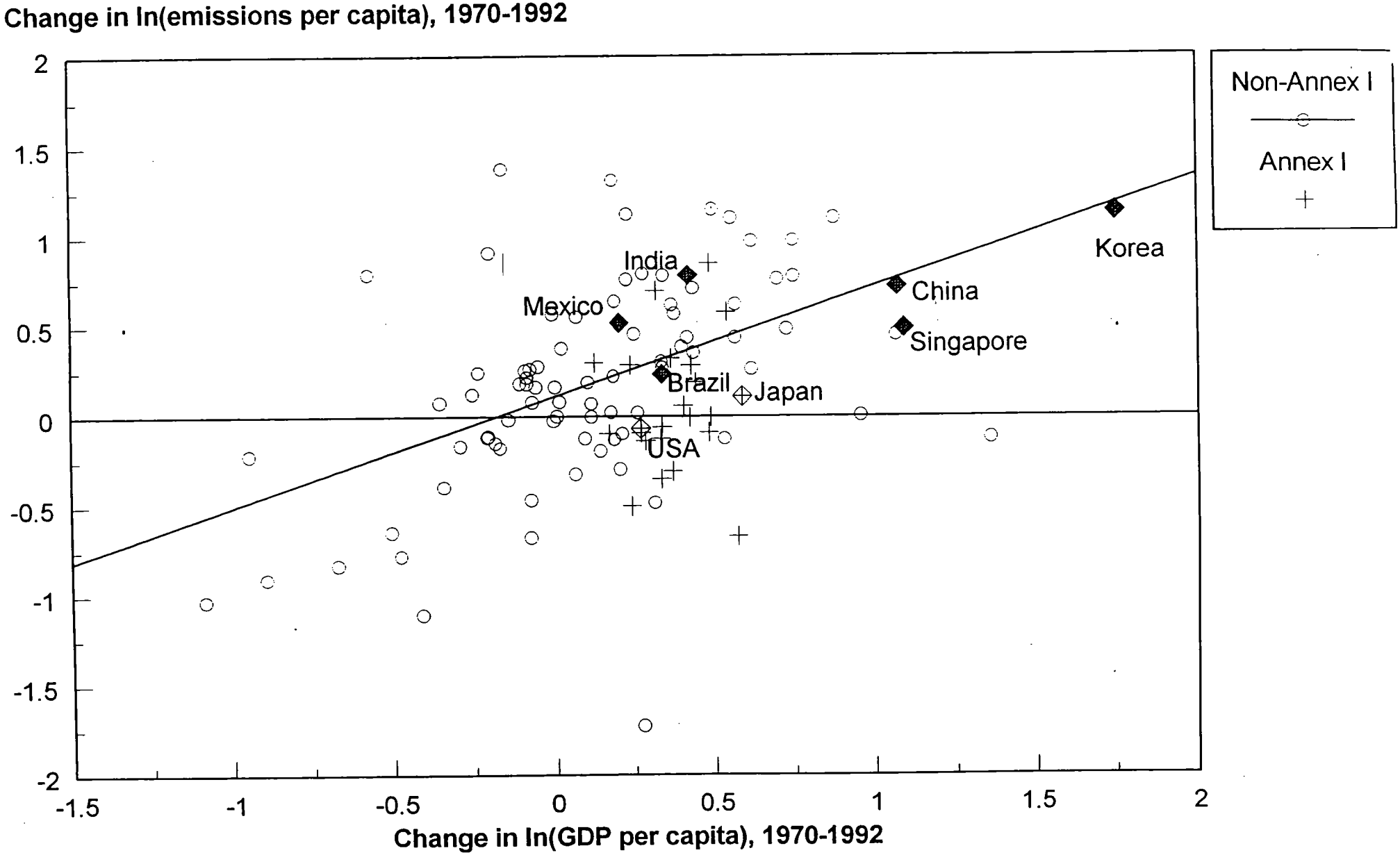
Source: EMF-14

Country Carbon Emissions vs. GDP, 1988-1992 Average



n = 110

Change in Country Carbon Emissions vs. GDP, 1970-1992



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