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THE WHITE HOUSE  
WASHINGTON  
November 30, 1990

MEMORANDUM FOR GOVERNOR SUNUNU

FROM: D. ALLAN BROMLEY *Duan*  
SUBJECT: Global Change Strategy Task Force Meeting

The Global Change Strategy Task Force met on Wednesday, November 28. The State Department discussed logistics for the Framework Convention negotiations, Justice gave a briefing on the Comprehensive Approach, and EPA gave a summary of recent work using the comprehensive approach to estimate U.S. greenhouse gas emissions.

Preparations for the Framework Convention on Climate Change.

The first negotiating session of the Framework Convention will be held in the Westfields Conference Center in Chantilly, Virginia, located 8 miles south of Dulles Airport. The location and surroundings of the conference center are conducive to a focus on work, rather than engaging in press contacts. The session will run from February 4 - 14, and a tentative agenda is attached (Tab A). One agenda item is election of a chair. At this time, there is only one viable candidate, Mr. Jean Ripert of France. He is considered by the U.S. to be qualified and reasonable.

The Comprehensive Approach.

The basics of the Comprehensive Approach were described to the group including its advantages, applications, potential objections to it, research needed to support the approach, options for including it into the Framework Convention, and options for developing the basis in the Convention for international trading. A summary of the briefing is attached. (Tab B)

U.S. Greenhouse Gas Emissions.

An EPA study was presented which uses the comprehensive approach and assumptions about U.S. environmental initiatives (such as the Clean Air Act) to estimate current and future U.S. emissions of greenhouse gases (Tab C). In addition, the sources of and underlying assumptions for these estimates is attached (Tab D). The full paper upon which this presentation was based is provided for your reference (Tab E).

Outstanding Issues.

There are seven broad categories of issues and tasks currently being worked on: 1) preparation of a climate action plan, 2) an economic feasibility study, 3) draft language on a comprehensive approach, 4) monitoring and science, 5) lesser developed country issues, 6) negotiating subgroups in relation to the IPCC, and 7) verification monitoring.

cc: Ede Holiday

Proposed Agenda  
First Negotiating Session  
Framework Convention on Climate Change  
Washington, D.C.  
February 4 - 14, 1991

1. Welcoming Remarks
2. Opening of Meeting: Remarks by WMO Sec-Gen Obasi, UNEP Ex Director Tolba, IPCC Chair Bolin
3. Adoption of Rules of Procedure: Draft to be available
4. Adoption of Agenda
5. Election of Chair
6. Election of Bureau: Refer to Prepcom report and recommendations
7. Organization of Work: To cover hours of sessions, meeting rooms, translation facilities (available only for negotiating group and subgroups, not regional and other interest groups)
8. Credentials Committee
9. Statements by Governments: To be brief (10 min max) and focused on issues raised in IPCC and other supporting documents
10. Preparation of Legal Negotiating Text
  - a. work program
  - b. establishment of subgroups
  - c. legal drafting group
  - d. review of draft legal text
11. Future Work
  - a. relationship with IPCC
  - b. time and place of next meeting
12. Adoption of Report
13. Close of Meeting

## Suggested timing for proposed agenda:

4	Monday	Agenda items 1 to 8
5	Tuesday	Agenda item 9
6	Wednesday	Agenda item 9 cont'd
7	Thursday	Agenda item 10
8	Friday	Agenda item 10 cont'd
11	Monday	Agenda item 10 cont'd
12	Tuesday	Agenda item 10 cont'd
13	Wednesday	Agenda item 10c and 11
14	Thursday	Agenda item 10d, 12 and 13

A COMPREHENSIVE APPROACH TO CLIMATE CHANGE

Briefing to the DPC Global Change Strategy Group

Presentation by the Department of Justice,  
Environment & Natural Resources Division

November 28, 1990

- OFFICIAL USE ONLY -

**"Comprehensive Approach" described**

- o An approach or heuristic to guide consideration of climate change issues.
- o Considers all anthropogenic inputs: net emissions (sources less sinks) of relevant trace gases, weighted by the environmental impacts of each gas.
- o Considers the several trace gases of interest:
  - Carbon dioxide (CO<sub>2</sub>)
  - Methane (CH<sub>4</sub>)
  - Nitrous oxide (N<sub>2</sub>O)
  - Chlorofluorocarbons (CFCs)
  - Hydrochlorofluorocarbons (HCFCs)
  - Tropospheric Ozone (O<sub>3</sub>) and its precursors:
    - Nitrogen oxides (NO<sub>x</sub>)
    - Carbon monoxide (CO)
    - Volatile organic compounds (VOCs)
- o Considers sources and sinks of these trace gases in every sector of human activity:
  - Energy generation
  - Transportation
  - Agriculture
  - Forestry and land clearing
  - Industry
- o Employs a measure, such as an index, of the comparative environmental impacts of the gases

Anthropogenic Sources & Sinks of Selected Gases

<u>Gas</u>	<u>Sources</u>	<u>Sinks</u>
Carbon dioxide (CO <sub>2</sub> )	Fossil fuel combustion Land clearing	Forests Grasses Soils Ocean biota & storage
Methane (CH <sub>4</sub> )	Enteric fermentation in livestock Rice cultivation Wetlands Landfills Natural gas drilling, venting, transmission Coal mining Biomass combustion	Atmospheric OH interaction Soil removal
Nitrous oxide (N <sub>2</sub> O)	Agricultural fertilizers Land clearing	Soil removal
Halocarbons (CFCs and related)	Refrigerants Aerosol propellants Foam blowing agents Solvents and cleaning agents Fire retardants	
Tropospheric Ozone (O <sub>3</sub> )	Precursors: CH <sub>4</sub> , CO, VOCs, in the presence of NO <sub>x</sub> Transport of strat. O <sub>3</sub> into troposphere	Halocarbon depletion
Carbon monoxide (CO)	Fossil fuel combustion Biomass combustion Precursors: CH <sub>4</sub> , VOCs	Atmospheric OH interaction
Nitrogen Oxides (NO <sub>x</sub> )	Fossil fuel combustion Biomass combustion Agriculture	
Volatile Organic Compounds (VOCs)	Fossil fuel combustion Biomass combustion Industry	Atmospheric OH interaction
Aerosols/sulfates (e.g. SO <sub>2</sub> )	Fossil fuel combustion	

### Comparing trace gases

- Need for a measure of relative impacts. A measure, or index, is needed to compare the environmental impacts of each trace gas. This measure ensures accounting for activities' overall impacts on the environment, while allowing decision makers the flexibility to fashion a mix of efforts directed at diverse gases.
- Weighting can't be avoided. Any policy will employ some index to weight the gases, whether implicit or explicit. A CO<sub>2</sub>-only policy implicitly weights the other gases at zero.
- GWP. One such measure is the "Global Warming Potential" (GWP) index, presented in the IPCC Report. The GWP measures the relative radiative forcing of each gas over time -- its potential to warm the atmosphere.

Gas	<u>Instantaneous radiative forcing per kg</u>	<u>Atmospheric residence years (estimated)</u>	<u>Relative radiative forcing potential over years</u>		
			<u>20</u>	<u>100</u>	<u>500</u>
CO <sub>2</sub>	1	120	1	1	1
CH <sub>4</sub>	58	10	63	21	9
N <sub>2</sub> O	206	150	270	290	190
CFC-11	3970	60	4500	3500	1500
CFC-12	5750	130	7100	7300	4500

(Source: IPCC Scientific Assessment, tables 2.3 and 2.8.)

- Some uncertainties remain in the GWP values, relating principally to the residence times of gases such as CO<sub>2</sub> and N<sub>2</sub>O. They do not warrant abandoning the index.
- Time and discounting need further discussion.
- Other comparative measures might also be developed. For example, a "global change index" could incorporate other salient global impacts of the gases in addition to their radiative forcing. These other global impacts include beneficial plant enrichment from CO<sub>2</sub>, and adverse stratospheric ozone depletion from CFCs and some of their substitutes. Ignoring these impacts could lead to perverse results, such as a limit on warming that induces other adverse environmental consequences. Yet a multiple attribute index would require a challenging analytic exercise, and its development should initially proceed as a complement not a rival to a radiative forcing index.

**Comprehensive approach has multiple applications**

- Research. Designing research strategies to generate the most valuable information, by focusing attention on the climate variables of concern for which information is lacking.
- Technology evaluation. Calculating the effects on net emissions of new technologies and practices. Possible uses in foreign technology assistance, federal R&D funding, assessments of technology choices encouraged by other regulatory programs.
- Inventories. Calculating current net emissions of relevant trace gases, by nation and sector.
- Report cards. Calculating the likely effects on net emissions of current policy actions.
- Policy choices. Calculating the effects on net emissions of potential policy actions proposed by others or considered by the U.S.
- Policy design. Defining any agreed response measures in terms of a comprehensive approach, accounting for and allowing flexibility among all relevant gases, sources and sinks.

**"How to" and "how much"**

- In general, the comprehensive approach addresses "how to," that is, the design of cost-effective responses (including research, technology development, limitations, etc.). It does not directly address the question of "how much" response to potential climate change is desirable; that is the province of overall cost-benefit analysis, which considers the aggregate costs and benefits of change and of actions to respond.
  
- The comprehensive approach does shed light on some approaches to the question of "how much," by ensuring attention to the arguably limited environmental benefits and high economic costs of piecemeal policy measures.

**Advantages of a Comprehensive Approach to Policy Design**

- A. The dominant tenor of climate policy discourse has been piecemeal, addressing each trace gas and each sector separately. Most policy proposals, and most data collection efforts, have focused on energy sector CO2 emissions.
  
- B. Comprehensive approach offers environmental advantages
  - o Piecemeal policies have proved environmentally ineffective or even counterproductive. The history of environmental policy has been piecemeal efforts aimed at air, water, and land emissions separately, leading to cross-media shifts in residuals.
  
  - o Administration efforts to employ better approaches:
    - multimedia approach to solid and hazardous emissions
    - multipollutant approach to air emissions
    - multimedia enforcement actions
    - comprehensive approach to climate context

- o Shifting residuals. Piecemeal approaches in the climate area could lead to counterproductive cross-gas tradeoffs. Narrow focus on one trace gas could induce shifts in emissions to unregulated gases and sectors.

Examples:

(1) Piecemeal policy aimed at CO2 alone could induce fuel-switching from coal or oil to natural gas, with attendant reduced CO2 emissions from combustion, but increased CH4 output from transmission leakage.

Methane offset from fuel-switching to Natural Gas:

	<u>Typical grams of CO2 emitted per MJ (in Sweden)</u>	<u>CH4 leakage rate that offsets 100% of CO2 savings</u>
Coal	92	6%
Oil	78	4%
Nat. Gas	56	--

(Calculated from Rodhe, Science 8 June 1990, using Rodhe's GWP figure of CH4 = 10 GWP per mole CO2 over 100 year integration period.)

Current average Natural Gas transmission CH4 leakage rates:

USA:	1%
Australia:	3%
USSR:	5-10% ?

(2) Piecemeal focus on limiting agricultural CH4 could induce use of nitrogenous fertilizers that reduce CH4 emissions per yield but raise N2O emissions.

(3) Piecemeal focus on transport emissions might induce shifts to energy sector (e.g. if electric vehicles are powered by coal-fired boilers) or to agriculture sector (e.g. if biomass for alternative fuels is cultivated with nitrogen fertilizers).

- o Comprehensive approach ensures that such shifts are accounted for by decisionmakers.
  - o Side benefits. By focusing on "net" emissions, the comprehensive approach fosters sink protection and expansion, such as afforestation and protection of phytoplankton. Benefits include biodiversity, reduced soil erosion, protected food webs.
- C. Comprehensive approach offers economic and social advantages
- o Piecemeal approach is economically inefficient. Piecemeal policy would preclude alternatives that achieve the same environmental outcome at less cost. For example, a policy aimed only at energy sector CO2 would bar less costly abatement options such as afforestation, CH4 reductions, attention to CFC-substitutes, or N2O reductions.
  - o Flexibility reduces costs. The costs of different options will vary across nations, so to minimize costs each ought to have the flexibility to build its least-cost policy mix among the gases and sectors.  
(Even if a multi-gas inventory would rank some nations higher in net emissions than they would under a single-gas accounting, all nations could gain as the marginal cost of abatement is reduced through greater flexibility.)
  - o Burden sharing. A comprehensive approach provides a more "level playing field" across nations, in contrast to a piecemeal approach which effectively singles out nations with one pattern of economic and social activity. Offers the possibility of smoother, and more sober, international cooperation.

**Potential objections to a comprehensive approach**

- o Data and monitoring of sources and sinks are inadequate
  - Build better data and monitoring
  - Employ carefully chosen proxies or surrogates for difficult-to-measure emissions
  - Design incentives for monitoring improvements, such as offering emissions credit to those who demonstrate better monitoring techniques.
- o GWP Index is uncertain
  - Boulder workshop suggests fundamentals well accepted
  - Work toward improvements
  - Absolute precision may not be required initially; changes in index numbers could be made at wide intervals and/or prospectively
- o Other discrete actions will have already been taken, e.g. forestry agreement, CFCs, VOCs
  - Integration of prior and current actions into comprehensive approach will be necessary
- o CFCs should not be included in comprehensive basket
  - Comprehensive approach would not allow violation of the Montreal Protocol
  - CFCs are a major share of radiative forcing, and their elimination should be recognized
  - Some nations are doing more to reduce global CFCs than others, and their contribution should be recognized
  - Faster reductions, or reductions in other substances not controlled, or in other nations, could earn credit; this would provide helpful incentives in support of the Montreal Protocol
  - CFC substitutes may be quite important to radiative forcing

**Research needed in the short term to support the comprehensive approach.** The "Interim Report" of the Task Force on Comprehensive and Incentives Approaches identified tasks needed in the next three months, including:

(1) Index. Develop an improved radiative forcing index and outline a plan for further improvements. Incorporate new research results. Draft a proposal for a standing international expert group, to be established in the framework convention, that would develop the index further and would shepherd it toward accuracy, international consensus, and continuing reassessment in light of new research. Draft talking points on time horizons. Outline a global change index, incorporating salient environmental effects in addition to radiative forcing; provide a rough quantitative estimate of its measure.

(2) Emissions monitoring. Draft a proposal for international emissions monitoring network(s) to cover all gases, sources and sinks. Identify specific techniques to be used (e.g. satellites, ground stations). Highlight gaps in knowledge and disputes over methods. Develop proxies or surrogates where needed.

(3) Documenting environmental advantages of a comprehensive approach. Formulate "crisp retorts" or "zingers" to deflate piecemeal proposals, showing they would have little environmental benefit, or actually be counterproductive. Calculate effects of cross-nation, cross-gas, cross-sector shifts. Collect empirical examples of the environmental backfiring of piecemeal strategies applied to other environmental problems.

(4) Documenting economic advantages of a comprehensive approach. Develop quantitative estimates of the marginal cost of abatement of different gases in different selected nations.

(5) Report card. Update the comprehensive "report card" or "budget" of net index-weighted emissions changes achieved by climate-relevant actions taken for other reasons. Repeat analysis for selected foreign nations.

(6) Updated discussion papers on comprehensive and economic incentives approaches. Write updated and improved paper(s) explaining the comprehensive and incentives approaches, giving empirical examples, and discussing practical advantages and challenges to their use in the climate context. Develop plans for future seminars.

### Options for Including a Comprehensive Approach in the Convention

- (1) Monitoring. Comprehensive source and sink monitoring: cooperative international networks addressing all relevant trace gases. Create institutions for data sharing, harmonizing methodologies, R&D on new techniques.
- (2) International inventories. Build the capacity to estimate international net emissions of relevant trace gases: baseline levels and changes due to policy actions. National reporting, workshops to compare numbers and methods.
- (3) Index. Cooperative development and refinement of an index. Create institutional expert body to conduct regular reassessments and keep policy makers informed of research developments.
- (4) Framing policy. Ensure that any limitations obligations (if any, whether now or in the future) are defined in terms of a comprehensive approach. This could be required, or at least endorsed, in the convention.
- (5) Advance assurance. Give advance assurance that current actions will receive "credit" against any future limitations obligations, in accordance with a comprehensive approach.  
Pros: Helps avoid disincentives to taking actions justified on other grounds; nations may hold such actions in abeyance lest they lose credit for them. Provides an institutional means to integrate discrete initiatives (e.g. CFCs, forestry, VOCs, and any national actions such as CAA, tree planting, energy efficiency). Ensures that a comprehensive approach to such credit will be used.  
Cons: Requires debate over baseline.
- (6) Technology evaluation. Employ a comprehensive approach to assess any technology transfer activities.

**Options for Laying the Basis for International Trading in the Convention**

- (a) REIOs. Broaden the notion of "regional economic integration organization" (REIO) to allow any group of nations to work together. The term REIO is employed in the Montreal Protocol to allow regional groups like the EC to form a group-wide CFC emissions bubble. It could be broadened to allow joint undertakings by less formalized groups of states, and by non-contiguous states.
- (b) Joint cooperation. Include language acknowledging that any obligations can be met through "joint cooperative arrangements." Applies to technology development, emissions limitations, other obligations.
- (c) Registry. Develop an international information center on trades. The center could initially gather information and provide advice on how to arrange and implement effective trades. It could start with information on, e.g., debt-for-nature swaps and EC bubble activities. It could grow to become a trading registry if full-scale international trading developed.
- (d) Financial and technology transfers. Incorporate emissions credits into international technology transfer and financial assistance arrangements. Funds and technology transferred by donor countries, directly or through a global environmental funding facility, could earn credits for the donors corresponding to the net emissions change (calculated in terms of a comprehensive approach) achieved by the transfer. The donor could then submit the credit in compliance with any international limits on emissions that might later be agreed.

**GREENHOUSE GAS EMISSIONS  
TRENDS AND POLICY OPTIONS**

# **GREENHOUSE GAS INVENTORY**

## **0 GREENHOUSE GASES:**

**CARBON DIOXIDE (CO<sub>2</sub>)**

**METHANE (CH<sub>4</sub>)**

**CHLOROFLUOROCARBONS (CFCs)**

**NITROUS OXIDES (N<sub>2</sub>O)**

**TROPOSPHERIC OZONE (O<sub>3</sub>)**

## **0 GASES THAT AFFECT CONCENTRATIONS OF GREENHOUSE GASES:**

**VOLATILE ORGANIC COMPOUNDS (VOCs)**

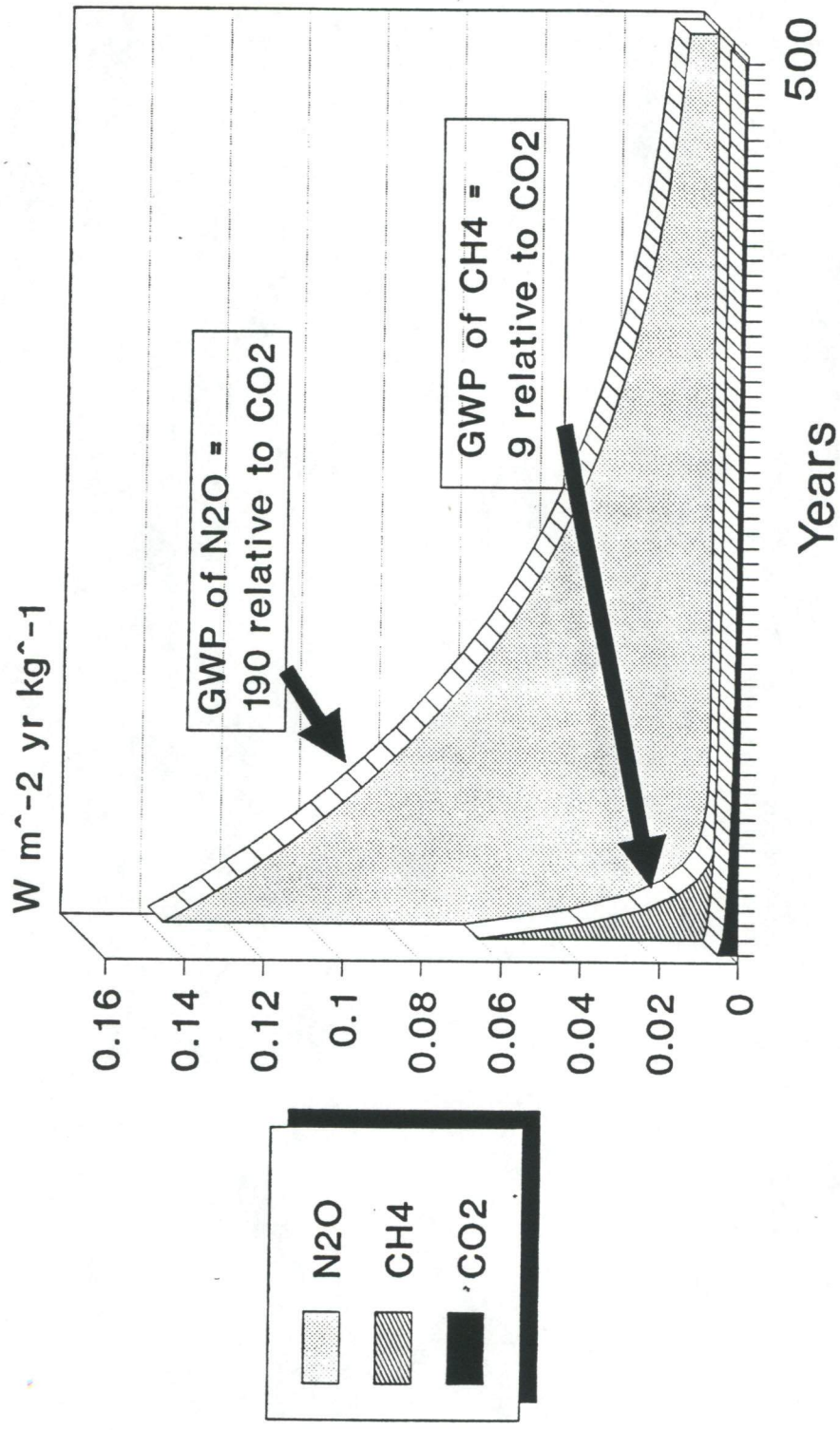
**CARBON MONOXIDE (CO)**

**NITROGEN OXIDES (NO<sub>x</sub>)**

## **0 PROBLEM: NEED WAY TO TRANSLATE VARIOUS GASES INTO A COMMON CURRENCY**

# GHG Time Profiles

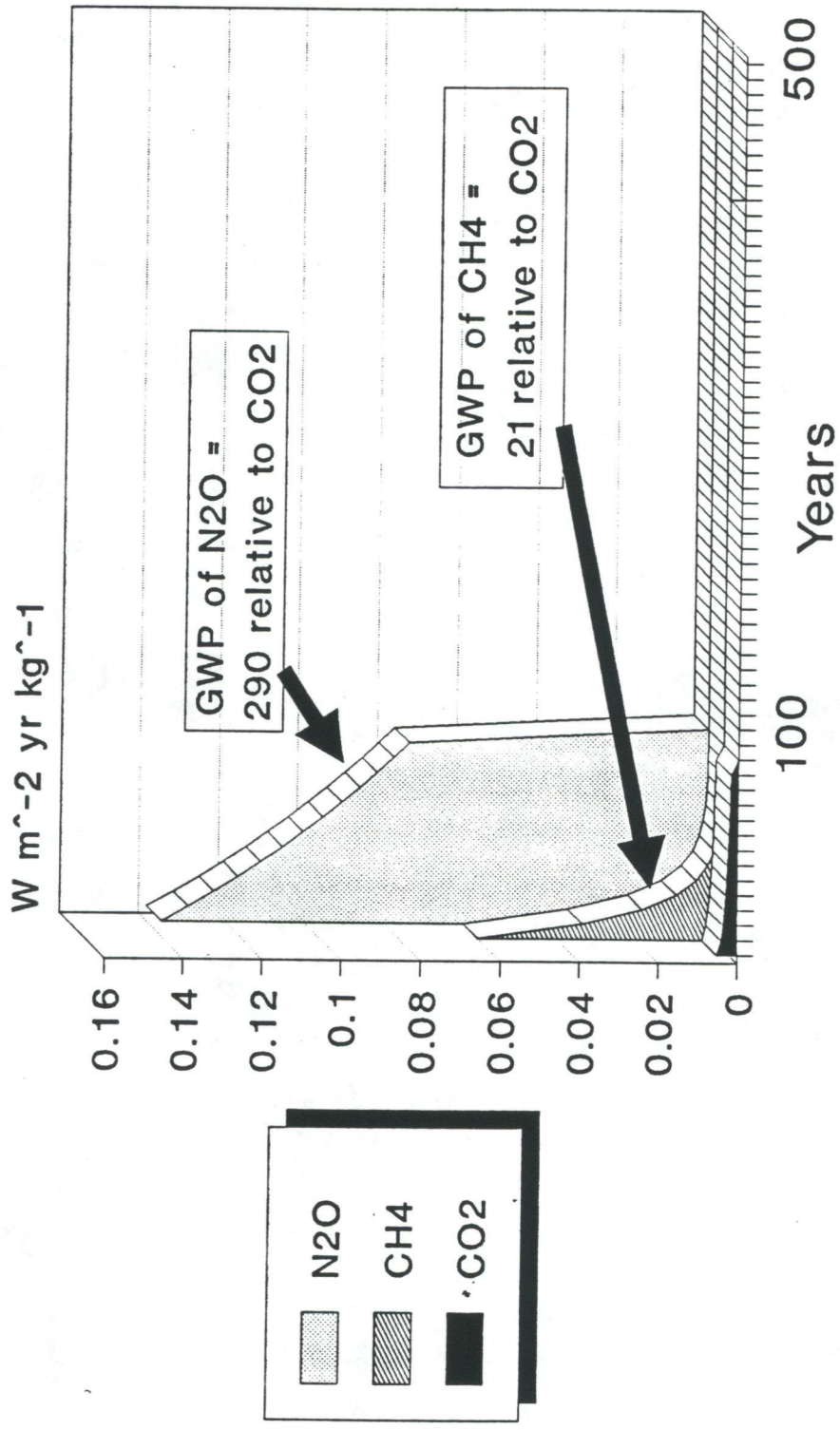
## 500 Years



Radiative forcing of a gas is expressed as a change in the flux of energy, i.e., watts per sq. meter per kg of gas.

# GHG Time Profiles

## 100 Year

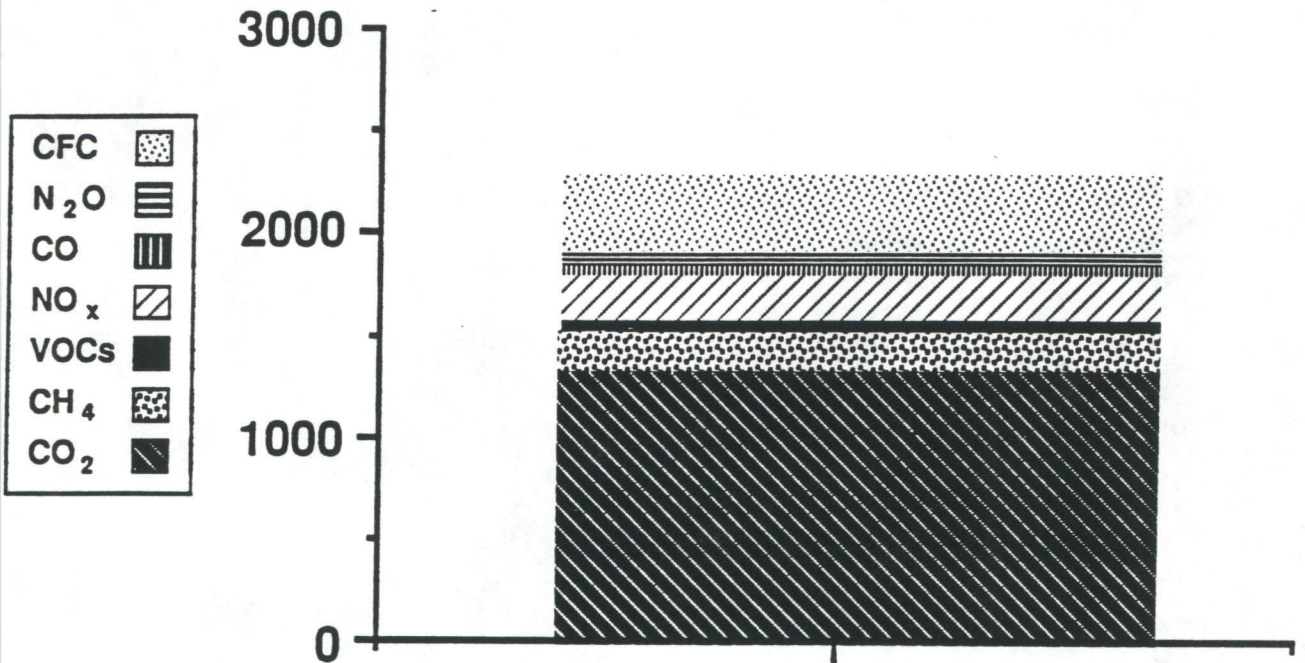


Radiative forcing of a gas is expressed as a change in the flux of energy, i.e., watts per sq. meter per kg of gas.

Trace Gas	Estimated Lifetime, years	Global Warming Potential		
		Integration Time Horizon, Years		
		20	100	500
Carbon Dioxide	*	1	1	1
Methane - inc indirect	10	63	21	9
Nitrous Oxide	150	270	290	190
CFC-11	60	4500	3500	1500
CFC-12	130	7100	7300	4500
HCFC-22	15	4100	1500	510
CFC-113	90	4500	4200	2100
CFC-114	200	6000	6900	5500
CFC-115	400	5500	6900	7400
HCFC-123	1.6	310	85	29
HCFC-124	6.6	1500	430	150
HFC-125	28	4700	2500	860
HFC-134a	16	3200	1200	420
HCFC-141b	8	1500	440	150
HCFC-142b	19	3700	1600	540
HFC-143a	41	4500	2900	1000
HFC-152a	1.7	510	140	47
CCl <sub>4</sub>	50	1900	1300	460
CH <sub>3</sub> CCl <sub>3</sub>	6	350	100	34
CF <sub>3</sub> Br	110	5800	5800	3200
INDIRECT EFFECTS				
Source Gas	Greenhouse Gas Impacted			
CH <sub>4</sub>	Tropospheric O <sub>3</sub>	24	8	3
CH <sub>4</sub>	CO <sub>2</sub>	3	3	3
CH <sub>4</sub>	Stratospheric H <sub>2</sub> O	10	4	1
CO	Tropospheric O <sub>3</sub>	5	1	0
CO	CO <sub>2</sub>	2	2	2
NO <sub>x</sub>	Tropospheric O <sub>3</sub>	150	40	14
NMHC	Tropospheric O <sub>3</sub>	28	8	3
NMHC	CO <sub>2</sub>	3	3	3

# Current Emissions 1987 (100 Year GWP Factors)

Carbon Equivalents – Millions of Tonnes



	1987
CO <sub>2</sub>	1310
CH <sub>4</sub>	235
VOCs	72
NO <sub>x</sub>	218
CO	52
N <sub>2</sub> O	74
CFC	367
<b>Total</b>	<b>2328</b>

**EMISSIONS REDUCTIONS EXPECTED IN THE YEAR 2000  
DUE TO CURRENT ENVIRONMENTAL COMMITMENTS  
AND OTHER INITIATIVES ASSUMED IN THE ANALYSIS**

<u>CURRENT COMMITMENTS</u>	<u>MILLIONS OF TONNES REDUCED (Carbon Equivalents) 2000<sup>4</sup></u>
o TREE INITIATIVE	~9
o DOE ENERGY EFFICIENCY INITIATIVES	28
o DOE APPLIANCE STANDARDS	4
o DOE RENEWABLE INITIATIVES	4
o CLEAN AIR ACT	17
o LANDFILL REGULATION	44
o CFC PHASEOUT & MONTREAL PROTOCOL	551

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<sup>4</sup> Assumes a 100 year time horizon in GWP calculations.

**DOE-RELATED CO<sub>2</sub> EMISSIONS REDUCTIONS  
USED IN EPA'S GHG EMISSIONS INVENTORY**

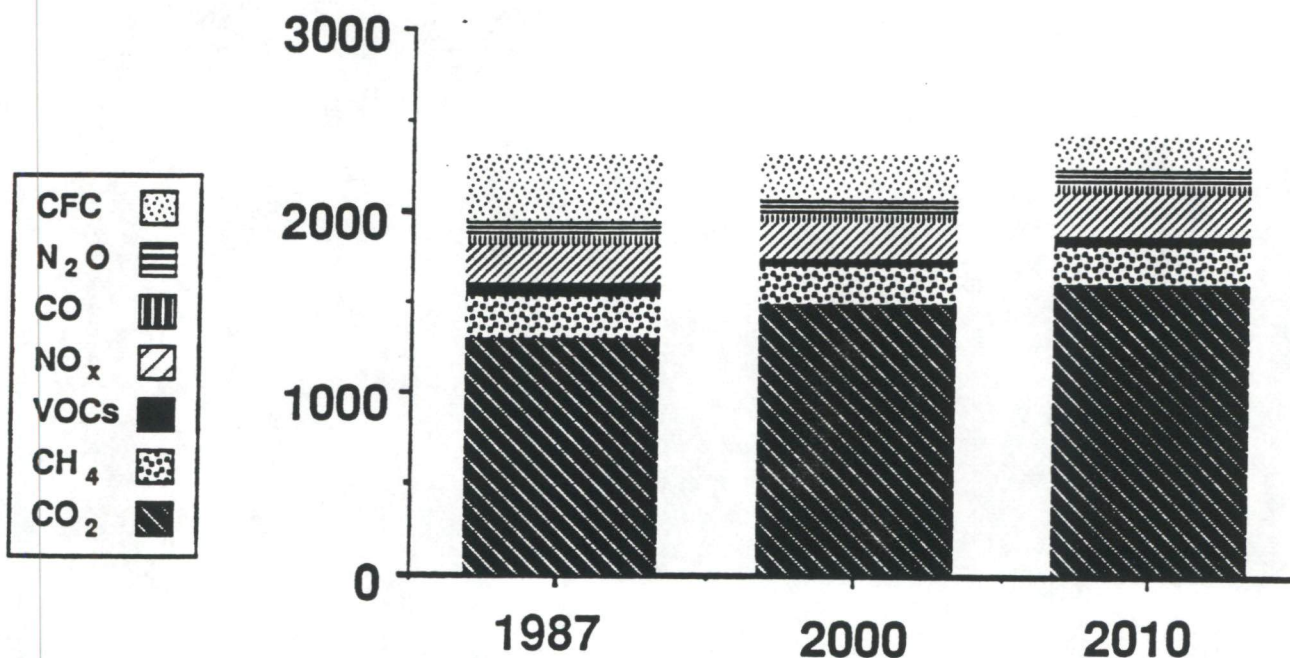
<u>ACTION/PROGRAM</u>	<u>2000</u>	
	<u>CO<sub>2</sub></u>	<u>Carbon</u>
<b>DOE Appliance Standards</b> (Refrigerators, Washers, Dryers, Dishwashers)	16.0	4.4
<b>DOE Efficiency Initiatives</b>	<b>102.0</b>	<b>27.8</b>
Federal Buildings Lighting	5.0	1.4
Commercial Buildings Lighting	9.0	2.5
Promote State LCUP	33.0	9.0
State Adoption of Interim Building Standards	30.0	8.2
Energy Analysis and Diagnostic Centers	22.0	6.0
HUD Adoption of DOE Building Standards	3.0	0.8
<b>DOE Renewable Initiatives</b>	<b>15.0</b>	<b>4.1</b>
Expanded Hydro Power	13.0	3.5
Photovoltaic Technology Transfer	2.0	0.5
<b>Clean Air Act</b>	<b>63.0</b>	<b>17.2</b> *
Acid Rain	60.0	16.4
Transportation Biofuels and Natural Gas Use	3.0	0.8
 <b>GRAND TOTAL</b>	 <b>196.0</b>	 <b>53.5</b>

\* Does not include reductions of 51 million metric tonnes due to decreases in NO<sub>x</sub> (19.6 million tonnes), CO (7.4), and VOCs (23.7).

# Emissions

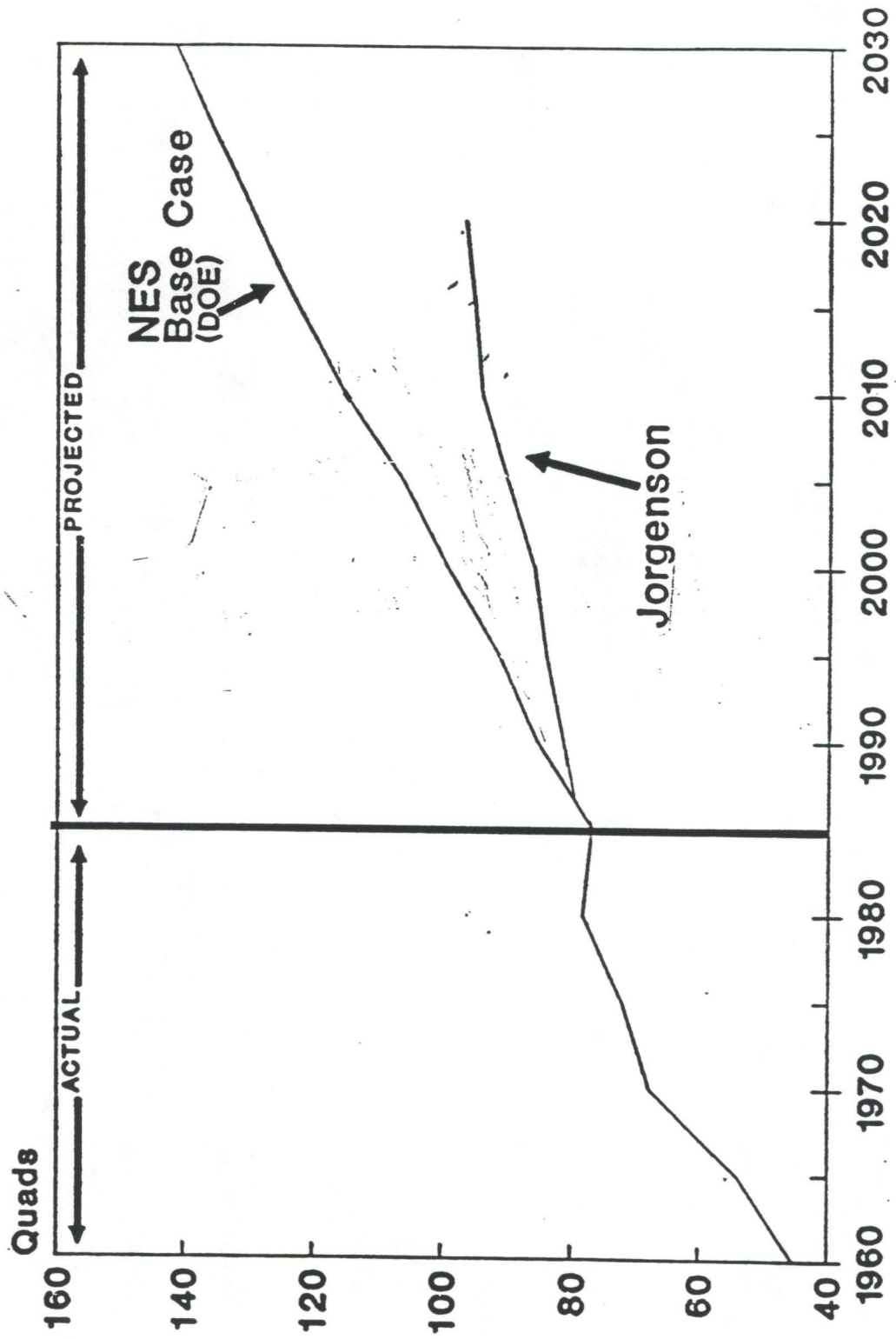
(With Current Commitments)  
(100 Year GWP Factors)

**Carbon Equivalents – Millions of Tonnes**

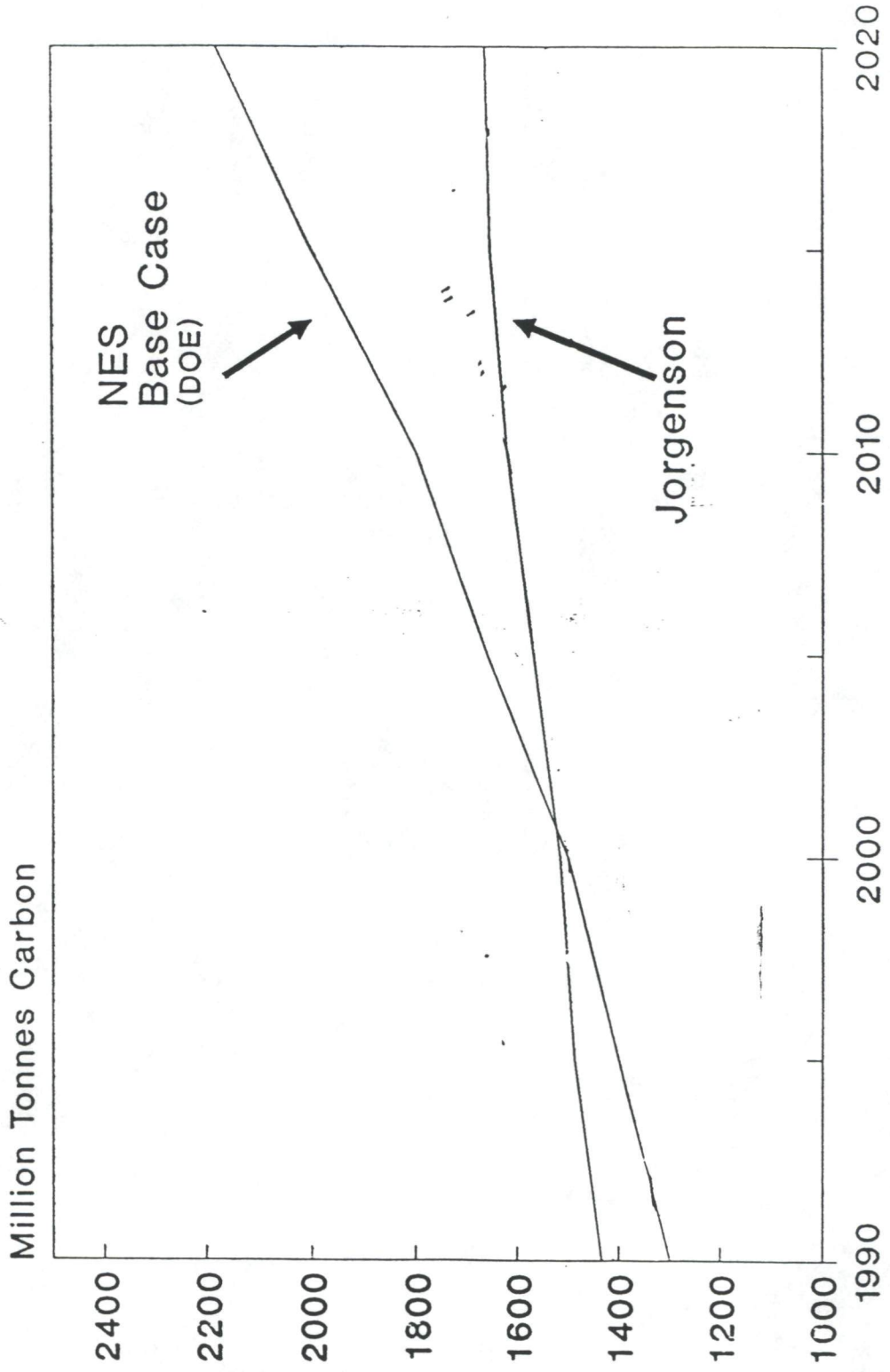


	1987	2000	2010
CO <sub>2</sub>	1310	1503	1627
CH <sub>4</sub>	235	208	212
VOCs	72	48	50
NO <sub>x</sub>	218	199	235
CO	52	45	46
N <sub>2</sub> O	74	74	74
CFC	367	256	188
<b>Total</b>	<b>2328</b>	<b>2332</b>	<b>2430</b>

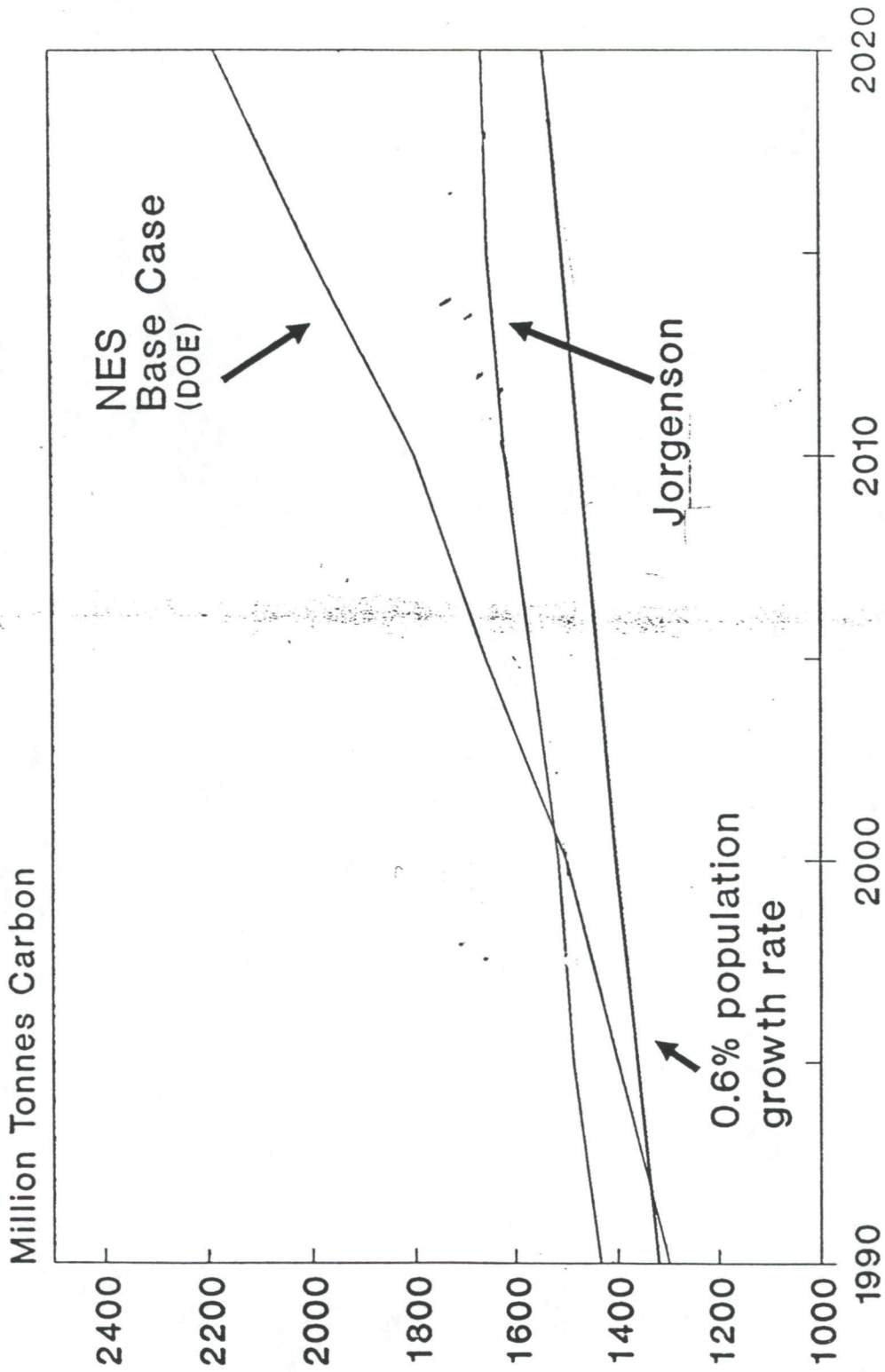
# U.S. Primary Energy Consumption



# U.S. CO2 Emissions



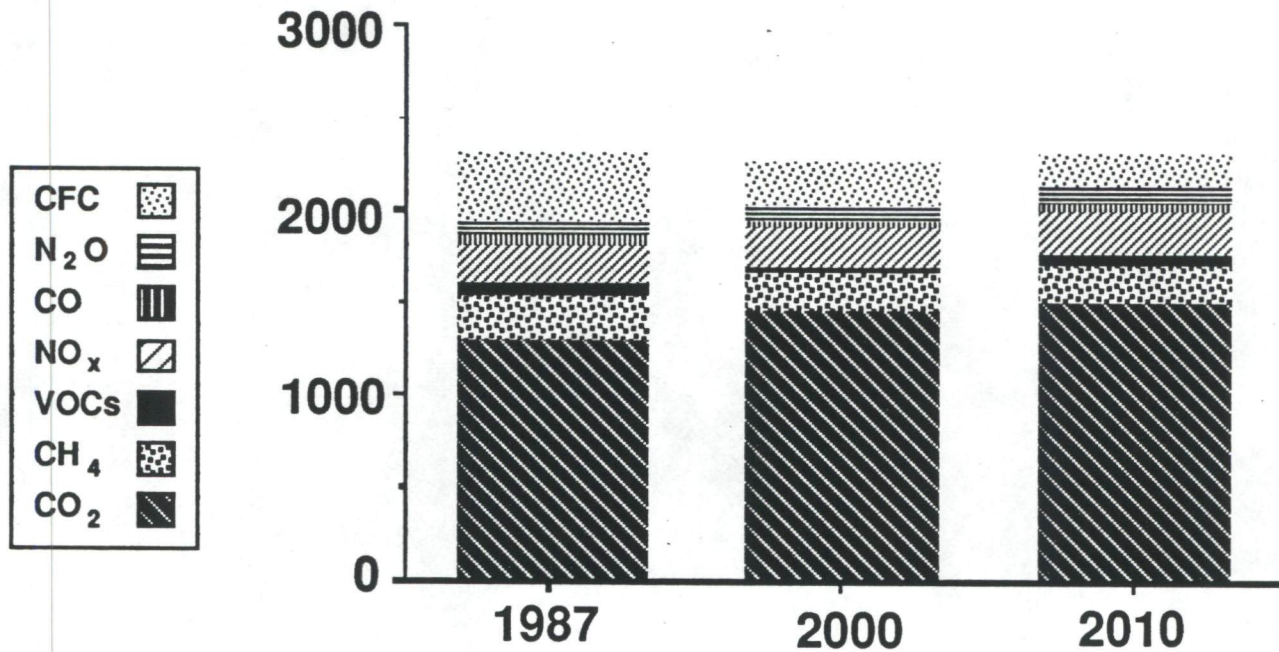
# U.S. CO2 Emissions



# Emissions

(With Current Commitments)  
(100 Year GWP Factors)

**Carbon Equivalents – Millions of Tonnes**



	1987	2000	2010
CO <sub>2</sub>	1310	1453*	1498*
CH <sub>4</sub>	235	208	212
VOCs	72	48	50
NO <sub>x</sub>	218	199	235
CO	52	45	46
N <sub>2</sub> O	74	74	74
CFC	367	256	188
<b>Total</b>	<b>2328</b>	<b>2283</b>	<b>2303</b>

\* CO<sub>2</sub> estimates derived from baseline emissions projections in Jorgenson and Wilcoxon (1990)

## **SOURCES OF GREENHOUSE GAS EMISSIONS ESTIMATES**

The following appendix documents the sources of the emissions estimates for each of the greenhouse gases, as well as important underlying assumptions. Documentation is presented for: (i) the 1987 "base case," (ii) emissions in 2000 without current environmental commitments, and (iii) emissions in 2000 with current environmental commitments.

### **CO<sub>2</sub>:**

Estimates of CO<sub>2</sub> emissions for 1987 and 2000 (without current environmental commitments) were derived from figures provided by the U.S. Department of Energy (DOE) to the Energy and Industry Subgroup (EIS) of the Response Strategies Working Group of the Intergovernmental Panel on Climate Change (IPCC).

CO<sub>2</sub> emissions reductions in the year 2000 were estimated by DOE for the following current environmental commitments:

- o **DOE Energy Efficiency Initiatives**
- o **DOE Appliance Standards**
- o **DOE Renewable Initiatives**
- o **Proposed Clean Air Act Legislation and DOE Transportation Fuels Program**

A detailed discussion of each of these initiatives follows:

#### **I. DOE Energy Efficiency Initiatives (102 million tons CO<sub>2</sub>)**

- o **More Efficient Lighting in Federal Buildings** (5 million tons CO<sub>2</sub>)

It is assumed that federal agencies fully comply with the relevant Executive Order by 2000. Electricity savings would be 0.05 quad.

- **More Efficient Lighting in Commercial Buildings (9 million tons CO<sub>2</sub>)**

It is assumed that approximately one-half of buildings convert to high efficiency lighting with an average savings of 25 percent of electrical demand for lighting. Electricity savings are 0.125 quad.

- **Promotion of State Efforts to Institute Utility Integrated Resource Planning for End-use Energy Efficiency (33 million tons CO<sub>2</sub>)**

This and CO<sub>2</sub> reductions from the Clean Air Amendments are linked. Many states are emphasizing Integrated Resource Planning, although methods of analysis and implementation plans are not fully developed for all states. Due to the impetus for Clean Air Act legislation, the need for coal/fossil fuel generation may be reduced by 10-15 percent due to demand reduction. Supporting DOE programs would primarily include methods development and promotional options. Hence, reductions by the year 2000 would probably be lower than would otherwise be achieved. A 7.5 percent reduction in added demand is assumed, resulting in an electricity savings of 0.48 quad.

- **Adoption of DOE Interim Building Standards by the States (30 million tons CO<sub>2</sub>)**

The DOE program includes dissemination of information and provision of voluntary guidelines. States could transform the guidelines into enforceable standards. Federal buildings must meet new standards beginning in 1989. It is assumed that there would be a 50 percent acceptance rate for new non-Federal buildings and a 20 percent demand reduction per building. Savings would be .43 quads of electricity.

- **Expansion of the Energy Analysis and Diagnostic Centers to Increase Energy Audits (22 million tons CO<sub>2</sub>)**

Program expansion would occur to 40 energy efficiency engineering centers by 2000, resulting in audits of 3 percent of eligible industrial facilities by 2000. The estimate assumes implementation of 60 percent of audit recommendations, with a 15 percent improvement in energy efficiency. Total savings of all fuels would be .28 quads, including .05 quads of electricity.

- **Use of DOE Building Standards by HUD in Public Housing Assistance Programs (3 million tons CO<sub>2</sub>)**

Although the program is still being designed, it is assumed that it will be successful in providing a required 25 percent efficiency increase in buildings that are refurbished. It is projected that 1.4 million units in the 7 major public assistance programs will be retrofitted by 2000, resulting in annual efficiency gains of 0.05 quads.

## **II. DOE Appliance Standards (16 million tons CO<sub>2</sub>)**

The new appliance standards refer to refrigerators, freezers, clothes washers, clothes dryers, and dishwashers. DOE appliance standards call for an increase in the efficiency of refrigerators and freezers by 25 percent by 1993. The standards applying to refrigerators and freezers are already in the law. It is assumed that 1993 and subsequent model year refrigerators and freezers meet the regulation exactly. The remaining standards are still being promulgated. All of the standards are due to take effect in 1993.

It is assumed that patterns of consumer purchases will be similar to today's buying and replacement patterns. Annual electricity savings due to units installed by the year 2000 would be 0.15 quad.

## **III. DOE Renewable Initiatives (15 million tons CO<sub>2</sub>)**

- **Expanding Hydropower Capacity (13 million tons CO<sub>2</sub>)**

The DOE program involves working with permitting/development authorities to streamline present complex processes. At maximum levels, 20,000 Mw of capacity could be added by the year 2000. It is assumed that 25 percent of this could be realized by the year 2000, reducing fossil energy electricity requirements by .27 quads. (EPA further reduced this estimate by 50 percent.) Present capacity is 90,000 Mw.

- **Transfer of Photovoltaic Technology: (2 million tons CO<sub>2</sub>)**

This estimate assumes that the U.S. initiative would be 675 Mw of installed capacity by 2000, or a savings of .03 quads of demand for fossil fuel electricity.

**IV. Proposed Clean Air Act Legislation and DOE Transportation Fuels Program (63 million tons CO<sub>2</sub>)<sup>10</sup>**

- **Conservation Due to Clean Air Act Provisions on Acid Rain Controls: (60 million tons CO<sub>2</sub>)**

Clean Air Act amendments place requirements for SO<sub>2</sub> reduction on present coal facilities but allow the facilities to determine how these reductions will be met. New facilities must obtain offsetting emissions allowances. One method to reduce emissions allowance purchase requirements would be to reduce end-use demand supplied by older coal-fired plants (for largest SO<sub>2</sub> reductions). EPA has estimated that this reduction could be as great as 10 percent of present coal-fired generation. Because of the linkage with state efforts to institute Utility Integrated Resource Planning for end-use energy efficiency, the estimate here is cut to 5 percent of present coal-fired generation, with an annual CO<sub>2</sub> reduction of 60 million tons.

- **Increased Use of Biofuels for Transportation (1 million tons CO<sub>2</sub>)**

Preliminary estimates assume 10 percent ethanol fuel for 13 percent of gasoline used in year 2000. It is also assumed that the ethanol is made from a biomass feedstock that is replaced or recycled. This represents 50 percent of the expected oxygenated fuel required by the Clean Air Act.

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<sup>10</sup> This does not include reductions of 51 million metric tonnes due to decreases in NO<sub>x</sub> (19.6 million tonnes), CO (7.4), and VOCs (23.7).

- **Increased Use of Natural Gas in Central Fleets Due to Clean Air Act (2 million tons CO<sub>2</sub>)**

One percent of the Nation's use of gasoline would be replaced by compressed natural gas, providing a 20 percent decrease in CO<sub>2</sub> for that amount.

### **METHANE:**

Estimates of methane (CH<sub>4</sub>) emissions for 1987 were derived from figures provided by DOE to the EIS of the IPCC Response Strategies Working Group. Estimates of emissions for 2000 (without current environmental commitments) were derived from the IPCC EIS and the Agricultural Working Group. For both 1987 and 2000, the estimates were adjusted upward by 6 million tonnes by EPA to reflect its landfill estimates.

Estimates of methane emission reductions in the year 2000 were obtained from EPA's Office of Air Quality Planning and Standards (OAQPS). The estimates reflect methane reductions that arise due to a 250 Mg/yr landfill standard.

### **VOCs:**

The estimate of 1987 VOC emissions were provided to OAQPS by E.H. Pechan & Associates and derived from the ERCAM-VOC model. The estimate uses the 1985 NAPAP emissions inventory as a base and (i) adjusts auto emissions using EPA's MOBILE4 model, and (ii) includes estimates of emissions from hazardous waste treatment storage.

VOC emissions for the year 2000 (without current environmental commitments) are assumed to remain at 1987 levels. This presumption was made in order to account for future implementation of the current Clean Air Act.

VOC emission reductions in the year 2000 were derived by EPA/OAQPS based on ERCAM-VOC model runs. The model runs assumed the provisions of the Senate version of the Clean Air Act.

### NO<sub>x</sub>:

1987 emission estimates for NO<sub>x</sub> were obtained from EPA (1989). Emissions in the year 2000 (without current environmental commitments) were assumed to remain at 1987 levels. Estimates of NO<sub>x</sub> emissions reductions in 2000 were provided by OAQPS, and assumed implementation of the Senate version of the Clean Air Act.

### CO:

1987 emission estimates for carbon monoxide (CO) were obtained from EPA (1989). Emissions in the year 2000 (without current environmental commitments) were assumed to remain at 1987 levels. Estimates of CO emissions reductions in 2000 were provided by the EPA Office of Mobile Sources (OMS), and assumed implementation of the Senate version of the Clean Air Act.

### N<sub>2</sub>O:

Estimates of N<sub>2</sub>O emissions for 1987 were derived from figures provided by DOE to the EIS of the IPCC Response Strategies Working Group. Emissions in the year 2000 (without current environmental commitments) were assumed to remain at 1987 levels. Emissions in the year 2000 with current environmental commitments were also assumed to remain constant at 1987 levels.

### CFCs:

EPA emissions estimates for 1987, 2000 (without current commitments), and 2000 with current commitments were obtained from EPA's Office of Air and Radiation (OAR). OAR estimates assumed that new production of CFCs declines over time, the stock of CFCs rises, and the number of CFC substitutes increases.

**POLICY IMPLICATIONS OF A COMPREHENSIVE  
GREENHOUSE GAS BUDGET**

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U.S. Environmental Protection Agency**

**September 1990**

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## POLICY IMPLICATIONS OF A COMPREHENSIVE GREENHOUSE GAS BUDGET

### ABSTRACT

A comprehensive approach that accounts for the differences in atmospheric lifetimes and radiative forcing effects of the greenhouse gases has been implemented, using values for the "Global Warming Potentials" of greenhouse gases recently published by the Intergovernmental Panel on Climate Change. Emissions of each greenhouse gas have been expressed in terms of a common metric, "carbon equivalents," permitting the integration of all gases into an overall greenhouse gas index.

Using the comprehensive approach, current U.S. emissions of greenhouse gases have been estimated, and projections made of U.S. emissions in the year 2000, given particular assumptions about future U.S. environmental initiatives and economic growth.

Given current U.S. environmental commitments, total greenhouse gas emissions (including CFCs) will be held to 1987 levels in the year 2000. If CFCs are not included in the total greenhouse gas budget, total emissions in the year 2000 will exceed 1987 levels by approximately 115 million metric tonnes of carbon equivalents.

The comprehensive approach provides policymakers with a valuable analytic tool. It provides a methodology with which they can evaluate an integrated set of policy options intended to achieve emissions reductions of all greenhouse gases. Also, by focusing on sources of all greenhouse gases, and not just on those that emit CO<sub>2</sub>, it permits a consideration of a wider diversity of policy options. This, in turn, enables policymakers to achieve reductions in greenhouse gas emissions in a more efficient, least-cost manner. Regardless of the magnitude of the reductions under consideration, policymakers will be able to achieve incremental reductions in carbon equivalent emissions at the lowest marginal cost.

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## INTRODUCTION

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Policy options for reducing greenhouse emissions may be evaluated in terms of an integrated budget of greenhouse gases. The purpose of this paper is to present a comprehensive approach that can account for the contributions to temperature change of all of the greenhouse gases, and provide policymakers with a meaningful measure by which to assess and compare the benefits of alternative policy packages for limiting greenhouse gas emissions. Although the reduction in growth or even stabilization of emissions would not stabilize atmospheric concentrations of the greenhouse gases, this framework provides a useful analytic tool and may be viewed as a first step towards the development of a comprehensive and meaningful policy.

Each of the many greenhouse gases has a different atmospheric residence profile (i.e., lifetime) and radiative forcing potential. These gases come from diverse sources, both natural and anthropogenic, including almost all economic sectors. Policymakers will find it difficult to compare reduction strategies which differ in the gases targeted. Unless a single metric is found by which to integrate the individual contributions to climate change of each of the gases, it will be difficult to assess the total impact of policy initiatives on global climate.

The comprehensive approach used in this analysis measures the emissions of each individual greenhouse gas in terms of a common metric: "carbon equivalents." Emissions are then summed to yield total current greenhouse gas emissions. Implementation of this approach is possible using values for the "Global Warming Potentials" of greenhouse gases recently published by the Intergovernmental Panel on Climate Change (IPCC).

Projections are also made of total emissions in the year 2000, given current U.S. commitments to environmental protection, coupled with assumptions about future U.S. environmental initiatives. These initiatives include the *America the Beautiful* tree planting program, the proposed amendments to the Clean Air Act, CFC phaseout and the Montreal Protocol, U.S. Department of Energy (DOE) energy efficiency initiatives, DOE renewables initiatives, DOE appliance standards, and a proposed EPA landfill regulation.

A comparison is made between what total emissions would have been in the absence of these current U.S. environmental commitments and what they are actually expected to be. This yields an estimate of the percentage reduction in carbon equivalents below what they would have been in 2000 had the U.S. not taken such initiatives.

To illustrate how the comprehensive approach can be used to evaluate additional policy initiatives to achieve further emissions reductions, a sample policy package consisting of three additional environmental initiatives has been examined. These initiatives include energy taxes, yet tighter landfill regulations, and a doubling of the *America the Beautiful* program. (They are drawn from a larger, diverse set of options, and therefore may not be the most cost-effective

way to achieve these reductions.) This exercise illustrates how the comprehensive approach can be used to assess reductions in emissions of all greenhouse gases, and to evaluate policies intended to achieve carbon equivalent reductions throughout the U.S. economy.

Although this analysis does not answer the question of whether there is a global climate change "problem" and how large greenhouse gas emission reductions should be, it does identify an appropriate approach for integrating emissions of all gases into a single index, and for evaluating an integrated set of policy options intended to achieve emission reductions of all greenhouse gases in an efficient, least-cost manner.

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## CREATING AN INTEGRATED GREENHOUSE GAS INDEX

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The scientific community has historically measured contributions to radiative forcing using estimated changes in *atmospheric concentrations*. However, when discussing the various greenhouse gases in a policy context, there is often a need for policymakers to have some means of describing the relative abilities of *emissions* of each greenhouse gas to affect radiative forcing, and hence climate, without the complex, time-consuming task of determining the impacts on atmospheric concentrations.<sup>1</sup> An index that translates the level of emissions (i.e., actual tonnage) of the various greenhouse gases into a common metric must be derived in order to compare the climate-forcing effects of the gases. This is the approach taken in this study.<sup>2</sup> Such an index permits a comparison of the changes in radiative forcing which arise from increases in the concentrations of radiatively active greenhouse gases in the troposphere and stratosphere. These include the direct effects due to growing concentrations of carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), chlorofluorocarbons (CFCs), and nitrous oxide (N<sub>2</sub>O). In addition, the index permits a consideration of the indirect effects on radiative forcing that can result from molecules that may not themselves be greenhouse gases, but which lead to chemical reactions which create greenhouse gases. These include volatile organic compounds (VOCs), nitrogen oxides (NO<sub>x</sub>), and carbon monoxide (CO) -- all of which contribute to the formation of tropospheric ozone.

The index is called the Global Warming Potential (GWP). There is no universally accepted methodology for combining all the relevant factors into a single global warming potential for greenhouse gas emissions. The GWP of an individual greenhouse gas depends on its absorptive strength within the infrared spectrum, the relative concentrations of all greenhouse gases, its longevity and decay profile in the atmosphere, the time period over which the climate effects are of concern, and the relative weight placed on effects at different times. As noted in the draft IPCC Science Report (1990), the development of an index is still at an early stage, but progress has been made and preliminary values derived (see, for example, Derwent [1990], Fisher *et al.* [1990], Rodhe [1990], and Lashof and Ahuja [1990]).

For the purposes of this study (and following the methodology used in the draft IPCC Science Report), the concept of global warming potentials is based on a comparison of the radiative forcing effect over a period of time of the concurrent emission into the atmosphere of an equal quantity of CO<sub>2</sub> and another greenhouse gas. Each gas has a different instantaneous radiative forcing effect. In addition, the atmospheric concentration of each gas decays with

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<sup>1</sup> Theoretically, if emissions were generated whose net effect was no change in atmospheric concentrations, the net contribution to radiative forcing would be zero.

<sup>2</sup> Throughout this document, "tonnes" refer to metric tonnes, and "tons" refer to short tons.

time. In general, other greenhouse gases have a much stronger instantaneous radiative forcing effect than does  $\text{CO}_2$ ; however,  $\text{CO}_2$  has a longer atmospheric lifetime and a slower decay rate than the other greenhouse gases. Atmospheric concentrations of certain greenhouse gases may decline due to atmospheric chemical processes, which in turn create other greenhouse gases or contribute to their creation or longevity. These indirect effects are included in each gas' GWP.

Following this convention, the GWP is defined as the time integrated commitment to climate forcing from the instantaneous release of 1kg of a trace gas expressed relative to that from 1kg of carbon dioxide. This technique for measuring the GWP is, however, sensitive to the time horizon over which the analysis is conducted (i.e., the time period over which the integral is calculated), as illustrated in Figures 1 and 2. Figure 1 depicts the incremental radiative forcing effects of  $\text{N}_2\text{O}$  and  $\text{CH}_4$ , assuming a 100 year horizon. Figure 2 depicts the incremental radiative forcing effects of the two gases, assuming a 500 year horizon.

The emissions forecasts presented in this report are based on a GWP of 100 years. Table 1 summarizes the relative radiative forcing factors (GWPs) of key greenhouse gases (assuming both a 20 year and 100 year time horizon).<sup>3</sup>

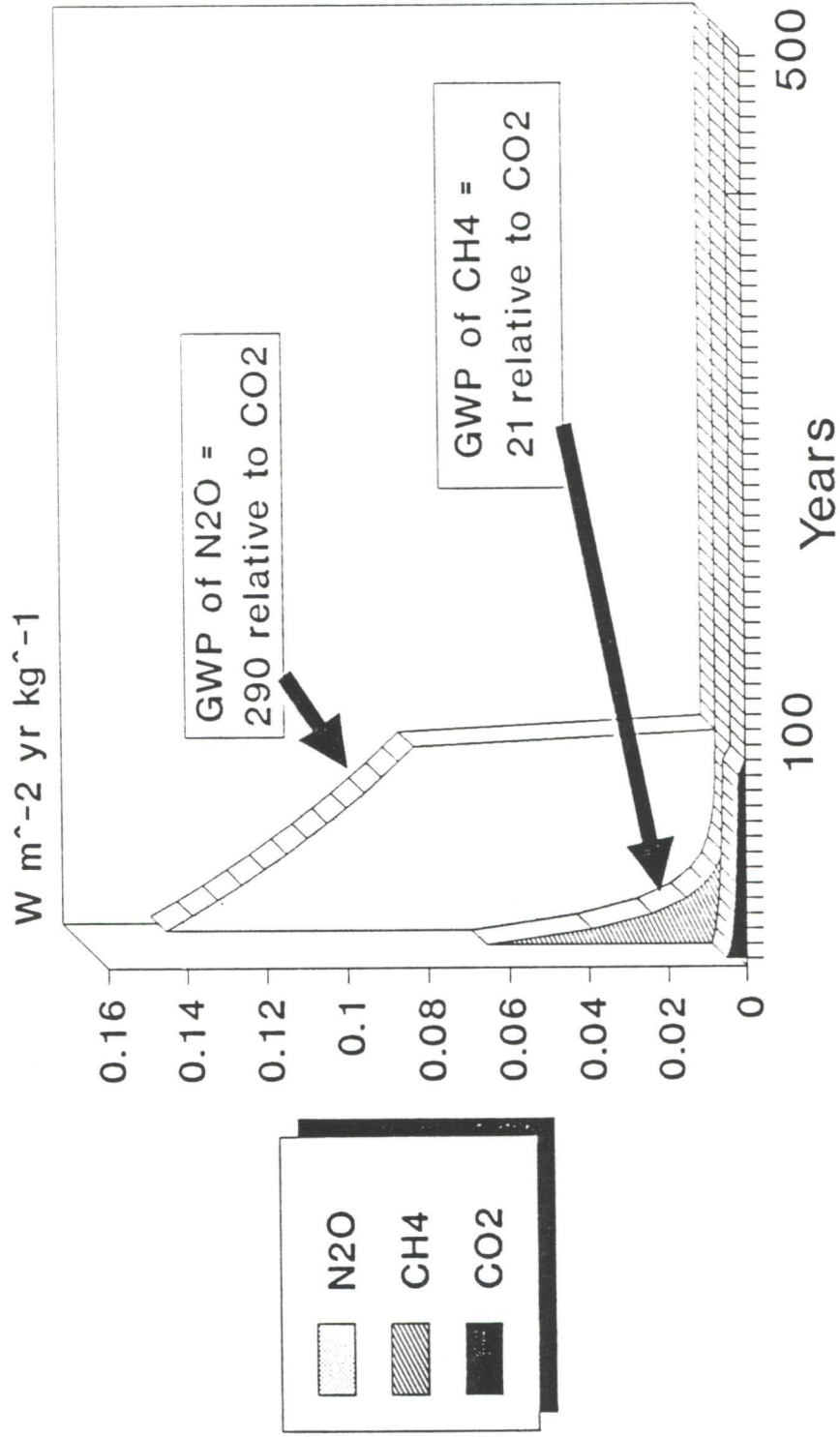
A careful interpretation of the GWPs must be made when conducting policy analyses. For policy purposes, the relative importance of the different greenhouse gases depends on projected levels of emissions, their total atmospheric concentration at any point in time, as well as on their respective global warming potentials. One cannot conclude, for example, that  $\text{CO}_2$  is the most important greenhouse gas over the long run simply because of its long lifetime and large current atmospheric concentration. Similarly, it is incorrect to conclude that in the short run, policy instruments designed to reduce emissions of methane, tropospheric ozone, and gases that contribute to the formation of greenhouse gases (e.g.,  $\text{CO}$ ,  $\text{NO}_x$ , VOCs) are more important than  $\text{CO}_2$  because of their relatively high GWP values. Careful attention is therefore given in the next section to defining the assumptions underlying forecasts of future greenhouse gas emissions.

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<sup>3</sup> In this analysis, it is assumed that the methane from landfills is flared, and thus converted into  $\text{CO}_2$ . Only partial credit can be taken for the  $\text{CH}_4$  emission reduction. A GWP of 18 was used for methane reductions. According to the IPCC, the GWP for  $\text{CH}_4$  on a weight basis, including both direct and indirect effects, is 21. This assumes a 100 year time horizon. In the landfill calculations, it was assumed that methane is flared and converted into  $\text{CO}_2$ . The  $\text{CO}_2$  from methane has a GWP of 3 (for a 100 year time horizon). Credit for the emissions reductions was approximated by subtracting the GWP of 3 for  $\text{CO}_2$  from the GWP of 21 for methane, yielding the GWP of 18. Similarly, emissions of carbon monoxide in the transportation sector are converted into  $\text{CO}_2$ . In the  $\text{CO}$  calculations for the transportation sector, it was assumed that  $\text{CO}$  is instantaneously converted into  $\text{CO}_2$  in a catalytic converter. This  $\text{CO}_2$  has a GWP of 2. Credit for the other indirect effects avoided (i.e., the impact of  $\text{CO}$  on tropospheric ozone,  $\text{GWP}=1$ ) was approximated with a GWP of 1.

# GHG Time Profiles

## 100 Year

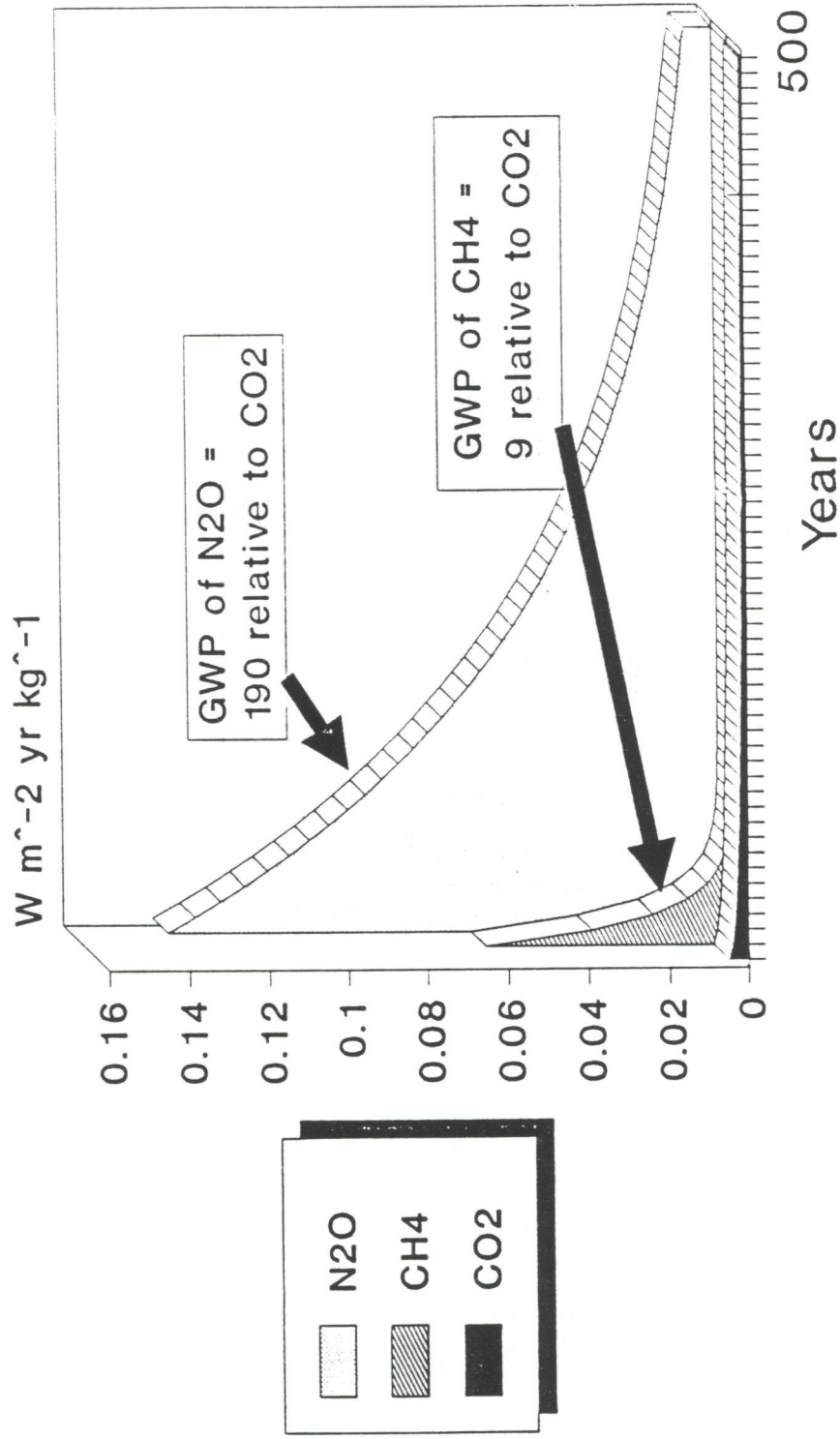


Radiative forcing of a gas is expressed as a change in the flux of energy, i.e., watts per sq. meter per kg of gas.

FIGURE 1

# GHG Time Profiles

## 500 Years



Radiative forcing of a gas is expressed as a change in the flux of energy, i.e., watts per sq. meter per kg of gas.

FIGURE 2

GLOBAL WARMING POTENTIALS

<u>GAS</u>	<u>LIFETIME (years)</u>	<u>INSTANTANEOUS RADIATIVE FORCING (relative to CO<sub>2</sub>)</u>	<u>POTENCY OVER 20 YEARS (relative to CO<sub>2</sub>)</u>	<u>POTENCY OVER 100 YEARS (relative to CO<sub>2</sub>)</u>
CO <sub>2</sub>	120	1	1	1
METHANE	10	58	63	21
CFCs	7-200	1640-5800	1500-7100	430-7300
NITROUS OXIDES	150	206	270	290
OZONE	1	1600	207	57

SOURCE: IPCC draft Science Report

TABLE 1

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## CURRENT ENVIRONMENTAL COMMITMENTS ASSUMED IN THE ANALYSIS

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Projections of future emissions of greenhouse gases must account for current commitments to environmental protection that will affect greenhouse gas emissions, as well as potential future initiatives. We present here a brief summary of the current U.S. environmental commitments accounted for in this study. Table 2 presents the carbon equivalent emissions reductions expected in 2000 due to these initiatives. A more detailed documentation of the sources for the emissions estimates used in the analysis, as well as underlying assumptions, is contained in the Appendix.

### Tree Initiative

The *America the Beautiful* reforestation initiative (currently under consideration by Congress) set a goal of planting one billion trees per year on 1.5 million acres, for ten to twenty years beginning in 1991, and to improve forest management practices on an additional 100,000 acres per year. The total program could sequester approximately 50 million tons of carbon per year by the year 2010, or between 4-5 percent of current net U.S. CO<sub>2</sub> emissions of carbon.

Reforestation options differ from other emissions reduction or sequestration options because of: (i) the long time frames required for both planting and growing trees (10 years to plant large acreages, and 30 years to grow to maturity), and (ii) the nonlinear shape of the carbon benefit curve, with only small offset potential in near-term years, but large potential in later years once all trees are planted and have grown. The program is targeted to first utilize low-productivity, economically marginal or environmentally sensitive lands (i.e., lands with low opportunity costs), and then attract more expensive lands in later stages.

TABLE 2

EMISSIONS REDUCTIONS EXPECTED IN THE YEAR 2000  
DUE TO CURRENT ENVIRONMENTAL COMMITMENTS  
AND OTHER INITIATIVES ASSUMED IN THE ANALYSIS

<u>CURRENT COMMITMENTS</u>	<u>MILLIONS OF TONNES REDUCED (Carbon Equivalents) 2000<sup>4</sup></u>
o TREE INITIATIVE	~9
o DOE ENERGY EFFICIENCY INITIATIVES	28
o DOE APPLIANCE STANDARDS	4
o DOE RENEWABLE INITIATIVES	4
o CLEAN AIR ACT	17
o LANDFILL REGULATION	44
o CFC PHASEOUT & MONTREAL PROTOCOL	551

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<sup>4</sup> Assumes a 100 year time horizon in GWP calculations.

The following estimates have been made of the CO<sub>2</sub> offset benefits and costs for U.S. reforestation initiative options (Moulton *et al.*, 1990):

<u>% Offset (in 2030) of U.S. CO<sub>2</sub> Emissions</u>	<u>Million Tons C (2000)</u>	<u>Million Tons C (2030)</u>	<u>Total Annual Program Cost (2000)<sup>5</sup></u>
5	9	55-69	\$545 mill.
10	18	110-138	\$1.4 bill.
20	36	220-276	\$3.7 bill.

#### DOE Energy Efficiency Initiatives, Renewable Initiatives, and Appliance Standards

The DOE energy efficiency initiatives include more efficient lighting in Federal and commercial buildings, promotion of state least-cost utility planning, state adoption of interim building standards, energy analysis and diagnostic centers, and HUD adoption of DOE building standards. Also included are DOE renewable initiatives, including expanded use of hydroelectric power and the transfer of photovoltaic technology.

Estimates of reductions in the year 2000 due to these initiatives were taken from numbers provided by DOE. Estimates of reductions in the year 2000 due to the renewable initiatives are also taken from data provided by DOE, except that expanded hydropower capacity was assumed to produce only half of the reduction estimated by DOE.

Revised DOE appliance standards apply to refrigerators and freezers, washers, dryers, and dishwashers. Estimates of reductions in the year 2000 due to revised standards for these four appliance groups were taken from DOE Technical Support Documents published as part of the rulemaking process.

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<sup>5</sup> These estimates are based on amortized costs over 40 years, discounted at a 10 percent real rate. It is assumed that it will take 10 years to plant the trees, beginning in 1990, and 30 years for the trees to grow to maturity in 2030. The range of carbon sequestration given assumes current sequestration rates of existing seedling stock (low estimate). An average carbon sequestration of 1.8-2.2 tons carbon per acre per year is assumed, varying by site index (growth conditions for appropriate species).

These data are summarized in Table 3. Further documentation of the sources for these estimates and underlying assumptions is contained in the Appendix.

### Clean Air Act

The new Clean Air Act initiative will result in emission reductions for CO<sub>2</sub>, NO<sub>x</sub>, CO, and VOCs, as well as other criteria air pollutants.<sup>6</sup> NO<sub>x</sub> reductions are projected to come from controls on motor vehicles, utilities, non-utility point sources, and area sources. VOC reductions are expected to come from control on motor vehicles. Reductions in CO are expected to come from automobile fleet turnover, the cold temperature rule, and an oxygenated fuels program. Estimates of CO<sub>2</sub> emissions reductions in the year 2000 were taken from data provided by DOE (and summarized in Table 3).

To be consistent with EPA national air pollutant emission estimates (EPA, 1989), N<sub>2</sub>O emissions rates are projected to remain unchanged through 2000.

### Landfill Regulation

There are approximately 6000 active landfills in the United States. Most landfills are relatively small (i.e., 70 percent contain less than one million tons). Landfills are "bioreactors" that generate 255,000 Mg/yr of non-methane organic emissions, as well as 10.5 million Mg/yr of methane.

Landfill control includes (i) collection of landfill gases by wells, and (ii) combustion or recovery of these gases. In this analysis, it is assumed that the methane from landfills is flared and converted into CO<sub>2</sub>.

The proposed landfill regulation results in approximately a 9 million tonne reduction in methane in 2000.

### CFC Phase out & Montreal Protocol

On January 1, 1989, the "Montreal Protocol on Substances That Deplete the Ozone Layer" (or the Montreal Protocol) came into force. The major provisions of the Protocol affecting U.S. emissions include a 50% reduction from 1986 levels in the use of CFC-11, -12, -113, -114, and -115 by 1998, and a freeze on the use of Halon 1211, 1301, and 2402 at 1986 levels starting in approximately 1992.

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<sup>6</sup> For this analysis, the Senate version of the Clean Air Act is assumed.

**DOE-RELATED CO<sub>2</sub> EMISSIONS REDUCTIONS  
USED IN EPA'S GHG EMISSIONS INVENTORY**

<u>ACTION/PROGRAM</u>	<u>2000</u>	
	<u>CO<sub>2</sub></u>	<u>Carbon</u>
<b>DOE Appliance Standards</b> (Refrigerators, Washers, Dryers, Dishwashers)	16.0	4.4
<b>DOE Efficiency Initiatives</b>	<b>102.0</b>	<b>27.8</b>
Federal Buildings Lighting	5.0	1.4
Commercial Buildings Lighting	9.0	2.5
Promote State LCUP	33.0	9.0
State Adoption of Interim Building Standards	30.0	8.2
Energy Analysis and Diagnostic Centers	22.0	6.0
HUD Adoption of DOE Building Standards	3.0	0.8
<b>DOE Renewable Initiatives</b>	<b>15.0</b>	<b>4.1</b>
Expanded Hydro Power	13.0	3.5
Photovoltaic Technology Transfer	2.0	0.5
<b>Clean Air Act</b>	<b>63.0</b>	<b>17.2</b> *
Acid Rain	60.0	16.4
Transportation Biofuels and Natural Gas Use	3.0	0.8
<b>GRAND TOTAL</b>	<b>196.0</b>	<b>53.5</b>

\* Does not include reductions of 51 million metric tonnes due to decreases in NO<sub>x</sub> (19.6 million tonnes), CO (7.4), and VOCs (23.7).

TABLE 3

A possible phase out of controlled CFCs and halons by 2000 is being considered by the U.S. and several other countries. This would eliminate 95 percent of the radiative forcing due to CFC emissions (in 2000).

The CFCs included in this study are CFC-11, -12, -113, -114, HCFC-22, CCl<sub>4</sub>, HCFC-134, HCFC-141b, and HCFC-124.

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## EMISSIONS PROJECTIONS

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### Emissions Given Current Environmental Commitments

Figure 3 depicts EPA estimates of the current status of emissions of greenhouse gases. Total U.S. greenhouse gas emissions, expressed in terms of carbon equivalents, are 2328 million metric tonnes. CO<sub>2</sub> emissions account for 56 percent of total U.S. greenhouse gas emissions.

Figure 4 depicts EPA estimates of projected emissions in the year 2000, given current commitments to environmental protection. Each estimate depends on an underlying assumption about growth in economic activity. In general, year 2000 emissions would be higher if the economy grew faster. Each estimate is also sensitive to other key influences, such as oil prices. Analysis using the comprehensive approach reveals that total U.S. greenhouse gas emissions in 2000 will be equivalent to 2332 million tonnes of carbon.

A comparison of emissions in 1987 with those in 2000 reveals *total emissions in the year 2000 will be held to 1987 levels*. (This does not imply, however, that total emissions will be stabilized at 1987 levels beyond the year 2000.) The difference between emissions in 1987 and 2000 is 4 million metric tonnes of carbon equivalent (within the range of uncertainty of the estimates). (If only direct CO<sub>2</sub> emissions are considered, CO<sub>2</sub> emissions in 2000 will still be about 15 percent higher than 1987 levels.) If CFCs are not included in the total greenhouse gas budget, total emissions in the year 2000 will exceed 1987 levels by 115 million tonnes of carbon equivalents.

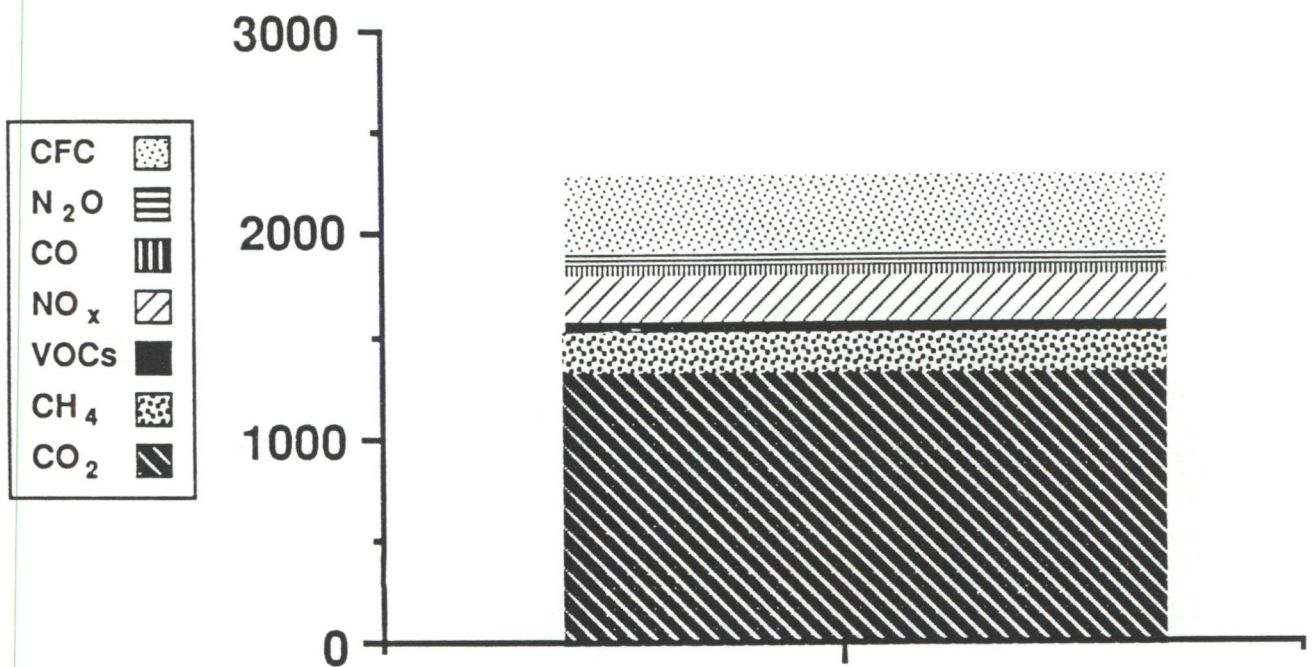
**Conclusion: Analysis reveals that given current environmental commitments, coupled with additional possible environmental initiatives, the U.S. contribution to the total budget of greenhouse gases will be held at 1987 levels in the year 2000 (if CFCs are included in the total greenhouse gas budget). This result is sensitive to underlying assumptions about economic growth and other key factors, such as oil prices.**

Table 4 provides information on the percentage contribution to global warming potential of U.S. emissions of key individual greenhouse gases included in this study. Individual contributions are calculated by multiplying emission levels by GWPs. Percentages are calculated for current (1987) U.S. emissions as estimated by EPA, and for projected emissions in the year 2000, accounting for current U.S. environmental commitments and possible additional

# Current Emissions 1987

(100 Year GWP Factors)

Carbon Equivalents – Millions of Tonnes



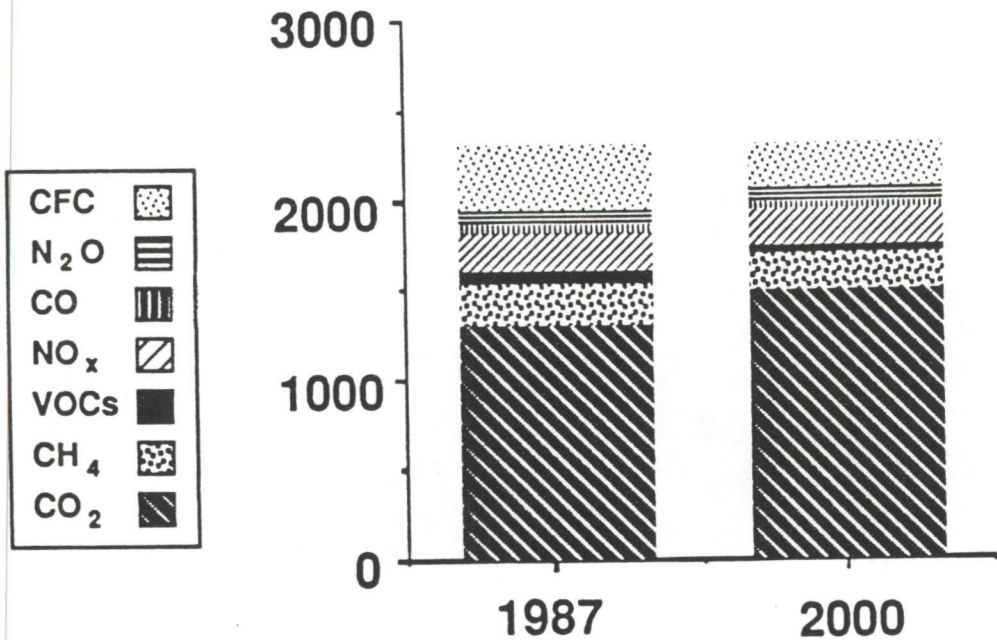
	1987
CO <sub>2</sub>	1310
CH <sub>4</sub>	235
VOCs	72
NO <sub>x</sub>	218
CO	52
N <sub>2</sub> O	74
CFC	367
<b>Total</b>	<b>2328</b>

FIGURE 3

# Emissions

(With Current Commitments)  
(100 Year GWP Factors)

Carbon Equivalents – Millions of Tonnes



	1987	2000
CO <sub>2</sub>	1310	1503
CH <sub>4</sub>	234	208
VOCs	72	48
NO <sub>x</sub>	218	199
CO	52	45
N <sub>2</sub> O	74	74
CFC	367	256
<b>Total</b>	<b>2328</b>	<b>2332</b>

FIGURE 4

environmental initiatives. For the purposes of comparison, percentages for worldwide emissions are also calculated for 1990, based upon IPCC emission projections.

**TABLE 4**  
**PERCENTAGE CONTRIBUTION TO GLOBAL WARMING POTENTIAL**  
**OF INDIVIDUAL GASES**  
**(100 GWP)**

<u>GAS</u>	<u>U.S.</u> <u>Emissions</u>		<u>Worldwide</u> <u>Emissions</u>
	<u>EPA</u> <u>1987</u>	<u>EPA</u> <u>2000</u> <u>(w/commitments)</u>	<u>IPCC</u> <u>1990</u>
CO <sub>2</sub>	56	64	61
CH <sub>4</sub>	10	9	15
N <sub>2</sub> O	3	3	4
CO	2	2	1
NO <sub>x</sub>	9	9	6
CFC-11	2	2	2
CFC-12	9	6	7
CFC-113	1.1	2.6	0.4
CFC-114	2.8	0	1.5
HCFC-22	0.4	0	0.2
CCl <sub>4</sub>	0.4	0.2	0.3

### Emissions in the Absence of Current Environmental Commitments

It is instructive to forecast what emissions *would have been* in the year 2000, had current commitments not been made by the U.S.<sup>7</sup> These projections are presented in Figure 5. A comparison of Figures 4 and 5 reveals that current U.S. environmental commitments, coupled with additional possible initiatives, will yield a 24 percent reduction in carbon equivalent emissions below what they would have been in 2000.

A close examination of U.S. emission trends in the individual greenhouse gases reveals the importance of CFC phaseout and the Montreal Protocol. The total contribution of CFCs to the greenhouse budget in 1987 was 367 million tonnes of carbon. In the absence of the Montreal Protocol and CFC phaseout, emissions of this gas would grow to 807 million tonnes of carbon. With current commitments to phaseout, emissions of CFCs will decline to 256 million tonnes of carbon by 2000.

**Conclusion:** Analysis reveals that current U.S. environmental commitments, coupled with additional possible initiatives, yields a 24 percent emissions reduction below what they would have been in the absence of these U.S. actions.

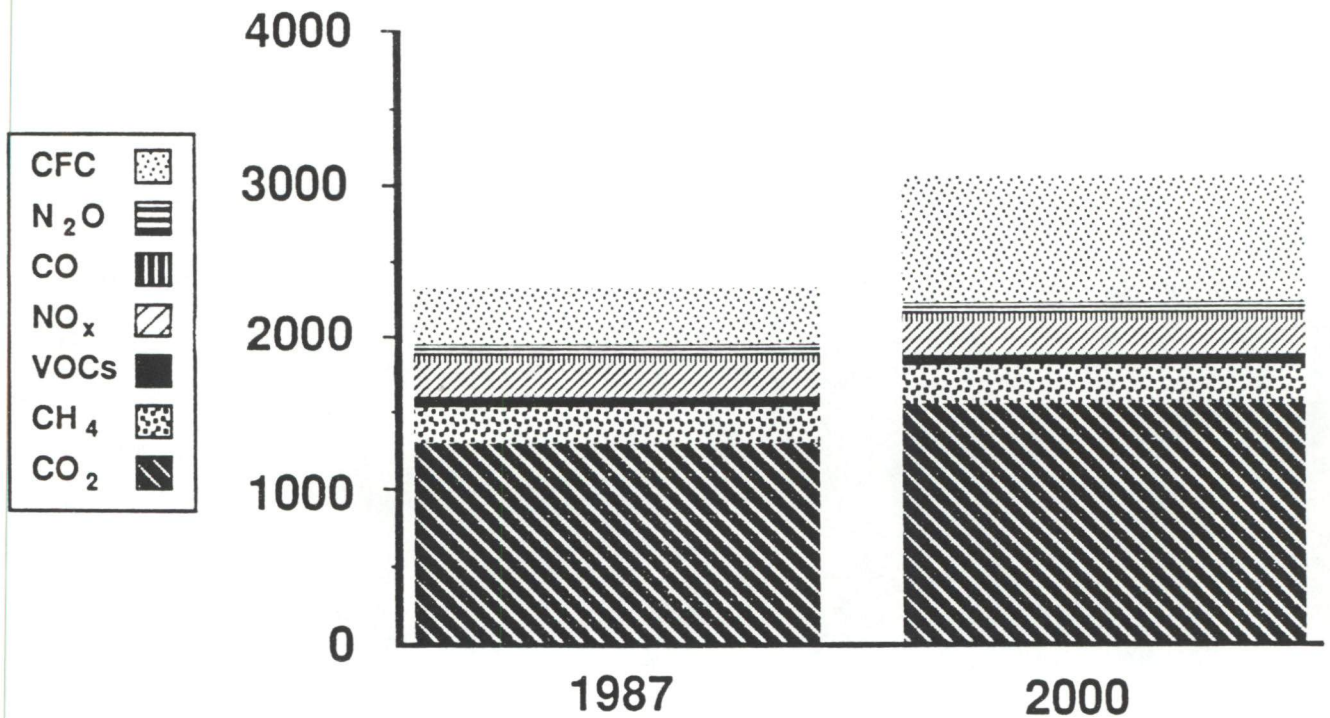
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<sup>7</sup> Credit is only being taken for the contributions from these initiatives from 1987 forward.

# Emissions

(Without Current Commitments)  
(100 Year GWP Factors)

Carbon Equivalents – Millions of Tonnes



	1987	2000
CO <sub>2</sub>	1310	1565
CH <sub>4</sub>	235	252
VOCs	72	72
NO <sub>x</sub>	218	218
CO	52	52
N <sub>2</sub> O	74	74
CFC	367	807
<b>Total</b>	<b>2328</b>	<b>3040</b>

FIGURE 5

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## ADDITIONAL POLICY INITIATIVES

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EPA has investigated additional policy options that could hold the greenhouse gas emissions index in the year 2000 at 1987 levels, and help maintain this emissions rate beyond 2000. This analysis included tax and nontax initiatives.

### TAX INITIATIVES

Two sets of tax-based policy options were considered for reducing CO<sub>2</sub> emissions. The first set of options consist of transportation taxes: a federal gasoline tax, and an oil import fee. The second set of taxes consist of general carbon taxes on fossil fuels. Estimates were made of total annual carbon reductions in the year 2000, annual tax revenues, and the change in GNP.

#### Transportation Taxes

To estimate the effects of a federal gasoline tax and an oil import fee, the Data Resources Incorporated (DRI) Transportation model was employed.<sup>8</sup> In both cases, it was assumed that the taxes were phased in over time.

Results for the transportation taxes are presented in Table 5. A \$0.33/gallon tax on gasoline (equivalent to a \$120/ton carbon tax) would reduce emissions of carbon by 16 million tonnes, which is more than sufficient to ensure that total emissions will be held at 1987 levels in the year 2000. The total effect on GNP would be a 0.3 percent annual decrease. To the extent that GNP is a measure of social welfare, this suggests that society will be worse off by 0.3 percent per year. It is important to note, however, that this GNP measure does not capture the social benefits (e.g., due to environmental protection) that accrue from the carbon reductions.

A phased-in oil import fee of \$6.00/barrel would also yield significant carbon reductions of 30 million tonnes per year, at a cost to society of a 0.6 percent annual reduction in GNP.

Both transportation taxes yield significant annual tax revenues. The \$0.33/gal. gasoline tax would yield \$35 billion of revenues, while the import fee would yield \$23 billion in tax revenues.

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<sup>8</sup> The results presented here are preliminary DRI model estimates.

# TRANSPORTATION TAXES

## FOR THE YEAR 2000

(all numbers in constant 1989 dollars)

	<u>Annual Revenues</u> (Bill. \$'s)	<u>Carbon Reductions</u> (Mill. tons)	<u>GNP Change</u> (Percent)	<u>Comments</u>
Gasoline Tax (Phased-in)				
\$0.33/Gal. (\$120/ton carbon)	35	18	-0.3	DRI interim results
\$1.24/Gal (\$452/ton carbon)	103	86	-2.0	DRI interim results
Oil Import Fee (Phased-in)				
\$6.00/Barrel (\$50/ton carbon)	23	33	-0.6	DRI interim results

### Carbon Taxes

Three models were used to estimate the effects of carbon taxes: the Manne-Richels *Global 2100* model, the Dynamic General Equilibrium Model (DGEM) developed by Dale Jorgenson (Harvard), and the DRI national energy model. A range of taxes were examined, from \$5.00/ton carbon to \$25.00/ton.<sup>9</sup> (Using the DRI model, estimates were also made of the gasoline tax that would yield similar impacts as each carbon tax.)

Results for the three models are presented in Table 6. The Manne-Richels model suggests that a carbon tax will generally be less efficacious in achieving carbon reductions than is suggested by either the DRI or DGEM models. Manne-Richels suggest that a \$5/ton tax will result in approximately a 9 million tonne reduction in carbon, as compared to the 25 million tonne reduction predicted by DRI and a 62 million tonne reduction forecast by DGEM. Nevertheless, this \$5/ton tax is sufficient to achieve the 4 million tonne reduction in carbon emissions necessary to hold year 2000 emissions at 1987 levels.

Results from the DGEM model suggest that the long-run GNP effects of a carbon tax will be small. DGEM results suggest that a \$25/ton carbon tax will result in "only" a 0.2 percent annual decrease in GNP. Manne and Richels have also estimated that the projected GNP loss associated with a \$5/ton carbon tax would be "negligible," assuming that increased taxes are employed for deficit reduction, and that this in turn will stimulate private investment.

It is important to note, however, that the short-run fluctuations in GNP forecast by the models differ dramatically because of structural differences in the models. As reported in Montgomery (1990), the DRI model projects much larger short-run effects of a CO<sub>2</sub> charge due to higher energy prices that stimulate a wage-price spiral. In the long-run, however, reduced interest rates lead to higher investment and significant improvement in GNP growth. In contrast, the immediate impact shown in the DGEM model occurs simply because the model ignores short-term difficulties in adjustment, focusing on long-run responses.

A comparison can be made of the effects of the transportation and carbon taxes (as estimated by the DRI models). A \$5.00 per ton carbon tax is equivalent to a 1 cent/gal. gasoline tax. Yet, the carbon tax will yield 25 million tonnes of carbon emissions reductions, whereas a \$0.33/gal. gasoline tax will only yield 16 million tonnes of carbon reductions. This result is not surprising given the multi-sectoral impacts of a carbon tax (which is imposed on all fossil fuels), as opposed to the gasoline tax which only affects the transportation sector.

It is important to note that distributional and equity issues have not yet been examined. For example, a carbon tax on fossil fuels will likely have significant impacts on the levels of output and employment in the coal industry, which are not captured in this analysis. Further, a carbon tax unilaterally imposed on U.S. production may lead to an "exportation" of energy-

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<sup>9</sup> A thorough description and comparison of these models is contained in Montgomery (March 1990).

## ENERGY TAXES

<u>Carbon Tax per ton</u>	<u>Annual Revenues 2000 (Bill. \$)</u>	<u>Carbon Reductions (Mill. tons)</u>	<u>GNP Change (Percent)</u>	<u>Comments</u>
<u>Manne-Richels</u>				
\$5.00	7	10	not available	Provided to EPA by authors
\$10.00	14	20	not available	
\$15.00	20	30	not available	
<u>DRI</u>				
\$5.00 (1 cent/gal.)	8	27	not available	GNP losses likely to be larger than Manne-Richels or Jorgenson
\$10.00 (3 cent/gal.)	11	54	not available	
\$15.00 (4 cent/gal.)	23	82	not available	
\$25.00 (6 cent/gal.)	38	136	not available	
<u>Jorgenson</u>				
\$5.00	10	68	0.1	Interpo- lated by EPA
\$10.00	14	136	0.1	
\$15.00	30	200	0.2	
\$25.00	50	272	0.2	

intensive production to other countries. Such a shift may lead to increased carbon emissions in other countries, offsetting the benefits gained from the tax in the U.S.

### NONTAX INITIATIVES

Several potential nontax initiatives have also been examined that could yield significant additional carbon reductions by the year 2000. These include tighter landfill regulations and the planting of more trees. These initiatives are summarized in Table 7. Several other energy sector options that are currently under investigation by EPA are presented as illustrations of alternative sources for emissions reductions.

If regulations to limit methane emissions from landfills were tightened beyond pending EPA regulations, an additional 39 million tonne reduction in carbon equivalent emissions could be achieved, at an annual cost of \$431 million dollars. If the *America the Beautiful* commitment were doubled, so that an additional one billion trees were planted per year, an additional reduction of 9 million tonnes of carbon could be attained at an annual cost of \$850 million.

The results for these case studies are presented to illustrate: (i) how the comprehensive approach can be used to assess reductions in emissions of all greenhouse gases, and to evaluate policies intended to achieve carbon equivalent reductions throughout the U.S. economy; (ii) that a diversity of sources exist from which reductions in greenhouse gas emissions can be achieved; and (iii) that many of these are cost-effective or low-cost options. No attempt, however, has been made in this analysis to measure the *net benefits* of any particular package of policy options.

# POTENTIAL NONTAX INITIATIVES -- 2000

	<u>CARBON TONNES REDUCED</u>	<u>ANNUAL COSTS (millions)</u>	<u>COMMENTS</u>
<b>TIGHTER LANDFILL REGULATION</b>	39	\$431	Tighten beyond pending EPA regulations
<b>MORE TREES</b>	9	\$850	Double <i>America the Beautiful</i> commitment
<u>Energy Sector Options</u>			
• <b>UTILITY-BASED INCENTIVE PROGRAMS</b>	?	?	Provide incentives for use of cost-effective energy- saving technologies in residential sector; beyond currently proposed DOE standards.
• <b>COMMERCIAL LIGHTING &amp; FAN MOTOR STANDARDS</b>	?	?	Technologies not currently covered by DOE standards.
• <b>BIOMASS ELECTRICITY PROJECT</b>	?	?	Short-rotation biomass and ISTIG demonstration programs.

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## CONCLUSIONS

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Several major conclusions emerge from this study:

- o In the evaluation of policy options for reducing greenhouse emissions, it is necessary to assess an integrated budget of all greenhouse gases. A comprehensive approach has been developed that accounts for the differences in atmospheric lifetimes and radiative forcing effects of greenhouse gases (including those gases which through chemical interactions affect concentrations of direct greenhouse gases), and expresses emissions of each greenhouse gas in terms of a common metric ("carbon equivalents"). Emissions of all greenhouse gases can then be integrated into an overall greenhouse gas budget.
- o An assessment of current (1987) emissions using the comprehensive approach indicates that total U.S. greenhouse gas emissions, expressed in terms of carbon equivalents, are 2328 million tonnes (assuming a 100 year Global Warming Potential [GWP]). CO<sub>2</sub> emissions account for 56 percent of total U.S. greenhouse gas emissions.
- o Given current U.S. environmental commitments, and assumptions made regarding growth in economic activity and energy price developments, coupled with additional environmental initiatives, total emissions (as opposed to atmospheric concentrations) will be held at 1987 levels in the year 2000. (This does not imply, however, that total emissions will be stabilized at 1987 levels beyond the year 2000.) Analysis using the comprehensive approach reveals that total greenhouse gas emissions in 2000 would be equivalent to 2332 million tonnes of carbon. (Direct CO<sub>2</sub> emissions will still be about 15 percent higher than 1987 levels.)
- o These environmental commitments, coupled with additional initiatives, will yield a 24 percent reduction in carbon equivalent emissions below what they otherwise would have been in 2000 in the absence of such initiatives. The programs accounting for this reduction include the Montreal Protocol and CFC phaseout, the Clean Air Act, DOE initiatives, the *America the Beautiful* tree planting program, and pending EPA landfill controls.
- o A close examination of emissions trends in the individual greenhouse gases reveals the importance of the Montreal Protocol and CFC phaseout. The total contribution of CFCs to the greenhouse budget in 1987 was 367 million tonnes of carbon equivalents. It is estimated that in the absence of the Montreal Protocol and CFC phaseout, emissions of this gas would grow to 807 million tonnes of

carbon equivalents. With current commitments to phaseout, emissions of CFCs will decline to 256 million tonnes of carbon equivalents by 2000.

- o The comprehensive assessment approach reveals that three additional policy initiatives can ensure that emissions will be held to 1987 levels in the year 2000. These initiatives include energy taxes, yet tighter landfill regulations, and a doubling of the *America the Beautiful* tree planting program.

These results have important implications for the formulation of both domestic and international policies to reduce greenhouse gas emissions. First, it suggests the importance of considering greenhouse gases other than just CO<sub>2</sub>. The comprehensive approach used here enables one to focus on the diverse sources of greenhouse gases other than just those that emit CO<sub>2</sub>. (This will also help ensure that an undue burden is not placed on those industries that emit CO<sub>2</sub>, such as those that are energy intensive and burn fossil fuels.) Many opportunities exist for achieving carbon equivalent reductions throughout the U.S. economy.

Finally, the comprehensive approach enables the U.S. and other countries to achieve greenhouse gas emissions reductions in a least-cost manner. It permits a country to achieve those reductions through limits on emissions of a diversity of greenhouse gases, some of which may be cheaper to control than others. Countries will be able to achieve incremental reductions in carbon equivalent emissions at the lowest marginal cost.

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## APPENDIX

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### SOURCES OF GREENHOUSE GAS EMISSIONS ESTIMATES

The following appendix documents the sources of the emissions estimates for each of the greenhouse gases, as well as important underlying assumptions. Documentation is presented for: (i) the 1987 "base case," (ii) emissions in 2000 without current environmental commitments, and (iii) emissions in 2000 with current environmental commitments.

#### CO<sub>2</sub>:

Estimates of CO<sub>2</sub> emissions for 1987 and 2000 (without current environmental commitments) were derived from figures provided by the U.S. Department of Energy (DOE) to the Energy and Industry Subgroup (EIS) of the Response Strategies Working Group of the Intergovernmental Panel on Climate Change (IPCC).

CO<sub>2</sub> emissions reductions in the year 2000 were estimated by DOE for the following current environmental commitments:

- o **DOE Energy Efficiency Initiatives**
- o **DOE Appliance Standards**
- o **DOE Renewable Initiatives**
- o **Proposed Clean Air Act Legislation and DOE Transportation Fuels Program**

A detailed discussion of each of these initiatives follows:

I. **DOE Energy Efficiency Initiatives** (102 million tons CO<sub>2</sub>)

- \* **More Efficient Lighting in Federal Buildings** (5 million tons CO<sub>2</sub>)

It is assumed that federal agencies fully comply with the relevant Executive Order by 2000. Electricity savings would be 0.05 quad.

\* **More Efficient Lighting in Commercial Buildings (9 million tons CO<sub>2</sub>)**

It is assumed that approximately one-half of buildings convert to high efficiency lighting with an average savings of 25 percent of electrical demand for lighting. Electricity savings are 0.125 quad.

\* **Promotion of State Efforts to Institute Utility Integrated Resource Planning for End-use Energy Efficiency (33 million tons CO<sub>2</sub>)**

This and CO<sub>2</sub> reductions from the Clean Air Amendments are linked. Many states are emphasizing Integrated Resource Planning, although methods of analysis and implementation plans are not fully developed for all states. Due to the impetus for Clean Air Act legislation, the need for coal/fossil fuel generation may be reduced by 10-15 percent due to demand reduction. Supporting DOE programs would primarily include methods development and promotional options. Hence, reductions by the year 2000 would probably be lower than would otherwise be achieved. A 7.5 percent reduction in added demand is assumed, resulting in an electricity savings of 0.48 quad.

\* **Adoption of DOE Interim Building Standards by the States (30 million tons CO<sub>2</sub>)**

The DOE program includes dissemination of information and provision of voluntary guidelines. States could transform the guidelines into enforceable standards. Federal buildings must meet new standards beginning in 1989. It is assumed that there would be a 50 percent acceptance rate for new non-Federal buildings and a 20 percent demand reduction per building. Savings would be .43 quads of electricity.

\* **Expansion of the Energy Analysis and Diagnostic Centers to Increase Energy Audits (22 million tons CO<sub>2</sub>)**

Program expansion would occur to 40 energy efficiency engineering centers by 2000, resulting in audits of 3 percent of eligible industrial facilities by 2000. The estimate assumes implementation of 60 percent of audit recommendations, with a 15 percent improvement in energy efficiency. Total savings of all fuels would be .28 quads, including .05 quads of electricity.

\* **Use of DOE Building Standards by HUD in Public Housing Assistance Programs (3 million tons CO<sub>2</sub>)**

Although the program is still being designed, it is assumed that it will be successful in providing a required 25 percent efficiency increase in buildings that are refurbished. It is projected that 1.4 million units in the 7 major public assistance programs will be retrofitted by 2000, resulting in annual efficiency gains of 0.05 quads.

**II. DOE Appliance Standards (16 million tons CO<sub>2</sub>)**

The new appliance standards refer to refrigerators, freezers, clothes washers, clothes dryers, and dishwashers. DOE appliance standards call for an increase in the efficiency of refrigerators and freezers by 25 percent by 1993. The standards applying to refrigerators and freezers are already in the law. It is assumed that 1993 and subsequent model year refrigerators and freezers meet the regulation exactly. The remaining standards are still being promulgated. All of the standards are due to take effect in 1993.

It is assumed that patterns of consumer purchases will be similar to today's buying and replacement patterns. Annual electricity savings due to units installed by the year 2000 would be 0.15 quad.

**III. DOE Renewable Initiatives (15 million tons CO<sub>2</sub>)**

\* **Expanding Hydropower Capacity (13 million tons CO<sub>2</sub>)**

The DOE program involves working with permitting/development authorities to streamline present complex processes. At maximum levels, 20,000 Mw of capacity could be added by the year 2000. It is assumed that 25 percent of this could be realized by the year 2000, reducing fossil energy electricity requirements by .27 quads. (EPA further reduced this estimate by 50 percent.) Present capacity is 90,000 Mw.

\* **Transfer of Photovoltaic Technology: (2 million tons CO<sub>2</sub>)**

This estimate assumes that the U.S. initiative would be 675 Mw of installed capacity by 2000, or a savings of .03 quads of demand for fossil fuel electricity.

IV. **Proposed Clean Air Act Legislation and DOE Transportation Fuels Program**  
(63 million tons CO<sub>2</sub>)<sup>10</sup>

\* **Conservation Due to Clean Air Act Provisions on Acid Rain Controls:**  
(60 million tons CO<sub>2</sub>)

Clean Air Act amendments place requirements for SO<sub>2</sub> reduction on present coal facilities but allow the facilities to determine how these reductions will be met. New facilities must obtain offsetting emissions allowances. One method to reduce emissions allowance purchase requirements would be to reduce end-use demand supplied by older coal-fired plants (for largest SO<sub>2</sub> reductions). EPA has estimated that this reduction could be as great as 10 percent of present coal-fired generation. Because of the linkage with state efforts to institute Utility Integrated Resource Planning for end-use energy efficiency, the estimate here is cut to 5 percent of present coal-fired generation, with an annual CO<sub>2</sub> reduction of 60 million tons.

\* **Increased Use of Biofuels for Transportation**  
(1 million tons CO<sub>2</sub>)

Preliminary estimates assume 10 percent ethanol fuel for 13 percent of gasoline used in year 2000. It is also assumed that the ethanol is made from a biomass feedstock that is replaced or recycled. This represents 50 percent of the expected oxygenated fuel required by the Clean Air Act.

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<sup>10</sup> This does not include reductions of 51 million metric tonnes due to decreases in NO<sub>x</sub> (19.6 million tonnes), CO (7.4), and VOCs (23.7).

\* **Increased Use of Natural Gas in Central Fleets Due to Clean Air Act  
(2 million tons CO<sub>2</sub>)**

One percent of the Nation's use of gasoline would be replaced by compressed natural gas, providing a 20 percent decrease in CO<sub>2</sub> for that amount.

**METHANE:**

Estimates of methane (CH<sub>4</sub>) emissions for 1987 were derived from figures provided by DOE to the EIS of the IPCC Response Strategies Working Group. Estimates of emissions for 2000 (without current environmental commitments) were derived from the IPCC EIS and the Agricultural Working Group. For both 1987 and 2000, the estimates were adjusted upward by 6 million tonnes by EPA to reflect its landfill estimates.

Estimates of methane emission reductions in the year 2000 were obtained from EPA's Office of Air Quality Planning and Standards (OAQPS). The estimates reflect methane reductions that arise due to a 250 Mg/yr landfill standard.

**VOCs:**

The estimate of 1987 VOC emissions were provided to OAQPS by E.H. Pechan & Associates and derived from the ERCAM-VOC model. The estimate uses the 1985 NAPAP emissions inventory as a base and (i) adjusts auto emissions using EPA's MOBILE4 model, and (ii) includes estimates of emissions from hazardous waste treatment storage.

VOC emissions for the year 2000 (without current environmental commitments) are assumed to remain at 1987 levels. This presumption was made in order to account for future implementation of the current Clean Air Act.

VOC emission reductions in the year 2000 were derived by EPA/OAQPS based on ERCAM-VOC model runs. The model runs assumed the provisions of the Senate version of the Clean Air Act.

NO<sub>x</sub>:

1987 emission estimates for NO<sub>x</sub> were obtained from EPA (1989). Emissions in the year 2000 (without current environmental commitments) were assumed to remain at 1987 levels. Estimates of NO<sub>x</sub> emissions reductions in 2000 were provided by OAQPS, and assumed implementation of the Senate version of the Clean Air Act.

CO:

1987 emission estimates for carbon monoxide (CO) were obtained from EPA (1989). Emissions in the year 2000 (without current environmental commitments) were assumed to remain at 1987 levels. Estimates of CO emissions reductions in 2000 were provided by the EPA Office of Mobile Sources (OMS), and assumed implementation of the Senate version of the Clean Air Act.

N<sub>2</sub>O:

Estimates of N<sub>2</sub>O emissions for 1987 were derived from figures provided by DOE to the EIS of the IPCC Response Strategies Working Group. Emissions in the year 2000 (without current environmental commitments) were assumed to remain at 1987 levels. Emissions in the year 2000 with current environmental commitments were also assumed to remain constant at 1987 levels.

CFCs:

EPA emissions estimates for 1987, 2000 (without current commitments), and 2000 with current commitments were obtained from EPA's Office of Air and Radiation (OAR). OAR estimates assumed that new production of CFCs declines over time, the stock of CFCs rises, and the number of CFC substitutes increases.

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THE WHITE HOUSE  
WASHINGTON

February 26, 1990

MEMORANDUM FOR JOHN H. SUNUNU

FROM: D. ALLAN BROMLEY *Acw*  
SUBJECT: PROPOSED LETTER TO EDITOR

Herewith a rough draft of a letter that I would propose sending to a relatively long list of editors in response to the recent spate of negative editorials concerning the Bush Administration's response to environmental issues.

Any suggestions concerning changes or additions that would strengthen the letter would be much appreciated.

Thank you.

# DRAFT

To the Editor:

Recent claims which portray President Bush as any less than a leader committed to protecting the environment are totally unfounded. During his first year in office, the President has taken significant steps to address environmental concerns as vital global issues.

The President's FY 1991 budget proposes over \$2 billion in new spending to protect the environment and over \$1 billion for global change research. This is ten times as much as any other nation in the world is spending to protect the environment. In addition:

- o By elevating the Environmental Protection Agency to Cabinet level the President communicates his unmistakable concern for environmental problem areas such as clean air, clean water and hazardous waste.
- o The Bush Administration is strongly dedicated to achieving the goal of "no net loss" of our nation's wetlands.
- o The President's "America the Beautiful" initiative will expand federal parkland, wildlife refuges, forests and other public lands, and establish a new reforestation program that calls for the planting of more than one billion new trees a year.
- o The Bush Administration is committed to the phase-out of both production and use of chloro-fluorocarbons that constitute 25 percent of U.S. greenhouse gas emission before 2000 -- ahead of the requirements of the Montreal Protocol.
- o The President has instructed his Secretary of Energy, Admiral James Watkins to develop a new National Energy Strategy that focusses on aggressive energy conservation and the development of alternatives to fossil fuel combustion -- both resulting in reduced carbon dioxide emission.
- o In April, 1990 the President will host his first White House Conference. The topic will be Science and Economics Research Relating to Global Change. This conference will support the ongoing work of the UN-sponsored Intergovernmental Panel on Climate Change (IPCC) and the President's strong conviction that US policies in this area must be based on sound science and sound economics.
- o At Malta in December 1989, and in an address to the IPCC plenary meeting in Washington last week, the President invited the nations of the world to hold the first negotiating session for the Framework Convention on Global Change in Washington in late 1990 or early 1991 following completion of the first phase of the IPCC activities.

Finally, the President supports enactment of tough new Clean Air requirements to reduce acid rain, urban smog and air pollution in a cost effective manner. Enactment of this legislation is one of the President's chief legislative priorities for the year.

Sincerely,

**D. Allan Bromley**  
Assistant to the President  
for  
Science and Technology

THE WHITE HOUSE  
WASHINGTON

DATE: February 13, 1990

TO: Dr. Allan Bromley

FROM: GOVERNOR JOHN H. SUNUNU

What is your recommendation?

The idea is a good one if it can be kept within bounds and does not seem as too much of a precedent

however - with Tim Wirth et al. on a visit to Brazil last year, I believe originated the debt for nature swap concept that has attraction features.

You know very little about this subject but AD and the Forest Service seem like the appropriate folks to ask to look into this further.  
Allan.



SMITHSONIAN INSTITUTION

*Washington, D.C. 20560*  
*U.S.A.*

February 9, 1990

Honorable John H. Sununu  
Chief of Staff  
The White House  
Washington, DC 20500

Dear John:

Enclosed please find a copy of my letter to the Vice President as you suggested.

Please note that in addition to the Amazon project it includes a modest project for Czechoslovakia. Martin Harwit who directs the National Air and Space Museum (and is Czech born) had a visit recently from Ivan Havel, brother of President Havel, who himself will be visiting Washington shortly. This would seem a good little project that the United States could do to help with the massive environmental problems that country is facing.

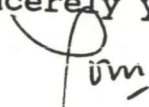
During the break at Camp David, I mentioned to the President the collapse of nature and forest protection in Panama and he showed interest in doing something about it. This of course is a problem we are acutely aware of because of the presence of the Smithsonian Tropical Research Institute, and I enclose a document which bears on it. (The Institute itself has similar immediate problems but we are working directly with OMB on them). I am told indirectly that EPA is approaching the Forest Service and AID with a view to getting some help. Also, indirectly I learned there is some interest in this up on the hill. What occurs to me is there might be a special opportunity here to back up the immediate help with a debt for nature swap?

Hon. Sununu  
February 9, 1990  
page two

I was glad of the opportunity to talk with you at length on Saturday and look forward to working with you.

With all best wishes,

Sincerely yours,

  
Thomas E. Lovejoy  
Assistant Secretary for  
External Affairs

TEL/crt

cc: Secretary Adams  
Professor Bromley

encl. (1)

## EMERGENCY ASSISTANCE FOR PANAMA'S NATIONAL PARKS

### BACKGROUND

For two decades, Panama's military exercised unchecked political power, helping to bring about an unprecedented socio-political and economic crisis. Moreover, the embargo imposed on the Noriega regime by the American government had devastating consequences.

Widespread unemployment has unleashed a massive process of emigration of peasants towards the country's tropical forests, including national parks and reserves. Our technicians estimate that 90% of the 70,000 hectares of tropical forest that will be burned this year will be destroyed during the next three months of the dry season.

Furthermore, once these settlers are in place, it will be difficult, dangerous, and expensive to remove them. Such wholesale relocations will be both politically and economically very difficult undertakings. It will be better and less expensive to prevent colonization now than to extract the campesino settlers later.

### STATUS OF INRENARE

The Institute of Natural Renewable Resources of Panama (Instituto Nacional de Recursos Naturales Renovables) or INRENARE, has lost much of its equipment. It lacks funds to pay \$500,000 to its creditors, and is unable to purchase essential supplies critical to maintaining its field projects. In the immediate future, it is quite probable that the Institute will not receive significant funding from the central government, whose main priorities will be to provide housing for the refugees caused by the American invasion, and to generate employment in the construction and commercial sectors of the urban economy.

INRENARE has a clear conceptual framework for a long-term master plan for conserving and managing Panama's natural resources. It also is sustained by a dedicated core of technical cadres. However, the lack of even the most basic supplies prevents them from acting. For example, forest guards are only paid \$150 per month, and there are no funds for uniforms, boots, machetes, first aid kits, vehicles, boats or fuel. Given these limitations, we would like to convey to you some of our urgent short-term necessities.

### IMMEDIATE PRIORITIES

Although all national parks and reserves are in jeopardy, it is essential to give the highest priority to the following environmentally and biologically critical areas:

1. Darien National Park
2. La Amistad National Park
3. The Panama Canal Watershed.

The first two areas are Biosphere Reserves, encompassing enormous biological and cultural diversity. Both are underprotected and under severe pressure from settlers. The Canal Watershed includes the Chagres and Soberania National Parks and smaller forest reserves, whose integrity guarantees the water supply for the operations of the Panama Canal as well as to the populations of Panama City and Colon. In the future, these parks will serve as centers for environmental education and eco-tourism.

Our request for emergency funding focuses on the need to put forest rangers into the field at these three sites with minimal logistical support, and to maintain our existing network of meteorological stations, which are nearly inoperable due to years of neglect. Tree nurseries require urgent attention to permit the propagation of tree seedlings during the next few months of the dry season, so they can be planted out during the early months of the wet season. Reforestation is urgent in these priority areas to control erosion and to provide alternatives to the cutting of natural forests. A third urgent necessity is basic environmental education. Environmental education in the vicinities of the three targeted areas is critical so that local villagers will assist, rather than actively resist the efforts of our forest rangers.

EMERGENCY OPERATIONAL BUDGET: FEBRUARY-APRIL 1990

1.	Forest Rangers: uniforms, boots, machetes, etc.	\$25,000
2.	First aid kits for forest rangers	5,000
3.	Ten Pickup trucks: 4x4, double cabin	145,000
4.	Dugout canoes, outboard motors	30,000
5.	Fuel and maintenance	50,000
6.	Communications: portable radios, antennas, etc.	150,000
7.	Tree nursery program: fungicides, fertilizers, irrigation pumps, etc.	20,000
8.	Environmental education	20,000
9.	Meteorological and hydrological stations	10,000
TOTAL:		\$455,000

## PRIORITIES

Although all of the emergency budget represents vital needs, partial funding would allow us to protect some of the most critical areas. The following list establishes three priority levels for funding within the emergency budget:

### PRIORITY I:

1. Five Pick-up Trucks (Darien and Canal Watershed)	72,500
2. Fuel and maintenance	50,000
3. Forest Ranger equipment	25,000
4. First Aid kits	5,000
	<hr/>
SUBTOTAL:	152,500

### PRIORITY II:

1. Communication System	150,000
	<hr/>
SUBTOTAL:	150,000

### PRIORITY III:

1. Five Pick-up Trucks (La Amistad and other areas)	72,500
2. Canoes and motors	30,000
3. Tree nursery program	20,000
4. Environmental education	20,000
5. Meteorological and hydrological stations	10,000
	<hr/>
SUBTOTAL:	152,000

THE WHITE HOUSE  
WASHINGTON  
February 16, 1990

MEMORANDUM TO JOHN SUNUNU

FROM: D. Allan Bromley *Allan*

SUBJECT: Possible Presidential Initiative on The Provision of Technological Support to the Third World and Eastern Europe in the Area of Increased Electrical Energy Utilization Efficiency and Other Possible Environmental Protection Areas.

Some time ago I wrote you a memo suggesting that if we in the U.S. take a proactive stand here we gain in three ways:

- a) We help these countries to sustain their development while minimizing environmental damage (primarily CO<sub>2</sub> emission from coal combustion);
- b) We reap positive political fallout; and
- c) We gain access for U.S. industry to what promises to be a huge market.

If, instead, we wait until external political pressure forces us to this course, we stand to lose most of items b) and c) above.

The Departments of Energy (Henson Moore) and of Commerce (Tom Murrin) are interested and have considerable activity underway. EPA has studies underway, as well.

In my earlier memo I asked you whether you thought that, properly developed, this might constitute an attractive initiative for the President.

Technology would clearly be involved as well as seed money in many cases--but I believe that know-how will remain the most important ingredient of any such initiative.

I would welcome your comments.

THE WHITE HOUSE  
WASHINGTON

DATE: February 13, 1990

TO: Dr. Allan Bromley

FROM: GOVERNOR JOHN H. SUNUNU

Your comments, please.

Dear John:

Mino is a good guy - and  
an activist with the right  
instincts - but I am convinced  
that through a revitalized  
FECSET and the new DEAST we  
can respond to your needs and  
the President's for expert advice. I  
would not recommend further  
ad hoc advisory groups

Allan

THE WHITE HOUSE

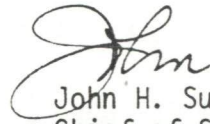
February 13, 1990

Dear Miro,

Thanks for the note.

I will be talking to Allan Bromley about your recommendation. I appreciate you taking the time to write and will follow up next time we meet.

Regards,



John H. Sununu  
Chief of Staff

THE WHITE HOUSE

WASHINGTON

Dr. Miro M. Todorovich  
410 Riverside Drive, Apt. 82A  
New York, New York 10025

bcc: Dr. Allan Bromley

MIRO M. TODOROVICH  
410 Riverside Drive, Apt. 82A  
New York, New York 10025

February 9, 1990

Dr. John H. Sununu  
Chief of Staff  
The White House  
Washington, DC 20500

Dear John:

In quick succession, the New York Times and other media noted (1) the toning down of the President's speech on global atmospheric concerns, (2) wetland's regulation relaxation, and (3) the one nuclear engineer in the White House allegedly responsible for these deeds.

While in more than full agreement with what was decided, I worry about your exposure to attack (remember Bork, etc.).

For more than a year now, I have held the belief that impeccably-crafted groups of prominent scientific experts (à la Seabrook panel) whom you would ask for council on specific issues could remove the lightning rod from above your head and guide hostile electricity to harmless neutralization.

You should be seen as a skillful executor of the best scientific/economic understanding held by competent people -- not portrayed as a capricious individual imposing his idiosyncratic predilections, via the President, onto a docile society.

Fred and I could assemble fully believable panels in support of any scientifically defensible decision. I strongly believe that it would be politically very wise that you lean visibly on such scientific validation.

Waiting to hear your reaction.

Cordially,



Miro M. Todorovich

THE WHITE HOUSE

WASHINGTON

January 4, 1990

MEMORANDUM FOR JOHN H. SUNUNU

FROM:

MICHAEL J. BOSKIN  
D. ALLAN BROMLEY

*Michael*  
*Allan*

SUBJECT:

· CONTRIBUTIONS BY CEA AND OSTP TO THE GLOBAL WARMING ISSUE AND RESULTING BUDGET PROBLEMS

We are writing to express our concern over the mismatch between our existing resources and the prominent role the President wants CEA and OSTP to take on the global warming issue.

To undertake its role, CEA is going to need one senior staff person working on global warming on a full-time basis. Our senior staff resources are already stretched very thin, and taking away one of our few senior staffers to work on this issue will dramatically reduce our ability to work on other important economic policy matters: the forecast, trade, monetary policy, etc. The CEA has already taken on significant extra responsibilities. For example, even our very limited financial contributions to the Presidential mission to Poland and our membership on the Structural Impediments Initiative with Japan have a significant impact on our minuscule budget. The CEA travel budget is especially tight and is already more than fully accounted for (we are already relying on 501(c)(3) and on other government agencies to help us pay a significant share of our travel expenses).

OSTP is also very thin in personnel with a single staff member having the responsibility for science and technology matters relating to energy and the environment. Recently she has been spending essentially all her time in work relating to the DPC Working Group on Global Climate Change. To continue that work and take on the additional organizational responsibilities for the April science and economics research conference that we are co-chairing, OSTP will require additional staff assistance and like CEA, additional travel support. It too is currently relying on 501(c)(3) and other agencies for administrative travel costs.

To enable OSTP to proceed it has obtained the services of a liaison staff member from the U.S. Geological Service at no cost for a period of 3 months--one now past. On his departure it will be essential for OSTP to replace him for the coming year with an appropriate detailee for whom OSTP will pay 50% of the total compensation package.

It would seem easiest and most sensible to resolve these funding and personnel problems by tapping a small amount of EPA's or NASA's budget to help OSTP and CEA. In addition to some travel expenses and specific consulting expenses associated with organizing the April conference--totalling an estimated \$20,000 for both CEA and OSTP, it would be especially helpful to CEA if funding could be provided for one senior personnel slot for CEA as soon as possible (estimated cost roughly \$75,000) and to OSTP if similar funding could be provided to cover 50% of a similar salary.

We would thus request your help in making available about \$132,500 to enable us to proceed effectively to implement the President's immediate global change program.

We shall much appreciate your help.

*file*

THE WHITE HOUSE  
WASHINGTON

December 6, 1990

MEMORANDUM FOR GOVERNOR SUNUNU

FROM: D. ALLAN BROMLEY

SUBJECT: EPA Report on Electromagnetic Field Carcinogenicity

This is to inform you of the status of the extremely low frequency radiation (ELF) issue.

Attached is a copy of a newsletter with a story based on leaks by EPA staff. EPA seems to be looking for someone else to take the heat for their poorly drafted, controversial report. We advised EPA that we were very concerned that their actions in leaking this information undermined their credibility and showed a lack of good faith in their dealings, as they had asked to brief us on November 26. EPA management has been more cooperative than this article would suggest and they informed us that they would take responsibility for not releasing the report. Nevertheless, the attached article actually looks good for us.

After consultations with a number of Federal agencies, EPA has indicated that they are willing to change the misleading conclusions in their executive summary. There have been many trade press reporter inquiries, however we have no indication of any major newspaper interest at this time. We will keep you advised on this issue as it develops.

THE WHITE HOUSE  
WASHINGTON

December 19, 1990

MEMORANDUM FOR JOHN H. SUNUNU

FROM:

D. ALLAN BROMLEY *Ala*  
EDE HOLIDAY *JK*

SUBJECT:

NEGOTIATOR FOR FRAMEWORK GLOBAL CLIMATE  
CHANGE CONVENTION

At a meeting in your office in August to review the Fall agenda in the global climate change area, we discussed the issue of the appropriate level of negotiator for the framework convention deliberations that were then expected to begin early in 1991. Several options were presented, but it was decided to defer any final decision on the issue until closer to the actual negotiations.

With the negotiations set to begin on February 4 in nearby Chantilly, Virginia, a decision is now timely. State has recommended and is prepared to proceed with the designation of Curtis "Buff" Bohlen, Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs (OES), as chairman of the U.S. delegation. Bob Reinstein, the Deputy Assistant Secretary for OES, would be designated vice-chairman of the delegation and would shoulder the principal negotiating responsibilities. You will recall that Bohlen and Reinstein are the respective successors to Fred Bernthal and Bill Nitze. Bohlen has recently led delegations to the first preparatory meeting in Nairobi for the 1992 Brazil U.N. Conference on Environment and Development and to meetings in Chile on protection of Antarctica's environment. Reinstein did most of the negotiating that led up to the ministerial portion of the Second World Climate Conference (SWCC), when Dr. John Knauss from the National Oceanic and Atmospheric Administration stepped in, and generally has been given significant credit for the reasonable ministerial declaration that ultimately emerged. The recommendation of State for the designation of Bohlen and Reinstein has received Bob Zoellick's attention and approval.

Alternatives to the designation of Bohlen and Reinstein do exist:

A senior official from elsewhere within the federal government could be designated. This individual would conduct the negotiations with technical support from State and the other appropriate federal agencies. One possible candidate for this role would be Dr. Knauss, who has experience in global climate change issues from his role at the SWCC and at the Bergen Conference earlier this year and who performed quite capably in both of those fora.

Bohlen and another senior government official could be designated as the co-chairs of the delegation and share the negotiating responsibility. This would ensure that a State Department official is tasked with overseeing the technical aspects of preparations and the work that must be performed between negotiating sessions. The naming of a co-chair might give emphasis to other aspects of the issue, such as science or economics.

An individual from outside the government could be designated and given special ambassador or similar rank. This individual would be supported by State and the other agencies or a separate office and staff could be established (or some combination of the two pursued). No names immediately come to mind, and it may be difficult to recruit someone to assume this role so close to the framework convention meeting and to obtain the needed eighteen-month commitment (the time it is anticipated it would take before a framework convention is signed).

State notes that the designation of Bohlen and Reinstein is consistent with the traditional approach of the department to international environmental negotiations since they hold positions comparable to the designated representatives from other countries. State argues that the designation of a more senior government official or an individual from outside the government would only heighten expectations and add extra pressure on the U.S., raise the overall visibility of the negotiations and--especially if someone from the government were brought in--more closely tie the White House to the process.

State has not advised of any critical date by which the designation must be made and an announcement through cables made. We have requested that no action be taken pending review of the question by the White House.

Our recommendation would be to accept the State Department offer to designate Bohlen and Reinstein, as outlined above.

We also request that you focus on the possibility of designating a special ambassador for the 1992 U. N. Conference on Environment and Development in Brazil, at your earliest convenience.

We would appreciate your thoughts on how we should proceed.

THE WHITE HOUSE

WASHINGTON

December 20, 1990

MEMORANDUM FOR GOVERNOR SUNUNU

FROM: D. ALLAN BROMLEY 

SUBJECT: THE 1992 BRAZILIAN CONVENTION ON  
THE ENVIRONMENT

In 1992 world attention will focus on Brazil as the host of a major conference on the global environment. This conference is one of a continuing series that included the 1972 Stockholm Conference and will address a very broad spectrum of environmental issues.

For the 1972 conference, the U.S. government appointed Senator Howard Baker as Special Ambassador and gave him a staff and the charge of developing U.S. positions for the Conference. He was appointed some eighteen months prior to the conference and reportedly felt that more lead time would have enabled him to do a much better job for the U.S.

Due to the growing interest in the issues, the scope and visibility of the 1992 Brazilian Conference will be very much higher than was the case in 1972.

Because of the importance of the 1992 Conference, the Carnegie Commission sent the enclosed letter urging that we take action as soon as possible to ensure appropriate U.S. participation in the Brazilian Conference. Timely action would support President Bush's commitment to global stewardship and environmental issues generally.

You, I am sure, will have people in mind as attractive candidates for this responsibility and I would only add the following as names that you might wish to include in your considerations:

- a) Robert White, President, National Academy of Engineering  
Superbly qualified if he could be convinced to take this on.
- b) Joshua Lederberg, President-emeritus, Rockefeller University  
Nobel laureate and co-chairman of the Carnegie Commission. Highly visible and no zealot.
- c) James G. Martin, Governor of North Carolina. Holds a chemistry Ph.D. and is someone for whom I have developed a very high regard. Unfortunately, as a setting governor he probably would not have the time needed or this job.

d) Howard Baker. Everyone agreed that he did a fine job in 1972. He is still vigorous and would certainly be able to hit the ground running. place

I believe that it is important that we act in a timely fashion to get our preparations underway. I was impressed, for example, by the extent to which the South American nations visited by the President two weeks ago already have in place extensive preparatory activities, and I am told the same is true of the major European countries and Japan.

Enclosure

# CARNEGIE COMMISSION ON SCIENCE, TECHNOLOGY, AND GOVERNMENT

10 Waverly Place, New York, N.Y. 10003 (212) 998-2150 FAX (212) 995-3181

6 July 1990

The Honorable D. Allan Bromley  
Assistant to the President for Science and Technology  
The White House  
Washington, D.C. 20506

Dear Allan,

As you are aware, the Carnegie Commission on Science, Technology, and Government was established in 1988 to seek ways in which the branches of the U.S. government can encourage and better use the contributions of the nation's scientists and engineers.

In early June the Commission convened a workshop to examine "International Environmental Organizations: The Science and Technology Dimensions." This meeting was designed to study, in depth, the institutional issues raised at the recent "White House Conference on Science and Economics Related to Global Change."

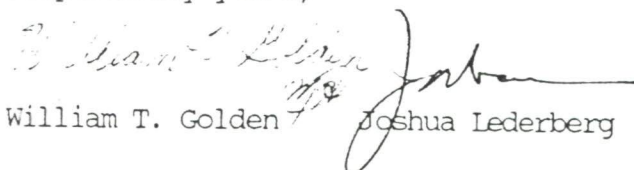
Workshop participants took particular note of the June 1992 United Nations ministerial Conference on Environment and Development to be held in Brazil. As a result, the co-chairs of the workshop have prepared a letter, attached here, which recommends three near-term actions by the U.S. government. These are:

- 1) appointment of a Special Ambassador for the 1992 Brazil Conference to oversee the complex U.S. efforts required to be successful at the meeting;
- 2) appointment of a Presidential Commission (or comparable body) for the Conference to synthesize data and concepts for the U.S. position; and
- 3) appointment of a Public Advisory Committee to the Special Ambassador to enhance dialogue among industry, universities, and citizens with the government on issues relating to the Conference.

The workshop participants believe that such actions could greatly facilitate the process of analysis and consultation needed to organize a unified U.S. position for this important meeting and to relay recommendations to the President for consideration. We understand that the Office of Science and Technology Policy is working with the Council on Environmental Quality, the Department of State, and other agencies in the preliminary preparation for Brazil. Thus, we bring the suggested actions to your attention. If the Workshop participants are correct, it would be desirable to take actions, in concert with the Congress, before the end of 1990, so that the mechanisms can be most effective.

Our Carnegie group would be pleased to meet with you and other officials to share detailed views relating to this matter.

Respectfully yours,

  
William T. Golden / Joshua Lederberg

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Co-Chair  
JOSHUA LEDERBERG  
Co-Chair  
DAVID Z. ROBINSON  
Executive Director  
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10 JUL 20 1990

CARNEGIE COMMISSION ON SCIENCE, TECHNOLOGY, AND GOVERNMENT

6 July 1990

Mr. William T. Golden  
Dr. Joshua Lederberg  
Co-Chairmen, Carnegie Commission  
on Science, Technology, and Government  
10 Waverly Place  
New York NY 10003

Dear Bill and Josh,

As co-chairmen of the meeting, we are pleased to report a successful Workshop of the Carnegie Commission on the subject of "International Environmental Organization: The Science & Technology Dimensions" at The Rockefeller University, June 4-6, 1990. The detailed findings of the Workshop will be conveyed to you later this summer.

During the course of our discussions, an important issue emerged that calls for early consideration. Our attention was drawn to the UN Conference on Environment and Development to be held in Brazil in June, 1992. Major recent studies have provided convincing evidence that the linkage between environment and development is now so compelling that the two very complex and important topics often need to be considered together. Decisions of lasting significance with regard to international institutions and decision-making processes bearing on both the quality of the global environment and the strategies for economic growth could be made in connection with the Conference.

The UN has appointed an outstanding Secretary General, Maurice Strong of Canada, for the Conference and established a Preparatory Committee to develop the agenda and supporting papers. A demanding schedule of international and regional meetings has been set by the Preparatory Committee for the next two years. Several scientific organizations in the United States (for example, the American Association for the Advancement of Science, American Association of Engineering Societies, Social Science Research Council, Consortium of Social Science Associations, the Council of Scientific Society Presidents, and Sigma Xi) have banded together to elicit and integrate the views of the scientific community in this country on these issues. There has been a call from the recent ministerial-level conference in Bergen, Norway, supported by influential scientists from many nations, for a "Science Summit" on environment and development that would be held only a few months before the 1992 Brazil Conference.

Our Workshop members agreed that it is a matter of prime importance that the United States be well prepared for the Brazil Conference. Several of the attendees were involved in similar preparatory work for other UN conferences, such as that on the Environment held in Stockholm in June, 1972, and on Science and Technology for Development held in Vienna during

August 1979. The strong and persuasive national position developed by the United States was a factor in the success at Stockholm. An experienced delegation coped well with the contentious problems faced in Vienna. Our Workshop participants were unanimous in the conviction that lessons from the past show that more activity in regard to the Brazil Conference is desirable, both within the government and in its interactions with the outside community. Several actions should be considered, as a matter of urgency, to assure a dynamic and creative participation by our country. We recommend the following:

1) The President should appoint a Special Ambassador to work with the Secretary of State and other high level officials to oversee policy planning and development of a unified U.S. government position for the Conference on Environment and Development. This Special Ambassador should be provided with adequate funds and staff to support careful preparation of papers outlining options for the U.S. position. To be effective, the initial papers should be in hand no later than 1 September 1991. Accordingly, the Ambassador should be appointed by the fall of 1990, this year.

2) The President and the Congress should establish a Presidential Commission (or comparable body) on the UN 1992 Conference on Environment and Development to provide and help synthesize a wide range of data and views from governmental and nongovernmental sources in order to assist the State Department and other federal agencies involved in the planning process. To assure an appropriate diversity of perspectives, the President and Congress should appoint individuals from the Congress, the Executive Branch, industry, labor, environmental organizations, the scientific and engineering community, and other professionally expert and concerned groups to serve on the Commission. Selected members of the Commission would later serve as members of the U.S. delegation to the Conference and would thus be well-prepared to represent the U.S. position. For the 1972 Stockholm Conference, Senator Howard H. Baker, Jr. of Tennessee served as chairman of the comparable advisory group. Having a distinguished and knowledgeable sitting member of the Congress lead the group worked exceptionally well.

3) The Secretary of State in consultation with appropriate federal officials<sup>1</sup> should appoint a larger Public Advisory Committee to work with the Ambassador in preparing for the Conference. The Committee would serve to assure broad public dialogue in the U.S., through regional conferences and other means, on the issues the Conference will address.

\* \* \* \* \*

<sup>1</sup> These include the Assistant to the President for Science and Technology, the Chairs of the Councils of Economic Advisors and Environmental Quality, the Secretary of Energy, the Secretary of the Treasury, the Administrator of the Environmental Protection Agency, the Administrator of the Agency for International Development, the Under Secretary of Commerce for Oceans and Atmosphere, and the Director of the National Science Foundation.

CARNEGIE COMMISSION ON SCIENCE, TECHNOLOGY, AND GOVERNMENT

We urge you to bring these considered recommendations to the attention of the President, key White House officials, the Secretary of State, and such other individuals in the executive and legislative branches whom you feel must be informed now. We note that the steps recommended are ones that traditionally have been taken by the U.S. government in preparing itself for world conferences of major potential significance, such as the 1972 Stockholm Conference and the 1979 Vienna Conference.

As agreed at the Workshop, this letter has been prepared in consultation with Harvey Brooks, Rodney W. Nichols, Walter A. Rosenblith, and H. Guyford Stever, members of the Commission and its international steering group who participated in the Workshop, and has their full agreement. A list of all the Workshop participants is attached.

We join in commending you for your initiative in bringing the participants of our Workshop together and look forward to discussing with you our conclusions on a range of issues during the months ahead.

Sincerely yours,



Jesse H. Ausubel



Thomas F. Malone

cc. Workshop participants

"International Environmental Organization: The S&T Dimensions"  
Workshop, The Rockefeller University, New York, NY  
June 4-6, 1990

Participants:

John F. Ahearne, Sigma Xi  
Jesse H. Ausubel, Carnegie Commission on Science, Technology, and Government  
D. James Baker, Joint Oceanographic Institutions  
Richard E. Benedick, World Wildlife Fund/ The Conservation Foundation  
Harvey Brooks, John F. Kennedy School of Government, Harvard University  
William C. Clark, John F. Kennedy School of Government, Harvard University  
Richard E. Hallgren, American Meteorological Society  
Philip W. Hemily, National Research Council  
John A. Knauss, National Oceanic and Atmospheric Administration  
J. W. M. La Riviere, Institute for Hydraulic & Environmental Engineering, Netherlands  
Jeffrey Laurenti, UN Association of America  
James R. Mahoney, National Acid Precipitation Assessment Program  
Thomas F. Malone, St. Joseph's College  
Rodney W. Nichols, The Rockefeller University  
William A. Nitze, Environmental Law Institute  
John S. Perry, National Research Council  
Peter H. Raven, Missouri Botanical Garden  
Walter A. Rosenblith, Massachusetts Institute of Technology  
H. Guyford Stever, Carnegie Commission on Science, Technology & Government  
Peter S. Thacher, World Resources Institute  
Mary Martha Treichel, National Research Council  
Gilbert F. White, University of Colorado  
Robert M. White, National Academy of Engineering  
Anne V.T. Whyte, International Development Research Centre, Canada

THE WHITE HOUSE

WASHINGTON

July 12, 1990

MEMORANDUM FOR JOHN H. SUNUNU

FROM:

D. ALLAN BROMLEY 

SUBJECT:

FORTHCOMING IPCC PLENARY SESSION IN SWEDEN

As you know, the final plenary session in the first round of activities of the IPCC is scheduled to take place in Sweden in early August. This memorandum is intended as a heads up concerning aspects of U.S. participation in that meeting.

Fred Bernthal, as Deputy Director of NSF, recognizes that the meeting coincides with Erich Bloch's last week on the job as Director of NSF and feels that he should be in place at NSF. In my discussions with him, however, he has agreed that if it is felt that his services are required in Sweden, he would be reluctantly willing to go and perform his swan song as Chairman of Working Group #3. I believe that it is important that he be present because otherwise we will have very little continuity with the discussions that have led up to this final meeting and very little effective input toward affecting the report that emerges from it. In his absence, also, we in the U.S. will have little chance of holding the chairmanship of this Working Group.

John Knauss, the Director of NOAA, called me to volunteer to head up the U.S. Delegation to the Swedish meeting but in order to make plans for the latter part of the summer, he requests that he be told as soon as possible whether he should plan on attending. Here again I think it is important for John to attend because he brings an extensive technical background to the discussions and in that role can complement Bernthal.

Finally, Bill Reilly has urged that Buff Bohlen, who has now been confirmed as Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs, be named as Bernthal's replacement as Chairman of Working Group #3, if, as seems probable, that Working Group and the entire IPCC structure continues to function after the forthcoming plenary. Unfortunately, although Bohlen has extensive experience in other aspects of international environmental matters, he has had very little contact thus far with the global climate change question and in particular, has had no contact whatsoever with the detailed IPCC discussions.

My recommendation to you would be that Bernthal, Knauss, and Bohlen should all attend this IPCC plenary; Bernthal, to wind up his activities and make sure that U.S. views are properly represented in the closing discussions leading to the final IPCC report; John Knauss, because of his technical competence and because I believe that he would be the logical replacement for Bernthal as Chairman of Working Group #3 if it continues and if, indeed, the U.S. is allowed to retain its chairmanship-- something that is far from certain at this point. Finally, Buff Bohlen, to give him an opportunity to become acquainted with some of the issues, meet some of the people and become sensitized to some of the very important political undercurrents that are conditioning activities in the global change area.

I would have some concern about naming Bohlen to the working group chairmanship if we are given the opportunity to name the chairman at least until he has had considerably more exposure to this whole international area, but I am quite prepared to admit that, after some decent interval and with such exposure, he might well be an appropriate person to replace John Knauss, if such replacement were deemed desirable. Knauss is not an accomplished chairman although a great scientist and I am told that Bohlen has demonstrated very real ability in running meetings--both national and internationally--very effectively.

Finally, I would welcome an opportunity, at your convenience, to discuss with you what role you see in the future for the DPC Working Group on Global Climate Change.

THE WHITE HOUSE

WASHINGTON

October 12, 1990

*file*

MEMORANDUM FOR GOVERNOR SUNUNU

FROM: D. ALLAN BROMLEY *DA*

SUBJECT: Global Change Research Act

ISSUE

The House and Senate science committees are working on a compromise bill entitled "The Global Change Research Act of 1990". Several provisions are unacceptable to the Administration. If Congress does intend to move the legislation, it may be necessary to attempt to change these provisions.

BACKGROUND

The legislation would codify activities of an existing environmental scientific and research subgroup of the Federal Coordinating Council on Science, Engineering and Technology (FCCSET) and codify the FCCSET Council itself with language similar to the current executive order under which FCCSET operates.

The FCCSET environmental subgroup coordinates the U.S. global change research program, assists OMB in budget cross-cuts, and publishes materials describing the research program. No new funding is requested in the legislation. This is precedent setting legislation as it may serve as the model for codification of other FCCSET subgroups. The legislation may move due to Congressional interest in being associated with an environmental or global change bill.

The House bill, H.R. 2984, was reported out of the Science Committee in early August and is being negotiated with Merchant, Marine and Fisheries and Foreign Affairs Committees, to which it was jointly referred. Other problems in the legislation include:

- o Several sections that undercut the President's authority (eg. requiring the Administration to make available to Congress budget materials prior to the annual transmission of the budget to Congress).
- o Restricting the flexibility to choose the chairperson of the subgroup and requiring approval by the subgroup of activities currently not within their authority.
- o A "National Remote Sensing Advisory Committee" to make recommendations on the Landsat program, which is objectionable to the Space Council and NSC.

The Senate version (S. 169) passed on a roll call vote, 100 to 0. As passed, it is less intrusive of executive authority and does not contain the National Remote Sensing Advisory Committee. However, the House and Senate majority staff are caucusing over the legislation in an attempt to strike a pre-conference deal. House minority staff report that the legislation could come up on the suspension calendar early next week.

Due to serious concerns expressed about this legislation, the limited involvement of the Administration in the Senate version, the advanced stage of the process on the Hill, and the prospect of an imminent House vote, the threshold question is whether this legislation can be vetoed. The options are: 1) outright veto, 2) pocket veto, 3) oppose the bill, but work to change the legislation and sign the bill, with a signing statement to clarify the Administration's position. After discussions with House minority staff, OMB, and affected agency staff, it is the general consensus that the legislation will probably pass the House. Unless there is a strong reason to veto, it is our recommendation to work with the Hill to try and correct the most onerous sections of this legislation. We understand that the House Science Committee majority staff are willing to make changes, but they are trying to get the legislation to the floor very soon.

Attached at Tab A is a recent draft of the legislation, as it was being negotiated between the House and Senate earlier this week. Also attached, at Tab B, is a copy of S. 169, as passed by the Senate. Finally, Tab C has a May 18, 1990 letter to the House Science Committee stating Administration objections to H.R. 2984. This will form the basis of our discussions with the Hill.

#### RECOMMENDATION

We are working with OMB, Counsel's office, NSC, Space Council staff, and other White House and Federal agency officials on the FCCSET environment subgroup. Unless you have objections, we will continue to work with these offices and approach the Hill to try and negotiate a better bill.

Approve \_\_\_\_\_ Disapprove \_\_\_\_\_ Further Discussion \_\_\_\_\_

Attachments

THE WHITE HOUSE  
WASHINGTON

November 5, 1990

MEMORANDUM FOR GOVERNOR SUNUNU

FROM: D. ALLAN BROMLEY  
SUBJECT: Second World Climate Conference

A preparatory committee completed the latest draft ministerial declaration today. Throughout the discussions the U.S. took a positive tone, while being tough on the issues. Many nations, including the European countries, indicated that they did not want to isolate the U.S.. This is reflected in the substantial revisions and additional language in the final draft that address U.S. concerns.

Attached is a copy of the current draft declaration (Tab A) and a statement from the scientific and technical session that took place from October 29 to November 2 (Tab B). The next session is the November 6 to 7 "ministerial" meeting.

The draft ministerial declaration produced in Geneva in September was used as the basis for changes. The U.S. prepared, alternative draft was circulated along with different alternative drafts from the Saudis, Latin Americans, and Norwegians. Although the U.S. draft was not adopted as the vehicle for changes, it was cited as a good example of language that is more ministerial in tone and content. As a result, much of the technical language in the September draft was dropped and agreements were reached on language which largely satisfies concerns of the U.S. delegation. Some bracketed language troublesome to the U.S. remains, but this is expected to be resolved in the next two days.

The U.S. delegation was successful in some specific areas.

PARAGRAPH 7. The precautionary principle, which requires action irrespective of the level of scientific uncertainty, presented some of the most contentious language. It was essential that the U.S. change the language or it would have been impossible to sign the declaration. The section addressing the precautionary principle has been revised to provide for "cost-effective measures" in the face of scientific uncertainty.

Some specific problems remain in the draft ministerial declaration.

PARAGRAPH 12. The draft contains bracketed language listing the European countries and their concerted "regional" plan to take action on targets and timetables. This isolates the U.S. The Europeans worked hard for this language. In exchange, the U.S. included language in the same paragraph to "acknowledge the initiatives of the United States which will have significant effects on limiting emissions of greenhouse gases." The

U.S. language will be used as a bargaining chip to remove the European community language. Other language in the paragraph reflects points won by the U.S. in negotiations.

PARAGRAPH 15. Language concerning financial resources for developing countries is as follows: "we recommend that adequate and additional financial resources should be mobilized. . ." leaving the process, criteria and characteristics of the resources broad enough that it should not be a problem. However, this is one area which should be monitored through the end of the conference.

PARAGRAPH 21. Bracketed language focuses on reductions in energy-related CO<sub>2</sub> emissions, and could serve to steer away from our efforts to develop the comprehensive approach; however, paragraph 14 appears to counterbalance this CO<sub>2</sub> focus, recommending that "all greenhouse gases, sources and sinks be considered in the most comprehensive manner possible."

PARAGRAPH 28. Bracketed language includes the consideration of the "feasibility of forestry options" as part of the scope of global framework negotiations. The President made a commitment in the Houston G-7 Summit to have a Forestry Convention by 1992. There is a consensus within the Administration that the forestry issue should be put on a different track or it will get bogged down in the climate negotiations, which could extend beyond 1992.

Other issues need to be monitored.

Other paragraphs containing specific U.S. interests that need to be monitored, but which are acceptable at this point, include:

1. Uncertainty issue: Paragraphs 2, 5, 6, and 8.
2. Economics: Paragraph 20.
3. Targets and timetables: Paragraphs 10, 11, 12, and 13.

5 November 1990

## DRAFT

## DRAFT MINISTERIAL DECLARATION

## PREAMBLE

1. We, the Ministers from countries representing the world community met in Geneva, Switzerland, from 6 to 7 November 1990 at the Second World Climate Conference.
2. We note that while climate has varied in the past and there is still a large degree of scientific uncertainty, the rate of climate change predicted by the Intergovernmental Panel on Climate Change (IPCC) to occur over the next century is unprecedented. This is due mainly to the continuing accumulation of greenhouse gases, resulting from a host of human activities since the industrial revolution, hitherto particularly in developed countries. The potential impact of such climate change could pose an environmental threat of an up to now unknown magnitude; and could jeopardize the social and economic development of some areas. It could even threaten survival in some small island States and in low-lying coastal, arid and semi-arid areas.
3. We appreciate the work of the World Climate Programme (WCP) during the past decade which has improved understanding of the causes, processes and effects of climate and climate change. We also congratulate the IPCC, established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) on its First Assessment Report on Climate Change. It has identified causes and possible effects and strategies to limit and adapt to climate change, and in the light of the United Nations General Assembly resolutions, has identified possible elements for inclusion in a framework convention on climate change.
4. Recognizing climate change as a common concern of mankind, we commit ourselves and intend to take active and constructive steps in a global response, without prejudice to sovereignty of States.

## I. GLOBAL STRATEGY

5. Recognizing that climate change is a global problem of unique character and taking into account the remaining uncertainties in the field of science, economics and response options, we consider that a global response, while ensuring sustainable development <sup>(1)</sup> of all countries, must be decided and implemented without further delay based on the best available knowledge such as that resulting from the IPCC assessment. Recognizing further that the principle of equity and the common but differentiated responsibility of countries should be the basis of any global response to climate change, developed countries must take the lead. They must all commit themselves to actions to reduce their major contributions to the global net emissions and enter into and strengthen co-operation with developing countries to enable them to adequately address climate change without hindering their national development goals and objectives. Developing countries must, within the limits feasible, taking into account the problems regarding the burden of external debt and their economic circumstances, commit themselves to appropriate action in this regard. To this end, there is a need to meet the requirements of developing countries, that adequate and additional financial resources be mobilised and the best available environmentally-sound technologies be transferred expeditiously on a fair and most favourable basis.

## II. POLICY CONSIDERATIONS FOR ACTION

6. We reaffirm that, in order to reduce uncertainties, to increase our ability to predict climate and climate change on a global and regional basis, including early identification of as yet unknown climate-related issues, and to design sound response strategies, there is a need to strengthen national, regional and international research activities in climate, climate change and sea level rise. We recognize that commitments by governments are essential to sustain and strengthen the necessary research and monitoring programmes and the exchange of relevant data and information, with due respect to national sovereignty. We stress that special efforts must be directed to the areas of uncertainty as identified by the IPCC.

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(1) Statement of sustainable development as agreed at the

We maintain that there is a need to intensify research on the social and economic implications of climate change and response strategies. We commit ourselves to promoting the full participation of developing countries in these efforts. We recognize the importance of supporting the needs of the World Climate Programme, including contributions to the WMO Special Fund for Climate and Atmospheric Environmental Studies. The magnitude of the problem being addressed is such that no nation can tackle it alone and we stress the need to strengthen international cooperation. In particular, we invite the 11th Congress of the World Meteorological Organization, in the formulation of plans for the future development of the World Climate Programme, to ensure that the necessary arrangements are established in consultation with UNEP, UNESCO (and its IOC), FAO, ICSU and other relevant international organisations for effective coordination of climate and climate change related research and monitoring programmes. We urge that special attention be given to the economic and social dimensions of climate and climate change research.

7. In order to achieve sustainable development in all countries and to meet the needs of present and future generations, precautionary measures to meet the climate challenge must anticipate, prevent, attack, or minimize the causes of, and mitigate the adverse consequences of, environmental degradation that might result from climate change. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent such environmental degradation. The measures adopted should take into account different socio-economic contexts.
8. The potentially serious consequences of climate change, including the risk for survival in low-lying and other small island States and in some low-lying coastal, and arid and semi-arid areas of the world, give sufficient reasons to begin by adopting response strategies even in the face of significant uncertainties.

Such response strategies include phasing out the production and use of CFC's, efficiency improvements and conservation in energy supply and use, appropriate measures in the transport sector, sustainable forest management, afforestation schemes, developing contingency plans for dealing with climate related emergencies, proper land use planning, adequate coastal zone management, review of intensive agricultural practices and the use of [safe and] cleaner energy sources with lower or no emissions of [carbon dioxide and other] greenhouse gases, paying special attention to new and renewable sources.

Further actions should be pursued in a phased and flexible manner on the basis of medium and long-term goals and strategies and at the national, regional or global level, taking advantage of scientific advances and technological developments to meet both environmental and economic objectives.

9. We note that per capita consumption patterns in certain parts of the world along with a projected increase in world population are contributing factors in the projected increase in greenhouse gases.
10. We agree that the ultimate global objective should be to stabilize greenhouse gas concentrations at a level that would prevent dangerous anthropogenic interference with climate.
11. We stress, as a first step, the need to stabilize, while ensuring sustainable development of the world economy, emissions of greenhouse gases not controlled by the Montreal Protocol on Substances that Deplete the Ozone Layer. Contributions should be equitably differentiated according to countries' responsibilities and their level of development. In this context, we acknowledge efforts already undertaken by a number of countries to meet this goal.

12. Taking into account that the developed world is responsible for about 3/4 of all emissions of greenhouse gases, we welcome the decisions and commitments [undertaken by many developed countries and a regional economic integration organization] [undertaken by the European Community with its Member States, Australia, Austria, Canada, Finland, Japan, New Zealand, Norway, Sweden, Switzerland, and other developed countries] to take actions aimed at stabilizing their emissions of CO<sub>2</sub>, or CO<sub>2</sub> and other greenhouse gases not controlled by the Montreal Protocol, by the year 2000 in general at 1990 level, yet recognizing the differences in approach and in starting point in the formulation of the above targets. [We also acknowledge the initiatives of the United States which will have significant effects on limiting emissions of greenhouse gases.] We urge other developed countries to establish targets and/or feasible national programmes or strategies which will have significant effects on limiting emissions of [CO<sub>2</sub> and other] greenhouse gases not controlled by the Montreal Protocol.
- We acknowledge, however, that those developed countries with as yet relatively low energy consumption (measured on a per capita or other appropriate basis) which can be reasonably expected to grow, and some countries with economies in transition, may establish targets, programmes and/or strategies that accommodate socio-economic growth, while improving the energy efficiency of their economic activities.
13. We urge developed countries, before the 1992 UN Conference on Environment and Development, to analyze the feasibility of and options for, and, as appropriate in light of these analyses, to develop programmes, strategies and/or targets for a staged approach for achieving reductions of [CO<sub>2</sub> and other] greenhouse gas emissions not controlled by the Montreal Protocol, over the next two decades and beyond.
14. We recommend that in the elaboration of response strategies, over time, all greenhouse gases, sources and sinks be considered in the most comprehensive manner possible and also that limitation and adaptation measures be addressed.

15. We recognize that developing countries have as their main priority alleviating poverty and achieving social and economic development and that their net emissions must grow from their, as yet, relatively low energy consumption to accommodate their development needs. Narrowing the gap between the developed and the developing world would provide a basis for a full partnership of all nations and would assist the developing countries in dealing with the climate change issue. To enable developing countries to meet incremental costs required to take the necessary measures to address climate change and sea-level rise, consistent with their development needs, we recommend that adequate and additional financial resources should be mobilized and best available environmentally sound technologies transferred expeditiously on a fair and most favourable basis. Developing countries also should, within the limits feasible, take action in this regard.
16. The specific difficulties of those countries, particularly developing countries, whose economies are highly dependent on fossil fuel production and exportation, as a consequence of action taken on limiting greenhouse gas emissions, should be taken into account.
17. We recommend that consideration should be given to the need for funding facilities, including the proposed World Bank/UNEP/UNDP Global Environmental Facility, a clearing house mechanism and a new possible international fund composed of adequate additional and timely financial resources and institutional arrangements for developing countries; taking into account existing multilateral and bilateral mechanisms and approaches. Such funding should be related to the implementation of the framework convention on climate change and any other related instruments that might be agreed upon. In the meantime, developed countries are urged to cooperate with developing countries to support immediate action in addressing climate change including sea-level rise without imposing any new conditionality on developing countries.
18. We recommend further that resources be assessed. Such assessments, to be conducted as soon as possible, should include country studies and mechanisms to meet the financing needs identified, taking note of the approaches developed under the Montreal Protocol.

19. Financial resources channelled to developing countries should, inter alia, be directed to:
- (i) Promoting efficient use of energy, development of lower and non-greenhouse gas emitting energy technologies and paying special attention to safe and clean new and renewable sources of energy;
  - (ii) Arranging expeditious transfer of the best available environmentally sound technology on a fair and most favourable basis to developing countries and promoting rapid development of such technology in these countries;
  - (iii) Co-operating with developing countries to enable their full participation in international meetings on climate change;
  - (iv) Enhancing atmospheric, oceanic and terrestrial observational networks, particularly in developing countries, to facilitate conducting research, monitoring and assessment of climate change and the impact on those countries;
  - (v) Rational forest management practices and agricultural techniques which reduce greenhouse gas emissions;
  - (vi) Enhancing the capacity of developing countries to develop programs to address climate change, including research and development activities and public awareness and education.

Funding should also be directed to the creation of regional centres to organize information networks on climate change in developing countries.

20. Appropriate economic instruments may offer the potential for achieving environmental improvements in a cost-effective manner. The adoption of any form of economic or regulatory measures would require careful and substantive analyses. We recommend that relevant policies make use of economic instruments appropriate to each country's socio-economic conditions in conjunction with a balanced mix of regulatory approaches.

21. We note that energy production and use account for nearly half of the enhanced radiative forcing resulting from human activities and is projected to increase substantially in the absence of appropriate response actions. We recognize the promotion of energy efficiency as the most cost-effective immediate measure, in many countries, for reducing energy-related emissions of greenhouse gases, [in particular CO<sub>2</sub>] while other [safe] options such as no or lower greenhouse gas emitting energy sources should also be pursued. These principles apply to all energy sectors. Transport energy use attracts special attention of many of us in the light of its role in many developed countries and of its expected importance in many developing countries.
22. We recognize that there is no single quick-fix technological option for limiting greenhouse gas emissions. However, we are convinced that technological innovation as well as individual and social behaviour and institutional adaptations is a key element of any long-term strategy that deals with climate change in a way that meets the goal of sustainable development. Therefore, we urge all countries, the developed countries in particular, to intensify their efforts and international cooperation in technological research, development and dissemination of appropriate and environmentally sound technologies, including the reassessment and improvement of existing technologies and the introduction of new technologies.
23. We urge that environmentally sound and safe technologies be utilized by all sectors in all countries to the fullest extent possible and further urge all countries, developed and developing, to identify and take effective measures to remove barriers to the dissemination of such technologies. To this end, the best available environmentally sound and safe technologies should be transferred to developing countries expeditiously on a fair and most favourable basis.

24. We note that the conservation of the world's forests in their role as reservoirs of carbon along with other measures are of considerable importance for global climatic stability, keeping in mind the important role of forests in the conservation of biological diversity and the protection of soil stability and of the hydrological system. We recognize the need to reduce the rate of deforestation in consonance with the objective of sustained yield development and to enhance the potential of the world's forests through improved management of existing forests and through vigorous programmes of reforestation and afforestation, and to support financially the developing countries in this regard through enhanced and well-coordinated international cooperation including strengthening Tropical Forest Action Plan (TFAP) and International Tropical Timber Organization (ITTO). We recommend that the protection and management of boreal, temperate, sub-tropical and tropical forest ecosystems must be well-coordinated and preferably compatible with other possible types of action related to reduction of emission of greenhouse gases, rational utilisation of biological resources, provision of financial resources, and the need for more favourable market conditions for timber and timber products. The developing countries should be able to realize increased revenue from these forests and forest products.

25. We also recognize that forests and forest products play a key social and economic role in many nations and communities. We recognize that States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.

26. We recommend that appropriate precautionary and control measures be developed and implemented at regional, sub-regional and country levels as appropriate to counter the increasing degradation of land, water, genetic and other productive resource bases by drought, desertification and land degradation.

Observatories on climate and climate change and observatories on ecosystems should be encouraged to work together on drought risks consequences.

Studies must be undertaken on drought and desertification.

We stress that stepped-up financial and scientific contributions be provided to facilitate these efforts.

27. We recommend that similar measures be adopted to address the particular problems and needs, including funding, of low-lying coastal and small vulnerable island countries, some of whose very existence is placed at risk by the consequences of climate change.

### III. GLOBAL FRAMEWORK CONVENTION ON CLIMATE CHANGE

28. We call for negotiations on a framework convention on climate change to begin without delay after a decision is taken by the 45th Session of the General Assembly of the United Nations recommending ways, means and modalities for further pursuing these negotiations. Taking note of all the preparatory work, particularly the recommendations adopted 26 September 1990 by the Ad hoc working group of government representatives and regional economic integration organizations to prepare for negotiations on a framework convention on climate change, we urge all countries and regional economic integration organizations to join in these negotiations and recognize that it is highly desirable that an effective framework convention on climate change, containing appropriate commitments, and any related instruments as might be agreed upon on the basis of consensus, be signed in Rio de Janeiro during the United Nations Conference on Environment and Development. We welcome the offer of the Government of the United States of America to host the first negotiating meeting. [We also welcome the invitations of Thailand and Italy to host workshops, respectively on the feasibility of forestry options, and on energy technologies and their transfer to developing countries.]

29. We recommend that such negotiations take account of the possible elements compiled by the IPCC, and that the framework convention on climate change be framed in such a way as to gain the support of the largest possible number of countries while allowing timely action to be taken. We reaffirm our wish that this convention contain real commitments by the international community. We stress, given the complex and multi-faceted nature of the problem of climate change, the need for new and innovative solutions including the need to meet the special needs of developing countries.
30. We believe that a well-informed public is essential for addressing and coping with as complex an issue as climate change, and the resultant sea-level rise, and urge countries, in particular, to promote the active participation at the national and when appropriate, regional levels of all sectors of the population in addressing climate change issues and developing appropriate responses. We also urge relevant United Nations organizations and programmes to disseminate relevant information with a view to encouraging as wide a participation as possible.



SECOND WORLD CLIMATE CONFERENCE  
SCIENTIFIC & TECHNICAL  
PORTION

S&amp;T/SWCC/No.: 13

SECOND WORLD CLIMATE CONFERENCE

CONFERENCE STATEMENT  
SCIENTIFIC/TECHNICAL SESSIONS

FOREWORD

1. The Second World Climate Conference was convened in Geneva, Switzerland, from 29 October through 7 November, 1990, under the sponsorship of the World Meteorological Organization; the United Nations Environment Programme; the United Nations Educational, Scientific, and Cultural Organization and its Intergovernmental Oceanographic Commission; the Food and Agriculture Organization; and the International Council of Scientific Unions. This Statement was adopted by the participants in the scientific and technical sessions from 29 October to 3 November 1990, on the basis of the presentations at the Conference, the deliberations of task groups of participants organized to address various problem areas, and plenary discussions involving all participants. The scientific and technical sessions involved more than 700 participants from over 100 countries.

2. The Conference discussed the results of the first decade of work under the World Climate Programme (WCP), the First Assessment Report of the Intergovernmental Panel on Climate Change (August, 1990) and the development of the International Geosphere-Biosphere Programme (IGBP) and other relevant global programmes. In particular, the Conference considered the role, priorities, and programme structure for the future development of the World Climate Programme.

SUMMARY STATEMENT

1. Climate issues reach far beyond atmospheric and oceanic sciences, affecting every aspect of life on this planet. The issues are increasingly pivotal in determining future environmental and economic well-being. Variations of climate have profound effects on natural and managed systems, the economies of nations and the well-being of people everywhere. A clear scientific consensus has emerged on estimates of the range of global warming which can be expected during the 21st century (paragraph B). If the increase of greenhouse gas concentrations is not limited, the predicted climate change would place stresses on natural and social systems unprecedented in the past 10,000 years.

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2. At the First World Climate Conference in 1979, nations were urged "to foresee and to prevent potential man-made changes in climate that might be adverse to the well-being of humanity". This Conference concludes that, notwithstanding scientific and economic uncertainties, nations should now take steps towards reducing sources and increasing sinks of greenhouse gases through national actions and negotiation of a global convention on climate change, and related legal instruments, with the long-term goal of halting the build-up of greenhouse gases at a level that minimizes risks to society and natural ecosystems. A major international observational and research effort will be essential to strengthen the knowledge-base on climate processes and human interactions, and to provide the basis for operational climate monitoring and prediction. The remaining uncertainties must not be the basis for deferring societal response to these risks. Many of the actions that would reduce risk are also desirable on other grounds.

#### PART I. MAIN CONCLUSIONS AND RECOMMENDATIONS

##### A. Greenhouse Gases and Climate Change

1. Emissions resulting from human activities are substantially increasing atmospheric concentrations of the greenhouse gases. These increases will enhance the natural greenhouse effect, resulting on average in an additional warming of the Earth's surface. The Conference agreed that this and other scientific conclusions set out by the IPCC reflect the international consensus of scientific understanding of climate change. Without actions to reduce emissions, global warming is predicted to reach 2 to 5 degrees C over the next century, a rate of change unprecedented in the past 10,000 years. The warming is expected to be accompanied by a sea level rise of 65 cm + 35 cm by the end of the next century. There remain uncertainties in predictions, particularly in regard to the timing, magnitude and regional patterns of climate change.
2. Climate change and sea level rise would seriously threaten low-lying islands and coastal zones. Water resources, agriculture and agricultural trade, especially in arid and semi-arid regions, forests, and fisheries are especially vulnerable to climate change. Climate change may compound existing serious problems of the global mismatch between resources, population and consumption. In many cases the impacts will be felt most severely in regions already under stress, mainly in developing countries.
3. Global warming induced by increased greenhouse gas concentrations is delayed by the oceans; hence, much of the change is still to come. Inertia in the climate system due to the influence of the oceans, the biosphere and the long residence times of some greenhouse gases means that climate changes that occur may persist for centuries.
4. Natural sources and sinks of greenhouse gases are sensitive to a change in climate. Although many of the response or feedback processes are poorly understood, it appears likely that, as climate warms, these feedbacks will lead to an overall increase rather than a decrease in greenhouse gas concentrations.

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5. The historical growth in emissions has been a direct consequence of the increase of human population, rising incomes, the related exploitation of fossil fuels by industrialized societies and the expansion of agriculture. Under "business-as-usual" assumptions\*, it is projected that emissions will continue to grow in the future as a consequence of a projected doubling of energy consumption in the first half of the 21st century and an expected doubling of population by the latter half. As a result, the effect of human-induced greenhouse gas concentrations on the earth's radiation balance would by 2025 correspond to a doubling of carbon dioxide unless remedial actions are taken.

6. Over the last decade, emissions of carbon dioxide (CO<sub>2</sub>) contributed 55% of the increased radiative forcing produced by greenhouse gases from human activities. The CFCs contributed about 24% of the past decade's changes, and methane 15%, with the balance due to other greenhouse gases. With controls on CFCs, the relative importance of CO<sub>2</sub> emissions will increase, provided the substitutes for CFCs have minimal greenhouse warming potential. Some 75% of total CO<sub>2</sub> emissions have come from the industrialized countries.

7. The above emissions can be expected to change the planet's atmosphere and climate, and a clear scientific consensus has been reached on the range of changes to be expected. Although this range is large, it is prudent to exercise, as a precautionary measure, actions to manage the risk of undesirable climate change. In order to stabilize atmospheric carbon dioxide concentrations by the middle of the 21st century at about 50% above pre-industrial concentrations, a continuous world-wide reduction of net carbon dioxide emissions by 1 to 2% per year starting now would be required. The Intergovernmental Panel on Climate Change (IPCC) also considered three other emissions scenarios, which would not lead to stabilization of CO<sub>2</sub> concentrations in the 21st century. A 15-20% reduction in methane emissions would stabilize atmospheric concentrations of that gas.

8. This Conference concludes that technically feasible and cost-effective opportunities exist to reduce CO<sub>2</sub> emissions in all countries. Such opportunities for emissions reductions are sufficient to allow many industrialized countries to stabilize CO<sub>2</sub> emissions from the energy sector and to reduce these emissions by at least 20 percent by 2005. The measures include increasing the efficiency of energy use and employing alternative fuels and energy sources. As additional measures to achieve further cost-effective reductions are identified and implemented, even greater decreases in emissions would be achieved in the following decades. In addition, reversing the current net losses in forests would increase storage of carbon. The economic and social costs and benefits of such measures should be urgently examined by all nations. An internationally coordinated assessment should be undertaken through the IPCC.

\* "Business-as-usual" assumes that few or no steps are taken to limit greenhouse gas emissions. Energy use and clearing of tropical forests continue and fossil fuels, in particular coal, remain the world's primary energy source. The Montreal protocol comes into effect but without strengthening and with less than 100 percent compliance.

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9. Countries are urged to take immediate actions to control the risks of climate change with initial emphasis on actions that would be economically and socially beneficial for other reasons as well. Nations should launch negotiations on a climate change convention and related legal instruments, without delay and with the aim of signing such a convention in 1992.

#### B. Use of Climate Information in Assisting Sustainable Social and Economic Development

Climate data, analyses, and eventually climate predictions can contribute substantially to enhancing the efficiency and security of economic and developmental activities in environmentally sustainable ways. These benefits are particularly important in food and wood production, water management, transportation, energy planning and production (including assessment of potential resources of biomass, hydropower, solar and wind energy), urban planning and design, human health and safety, combatting of drought and land degradation, and tourism. This requires both data on the climate system, and its effective application. Data acquisition, collection, management and analysis must be more vigorously supported in all countries and special assistance provided to developing countries through international cooperation. Transfer of techniques for applying climate information should be accelerated through more widespread use of software (e.g. CLICOM) for readily available personal computers and other means. Further development of methods for predicting short-term variations in climate and the environmental and social impacts should be vigorously pursued. These advances would provide enormous economic and other welfare benefits in coping with droughts, prolonged rain, and periods of severe hot and cold weather. Such predictions will require major steps forward in ocean-atmosphere-biosphere observing systems. Much greater efforts are needed to increase involvement in these fields by developing countries, especially through increased education and training.

#### C. Priorities for Enhanced Research and Observational Systems

1. A consensus exists among scientists as summarized in the Report of Working Group I of the IPCC that climate change will occur due to increasing greenhouse gases. However, there is substantial scientific uncertainty in the details of projections of future climate change. Projections of future regional climate and climate impacts are much less certain than those on a global scale. These uncertainties can only be narrowed through research addressing the following priority areas:

- clouds and the hydrological cycle
- greenhouse gases and the global carbon and biogeochemical cycles
- oceans: physical, chemical and biological aspects; and exchanges with the atmosphere
- paleo-climatic studies
- polar ice sheets and sea ice
- terrestrial ecosystems.

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2. These subjects are being addressed by national programmes, the World Climate Research Programme and the International Geosphere-Biosphere Programme. Increased national support and substantially increased funding of these programmes is required if progress on the necessary time scale is to be made in reducing these uncertainties.
3. Present observational systems for monitoring the climate system are inadequate for operational and research purposes. They are deteriorating in both industrialized and developing regions. Of special concern is the inadequacy of observation systems in large parts of the southern hemisphere.
4. High priority must be placed on providing high-quality, long-term data for climate-related studies. Data should be available at no more than the cost of reproduction and distribution. A full and open exchange of global and other data sets needed for climate-related studies is required.
5. There is an urgent need to create a Global Climate Observing System (GCOS) modelled on the World Weather Watch Global Observing System and the Integrated Global Ocean Service System and including both space-based and surface-based observing components. GCOS should also include the data communications and other infrastructure necessary to support operational climate forecasting.
6. GCOS should be designed to meet the needs for:
  - (a) climate system monitoring, climate change detection and response monitoring, especially in terrestrial ecosystems
  - (b) data for application to national economic development, and
  - (c) research towards improved understanding, modelling and prediction of the climate system.
7. The main components of such a GCOS would be:
  - (1) an improved World Weather Watch Programme;
  - (2) the establishment of a global ocean observing system (GCOS) of physical, chemical and biological measurements;
  - (3) the maintenance and enhancement of monitoring programmes of other key components of the climate system, such as the distribution of important atmospheric constituents (including the Global Atmosphere Watch), changes in terrestrial ecosystems, clouds and the hydrological cycle, the earth's radiation budget, ice sheets, and precipitation over the oceans.
8. The further development and implementation of the GCOS concept should be pursued with urgency by scientists, governments and international organizations. All countries must ensure a full and open exchange of the data sets needed for climate system research, process and impact studies, and modelling.

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9. The impacts of climate variability on human socio-economic systems have provided major constraints to development. Climate change may compound these constraints. In semi-arid regions of Africa, drought episodes have been directly responsible for major human disasters. Research undertaken during the first decade of the WCP and through other international and national programmes has improved drought early warning systems including FAO's Global Early Warning System and increased the reliability of climate impact analyses. But much more remains to be done. Intensified efforts are required to refine further our ability to predict short-term climate variability, anticipate climate impacts, and identify rational strategies to mitigate or prevent adverse effects. The threat of climate change brings new challenges to the future well-being of people. This requires greater efforts to understand impacts of climate change. Mitigation and adaptation strategies are also essential. Immediate steps to be taken include:

- (a) national and regional analyses of the impacts of climate variability and change on society, and study of the range of response and adaptation options available.
- (b) closer co-operation and communication among natural and social scientists, to ensure that climate considerations are accounted for in development planning.
- (c) significant increases in resources to carry out impact/adaptation studies.

10. Improvements in energy efficiency and non-fossil fuel energy technologies are of paramount importance, not only to reduce greenhouse gas emissions but to move to more sustainable development pathways. Such advances will require research and development, as well as technology transfer and co-development.

11. A specific initiative would create a network of regional, interdisciplinary research centres, located primarily in developing countries, and focussing on all of the natural science, engineering and social science disciplines required to support fully integrated studies of global change and its impacts. The centres would conduct research and training on all aspects of global change and study the interaction of regional and global policies.

#### D. Public Information

People need better information on the crucial role climate plays in development and the additional risks posed by climate change. Governments, intergovernmental and non-governmental organizations should give more emphasis to providing accurate public information on climate issues. The public information and education and training component in the WCP and IGBP must also be expanded.

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PART IISpecific Issues:1. Water

1.1 Among the most important impacts of climate change will be its effects on the hydrological cycle and water management systems, and through these, on socio-economic systems. Increases in incidence of extremes, such as floods and droughts, would cause increased frequency and severity of disasters.

1.2 The design of many costly structures to store and convey water, from large dams to small drainage facilities, is based on analyses of past records of climatic and hydrological parameters. Some of these structures are designed to last 50-100 years or even longer. Records of past climate and hydrological conditions may no longer be a reliable guide to the future. The design and management of both structural and non-structural water resource systems should allow for the possible effects of climate change.

1.3 Data systems and research must be strengthened to predict water resources impacts, detect hydrological changes, and improve hydrological parameterization in global climate models.

1.4 Transfer of existing and novel technologies, for more efficient use of water for irrigation, should be made available to developing countries in semi-arid zones.

2. Agriculture and Food

2.1 Important uncertainties remain regarding the prediction of the magnitude and nature of potential impacts of changing climate and higher CO<sub>2</sub> levels on global food security. The potential impact on food production in developing countries (with more than half the world's population) could be more uncertain than recent reviews suggest.

2.2 High priority should therefore be given to research on the direct effects of rising CO<sub>2</sub> concentrations on food and fibre crop productivity and equal priority should be given to research on agricultural emissions so as to determine agriculture's present and potential role as a source of and sink for greenhouse gases, and to clarify the costs and possible trade-offs arising from limitation measures.

2.3 New or strengthened institutional mechanisms are required to upgrade natural resource inventories, research strategies and extension services to raise agricultural productivity and minimize emissions. These mechanisms should include collaborative programmes between FAO and international and national agencies with stress on interdisciplinary activities on the food security implications.

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### 3. Oceans, Fisheries, and Coastal Zones

3.1 Shorter term variations in the earth's climate are determined by the coupled ocean - atmosphere system. Coastal zones and their associated high biological productivity, including fisheries, are especially affected. Thus, an improved data base of oceanic parameters is considered indispensable for operational climate forecasting. It is recommended that a global ocean observing and data management system be developed for improving predictions of climate change. Research on the ocean will provide quantification of the feedback loops in climate processes. Observation and research on the El Nino - Southern Oscillation phenomena, on upwelling areas and on biological productivity of the open sea are also important.

3.2 Coastal zones, which are the source of most of the global fish catch, are especially susceptible to effects of global warming and sea level rise. Predicting the impact of changes would be of enormous benefit to the increasing number of people living in coastal areas. Thus, it is also recommended that a programme of coastal zone research and monitoring be established to identify the effects of climate change on the coast and coastal ecosystems, and to assess the vulnerability of various natural and managed ecosystems such as coral reefs, mangroves and coastal aquaculture.

3.3 Action should be taken now to develop coastal zone adaptation strategies and policies.

### 4. Energy

4.1 In order to stabilize atmospheric concentrations of greenhouse gases while allowing for growth in emissions from developing countries, industrialized countries must implement reductions even greater than those required, on average, for the globe as a whole. However, even where very large technical and economic opportunities have been identified for reducing energy-related greenhouse gas emissions, and even where there are significant and multiple benefits associated with these measures, implementation is being slowed and sometimes prevented by a host of barriers. These barriers exist at all levels -- at the level of consumers, energy equipment manufacturers and suppliers, industries, utilities, and governments. Overcoming the barriers obstructing least-cost approaches to meeting energy demands will require responses from all parts of society -- individual consumers, industry, governments, and non-governmental organizations.

4.2 Developing countries also have an important role in limiting climate change. Maintaining development as a principal objective, energy and development paths can be chosen that have the additional benefit of reducing radiative forcing.

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## 5. Land Use and Urban Planning

Population growth, increasing urbanization, and competing demands for finite areas of arable land will produce increasingly severe problems of food supply, energy production, and water resources. Climate changes may exacerbate these problems in some regions. Prudent planning will require baseline analyses of land use, quality and quantity of water resources, and the vulnerability of urbanized societies to environmental change. In particular, improved adaptation of urban areas to local climatic regimes needs to be achieved by more appropriate design of their layouts and building densities, and of building construction through modifications of building and planning regulations. Because conurbations make a major contribution to energy-related greenhouse gas emissions, the design and efficiency of all aspects of urban systems should be enhanced.

## 6. Health and Human Dimensions

6.1 The direct impact of climate change on people, their health and cultural heritage, could be severe. There is likely to be increased health inequity between peoples of developing and developed countries. Climatic change could result in creating environmental refugees with associated increases of ill-health, disease and death among them.

6.2 Global warming is likely to shift the range of favourable conditions for certain pests and diseases, causing additional stresses on people, particularly those of the semi-arid tropics. It must be appreciated however that serious problems may arise in all parts of the world.

6.3 Research into how human behaviour contributes to and responds to climate change must have increased emphasis. Public awareness and education programmes are particularly essential in this regard.

## 7. Environment and Development

7.1 Climate change, superimposed on population pressures, excessive consumption, and other stresses on the environment imperils the sustainability of socio-economic development throughout the world. In addition, slowing climate change will give countries more time to enhance their prospects for sustainable development. The developed countries need to reduce emissions and assist the developing countries to adopt new, clean technologies.

7.2 Climate change has such important implications for the sustainability of development that policy responses, including measures to reduce greenhouse gases, measures to reduce deforestation, and the commitment of financial and other resources, are justified for that reason alone. Economic policies, such as subsidies and trade restraints, can distort markets so they harm the environment and contribute to global warming and sea level rise. There is an imperative need for development policies that not only reduce global warming trends but also increase economic and social resilience.

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8. Forests

While increasing forest cover can contribute to the slowing of global climate change, this is not the major cure for the problem.

Five priority actions are recommended:

Firstly, assessing national opportunities to increase forest carbon storage commensurate with national resource development policies, developing an approach by 1992 and completing assessment by 1995.

Secondly, managing the world's forests to optimize biomass and resultant carbon storage in addition to the maintenance of sustainable yields of forest products, biological diversity, water quality and the many other values that forests provide.

Thirdly, accelerating research to assess the added contribution that forests can make to atmospheric CO<sub>2</sub> reduction and the impacts of climate change on the world's forests.

Fourthly, designing and implementing international monitoring systems to determine conditions and changes in forest ecosystems in response to anticipated climate changes.

Finally, supporting the development of a proposed international instrument on conservation and development of the world's forest linked with the proposed climate and biodiversity conventions.

PART III

Organizational and Policy Issues for International Activities

1. The future structure of the WCP

1.1 The organizational framework for international scientific research is in place, constituted by the WCRP, emphasizing the physical aspects, and the IGBP, covering bio-geochemical aspects.

1.2 The World Climate Data Programme, renamed the World Climate System Monitoring Programme, should be redefined to take into account new objectives.

1.3 Additional elements of the new WCP (WCP-2) should cover adaptation and mitigation, and education.

1.4 Governments should establish national committees for the WCP to mobilize support for national activities and to coordinate efforts. The UN agencies and ICSU should work towards ensuring regular contact and exchange of information with national committees.

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1.5 The mechanism established for overall coordination of the WCP, involving meetings of the chairs of steering bodies for the various components, should be actively supported by WMO, the other UN bodies concerned and ICSU. Annual meetings of Executive Heads should consider their recommendations.

1.6 Restructuring and strengthening of the WCP will also be necessary to support new activities, such as the development of the proposed GOOS. The Conference recommended that a proposal for the new structure of WCP be formulated and presented to the Eleventh World Meteorological Congress, May 1991, and at appropriate meetings of other participating agencies.

## 2. Special needs of the developing countries

2.1 As stated in the IPCC report, industrialized and developing countries have a common but differentiated responsibility for dealing with the problems of climate change. The problem is largely the consequence of past patterns of economic growth in the industrial countries. However, in future the much needed economic growth in the developing countries could play an important role in determining the rate of climate change.

2.2 Developing countries are being asked to participate in the alleviation of the legacy of environmental damage from prior industrialization. If they are to avoid the potentially disastrous course followed by industrialized countries in the past, they need to adopt modern technologies early in the process of development, particularly in regard to energy efficiency. They also must be full partners in the global scientific and technical effort that will be required. It is clear that developing countries must not go through the evolutionary process of previous industrialization but rather, must "leapfrog" ahead directly from a status of under-development through to efficient, environmentally benign, technologies presently found only in the most advanced industrial economies.

2.3 Although developing countries have collaborated in providing data, and participated to a degree in meetings and research, they have benefited to a lesser extent from the analyses developed from their contributions, and even less so from the applications derived therefrom.

2.4 Therefore, a massive and sustained flow of scientific and technological expertise towards the development of the intellectual resources, technical and institutional capacity of the developing countries is a necessary complement to the efforts of those countries.

2.5 Developing countries should be assisted to build up their capabilities

- to monitor, assess and apply climate information;
- to prepare inventories of greenhouse gases emissions and future emissions projections;
- to identify impacts of potential global warming;

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- to prepare cost estimates and priorities for response strategies to adapt and mitigate problems posed by climate change;
- to participate in the World Climate Programme.
- o The mechanisms of the transfer of technology and provision of technical assistance and co-operation to developing countries should take into account considerations such as the need for preferential and assured access, intellectual property rights, the environmental soundness of such technology and the financial implications.
- o Taking note that industry plays a significant role in the development and transfer of science and technology, efforts by industry to promote further the development and transfer of environmentally sound technologies should be encouraged, and policies to encourage such efforts should be formulated.
- o Additional financial resources will have to be channelled to developing countries for those activities which contribute both to limiting greenhouse gas emissions and/or adapting to any adverse effects of climate change, and promoting economic development. Areas for co-operation and assistance could include the efficient use of energy, land use planning, forest management, soil and water conservations, strengthening of observational systems and scientific and technological capabilities.

### 3. Co-operation in international research

3.1 The existing and planned research projects of the WCRP and the IGBP address the highest priority scientific issues related to the understanding and prediction of climate variability and change.

3.2 These programmes should be implemented completely and rigorously. It is particularly important that adequate funding including long term funding be provided.

3.3 In view of the progress made in climate research, it is now timely to proceed to the detailed design of an operational global climate observing system, together with the data communications and other infrastructure needed to support operational climate forecasting. Governments should enter into early discussions aimed at international cooperation in operational climate forecasting and climate change research.

### 4. Co-ordinated International Activities

4.1 The Conference endorsed the three streams of international activity:

- a. continuing global measurement and research efforts through the WCP, IGBP, and other related international programmes.

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- b. Assessment functions of a continuing IPCC to support negotiation and administration of a Convention.
- c. Development of a Convention on Climate Change for governmental action.

4.2 The UN Conference on Environmental and Development (Brazil 1992) provides a valuable opportunity to relate the above three themes to all the other environment/development issues and objectives being examined by the Conference. It is therefore essential that the three streams should interact effectively with UNCED.

4.3 It is proposed that the sponsoring agencies for the SWOC consider the possibility of holding a Third World Climate Conference at an appropriate time about 2000 AD.

## 5. Policy Development

5.1 The development of policy regarding climate change requires on the part of policy makers an understanding of the underlying science and a weighing of the scientific uncertainties associated with the prediction of climate change and its likely impacts. An important aspect of future work is therefore a continued dialogue between scientists and policy makers.

5.2 It is essential that all parties to any Convention and related legal instruments should, under its obligations, participate fully in the free exchange and flow of information necessary for the development and technical input of the convention. Such a convention should include a technical annex to provide for:

- International co-operation in research, systematic observation and exchange of related information;
- Adjustments based on up-dates of scientific knowledge;
- Strengthening national scientific and environmental capabilities of developing countries.

THE WHITE HOUSE  
WASHINGTON

September 24, 1990

MEMORANDUM FOR GOVERNOR SUNUNU

FROM: D. ALLAN BROMLEY *Alan*

SUBJECT: ISSUES ON THE FRAMEWORK CONVENTION  
ORGANIZATIONAL MEETING AND THE SECOND WORLD  
CLIMATE CONFERENCE

Background

The President offered to host the first negotiating session for a Framework Convention on global climate change at Malta last year, and reiterated the invitation at the White House Conference on the Science and Economics of Global Change. In May of this year a tentative decision was made to begin the negotiations in the first week of February 1991, preceded by a preparatory committee meeting or meetings this fall. The first preparatory meeting will be held September 24 to 26. Organizational issues for the first negotiating session will be discussed at that time.

The Second World Climate Conference is scheduled for October 29 to November 7 in Geneva. It will focus on scientific issues, including the IPCC report. A ministerial session has been scheduled for the final two days of the conference, which will produce a Ministerial Declaration. A preparatory committee meeting will be held September 27 to 29 in Geneva.

The Global Change Strategy Task Force (a steering group of the DPC Global Change Working Group) met last Tuesday to address some minor, outstanding organizational issues for the first negotiating session and substantive issues in the proposed Ministerial Declaration for the Second World Climate Conference. Unanimous agreement was reached on the organizational issues for the Framework Convention, and this was relayed to the U.S. delegation. General agreement was reached on the Second World Climate Conference issues. A summary of the discussion and recommendations follows.

Framework Convention Negotiations - Organizational Issues

The Strategy Task Force recommended the following guidance for our representatives at the preparatory committee meeting with respect to the starting date, length, and location of the first negotiating session:

The U.S. strongly prefers a one-week session beginning February 4 in Washington, D.C.. However, if there is strong international pressure for a two-week meeting, we would agree to a ten-day meeting as a fallback position.

The group had considered either Washington, D.C., or Dallas, Texas as alternate locations. A paper comparing the suitability of the two cities was circulated to Task Force members and the group decided on Washington. This was based on cost considerations, the availability of appropriate facilities, press coverage, the amount of influence a U.S. delegation could have in the process, and the potential for a Presidential appearance.

### Second World Climate Conference

The State Department has compiled interagency comments on a draft ministerial declaration produced by the Second World Climate Conference Secretariat. The Strategy Task Force discussion focused on a limited number of issues on which the U.S. would not be prepared to negotiate. These include:

- o We should not agree to specific targets and timetables for reducing greenhouse gas emissions;
- o There should be no provision for "new and additional" funding (for developing countries);
- o There should be no mention of separate protocols to a framework convention;
- o The comprehensive approach, which addresses all greenhouse gases, their sources and sinks, must be an integral part of the approach;
- o The declaration must accurately describe the scientific context and uncertainties associated with potential climate change;

The Task Force prepared alternate language for these and other issues of particular interest, as well as fallback modifications of existing language which could be used in negotiating final language during the September 27 to 29 preparatory meeting. A more comprehensive briefing on these issues can be scheduled for you, if you would like.

State and Commerce will represent the U.S. at the September preparatory meeting. The Strategy Task Force strongly recommends that Dr. John Knauss, Undersecretary of Commerce, head the U.S. delegation to the ministerial portion of the conference in October. An immediate announcement of the Knauss appointment will tend to discourage head of state participation by other countries as well as prevent speculation on any appearance by higher level U.S. representatives. In addition, it reinforces our continuing commitment to focusing the climate change discussions on science and decreases the opportunity for rhetoric, as was characteristic of Noordwijk. Therefore, the Task Force recommends that Dr. Knauss be appointed to head the delegation as soon as possible.

Comments: \_\_\_\_\_

THE WHITE HOUSE  
WASHINGTON

August 30, 1990

MEMORANDUM FOR JOHN H. SUNUNU

FROM: D. ALLAN BROMLEY *Alan*

SUBJECT: ARTICLE ON GLOBAL CHANGE FOR  
ISSUES IN SCIENCE AND TECHNOLOGY

Attached is the final draft of an article scheduled to be published in the Fall issue of Issues in Science and Technology. The article has been scrubbed and approved by OMB, Cabinet Affairs, CEA, NSF, EPA, and USGS.

As you probably know, Issues in Science and Technology is the quarterly policy journal published by the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. They had asked me to write this article when I first came to Washington, and only now am I getting it done, just a few days before their final deadline. But the timing is propitious, because it allows me to make some points about global change that I believe will serve the Administration's purposes during the rough-and-tumble of the next few months.

Attachment

**DRAFT: DO NOT QUOTE OR DISTRIBUTE**

[August 30, 1990]

**THE MAKING OF A GREENHOUSE POLICY**

by D. Allan Bromley

[draft article for Fall issue of  
Issues in Science and Technology]

Within the past several years, global change has become the archetypal science policy issue. It combines almost all of the elements of public policy debates that have a substantial scientific component: questions about scientific data and conclusions, the difficulty of translating scientific analysis into politically relevant terms, competing interests with multiple agendas, differing international perspectives on common problems, and decision-making based on less-than-complete information. It has

received an enormous amount of attention from politicians, from environmentalists, from the media, and from the public. Since I became Assistant to the President for Science and Technology last August, no issue has consumed more of my time than has global change.

Given the broad slate of science policy issues that demand attention, it can sometimes be frustrating to dwell so predominantly on a phenomenon -- anthropogenic climate change on a global scale -- that has yet to be conclusively demonstrated. Not that the global environment has never changed. At the height of the last ice age about 20,000 years ago -- not long, in geological terms, before humans are widely believed to have first crossed the Bering land bridge into North America -- glaciers over two kilometers high covered much of the northern United States and Europe, and sea level was 100 meters lower than at present. These natural changes in the Earth's climate have occurred throughout its history, and they will continue to occur in the future.

It is also true that, during the past century, human society has entered into a new and momentous relationship with the global environment. For the first time in history, our species has become an agent capable of influencing the entire planet. We have altered the face of the Earth by clearing forests, building cities, and converting wild lands to agriculture. We have changed the composition of the Earth's atmosphere by burning fossil fuels, expanding agriculture, and producing and releasing industrial compounds. As Roger Revelle and Hans E. Suess wrote as early

as 1957, "human beings are now carrying out a large-scale geophysical experiment of a kind that could not have happened in the past nor be reproduced in the future."

It may be, as many have suggested, that global climate change will become a problem of very serious consequence. Certainly, the possibility of such change is being taken seriously by all governments, and appropriate actions are being considered to deal with the possible effects of climate change.

It may also be that the other issues usually subsumed under the term "global change" -- such as ozone depletion, the adequacy of food and water supplies, deforestation, desertification, levels of biodiversity, or soil erosion -- turn out to be more serious in terms of human impact than global climate change. The only reasonable course is to move forward on all of these issues simultaneously.

#### Scientific knowns and unknowns

Bertrand Russell once wrote, "The most savage controversies are those about matters as to which there is no good evidence either way." Certainly if more were known about global change, the policy disputes would not be nearly so acrimonious. If it were possible, for example, to unequivocally associate the warmer-than-average years of the 1980s with the greenhouse effect, multibillion-dollar decisions affecting life-styles and the quality of life would appear less open to question. If computer models of the earth system could precisely mimic the observed temperatures changes

of the past century, they would provide a more solid foundation for policymaking. For that matter, the policy debate will be quite different in the year 2000 if temperatures rise sharply in the 1990s.

For now, though, it is important for policymakers clearly to keep in mind what is known and what is not known about the Earth system. Based on exacting measurements of atmospheric gases and the bubbles trapped in ice sheets, researchers know that the level of carbon dioxide in the atmosphere has increased by about 25 percent since preindustrial times. Atmospheric levels of methane, another potent greenhouse gas, have doubled over the same period. Chlorofluorocarbons (CFC's) released into the atmosphere, which are almost certainly responsible for the ozone hole over Antarctica, also act as greenhouse gases, as do several other atmospheric constituents with increasing concentration levels, including tropospheric ozone and nitrous oxide.

Computer models of the atmosphere reproduce the current global climate and changes of seasons with a fair degree of accuracy. When these models are run with twice as much carbon dioxide in their atmospheres, global average surface temperature is somewhere between 1.5 and 4.5 degrees Celsius higher than at present. However, the treatment in these models of such fundamental and important features of the Earth system as clouds, oceans, and ice remain suspect. It may be that the models inadequately simulate some fundamental aspect of the Earth system that drastically reduces the predicted climate effects of greenhouse gas emissions -- or makes them worse.

Thus, computer models have been unable to specify with any certainty the magnitude, rate, or timing of future climate change. Nor do models give much indication of how potentially-important climate variables -- including mean annual temperatures, seasonal and daily maximums and minimums in temperature, seasonal and annual precipitation, the degree and frequency of variations in precipitation, and the degree and frequency of extreme events such as storms -- might change. Furthermore, present models are totally unable to make reliable climate predictions on regional and local scales, yet these are essential if we are to be able to quantify the detailed impacts of global change.

The geological record also offers incomplete clues to the effects of greenhouse forcing. Earth scientists have found that global temperatures and atmospheric carbon dioxide levels have risen and fallen naturally and largely in parallel for the past 160,000 years. However, it is difficult to tell whether temperatures lead carbon dioxide or vice versa, and the mechanisms connecting these natural fluctuations remain obscure.

The same pattern of concrete observations paired with uncertain implications marks the record of global temperatures. Scientists now generally agree that the planet has warmed up by 0.3 to 0.6 degrees Celsius during the past century. But very few scientists would claim that they are yet able to determine whether any of that warming can be attributed to an enhanced greenhouse effect or whether it represents a natural fluctuation. Of particular interest in this regard have been recent precise temperature measurements by satellite of the global atmosphere. They show that,

even though surface measurements in some regions indicate that the 1980s were one of the warmest decades on record, average global temperatures did not increase from 1979 to 1989. Yet the magnitude and rate of increase of anthropogenic loading of the atmosphere with greenhouse gases were at unprecedented levels during the 1980s.

Based on climatic modeling and paleoclimatic research, scientists now generally agree that continued loading of the atmosphere with greenhouse gases will lead to global climate change. But without further research, the nature and dimensions of that change will remain elusive. Furthermore, we are only beginning to understand what the impacts of a potential change might be on agricultural productivity, sea level changes, biological productivity in the oceans, shifting vegetation patterns, storm patterns and severity, droughts, and the like. The various components of the geosphere, hydrosphere, atmosphere, and biosphere are bound up in a fantastically intricate and mutually counterbalancing system, and it will be many years before we can reliably predict how changes in one part of the system affect every other part.

#### Numerous uncertainties

Many of the observations made above also appear in the report of Working Group I of the Intergovernmental Panel on Climate Change (IPCC), an international body of hundreds of scientists and government officials set up by the United Nations Environment Program and World Meteorological Program to establish a global

consensus on the likely causes and consequences of climate change. The charge to Working Group I, which was chaired by the United Kingdom, was to assess the current scientific understanding of climate change. The second working group, chaired by the Soviet Union, assessed the possible environmental and socioeconomic effects of a changing climate. The third, chaired by the United States, sought to identify potential responses to climatic changes.

The three working groups presented their reports at the end of the summer as input to the Second World Climate Conference in Geneva on October 29 - November 7, 1990. These reports are an important resource for policymakers grappling with issues of global change. They will be among the most authoritative statements on the causes and consequences of climate change well into the future.

Nevertheless, to read the reports of the IPCC is to be struck again by the formidable difficulties that still surround this subject. Working Group I devoted considerable attention to scientific uncertainties in its report (although they tend to be minimized in the Executive Summary), concluding that "much uncertainty exists in the prediction of global climate properties such as temperatures and rainfall" and that "even greater uncertainty exists in predictions of regional climate change, and the subsequent consequences for sea level and ecosystems."

Working Group II's study of potential impacts also cited the uncertainties hampering their task, pointing out that "confidence in regional estimates of critical climate factors is low, [particularly] of precipitation and soil moisture, where there is considerable disagreement between various general-circulation-model and paleoanalog

results." The working group also found many scientific questions surrounding the relationships between climate change and biological effects and between biological effects and socioeconomic impacts. Uncertainties about the lengths of time lags at each step from emissions to climate change to socioeconomic impacts are particularly troublesome, because the severity of impacts depends on the ability to adjust and hence partially on the length of the lags.

Finally, Working Group III concluded that the existing uncertainties make it very difficult to determine which responses to potential climate change make sense. It wrote: "The consideration of climate change response strategies . . . presents formidable difficulties for policymakers. On the one hand, the information available to make sound policy analyses is inadequate because of: (a) remaining scientific uncertainties regarding the magnitude, timing, rate, and regional consequences of potential climate change; (b) uncertainty with respect to how effective specific response options or groups of options would be in actually averting potential climate change; and (c) uncertainty with respect to the costs, effects on economic growth, and other economic and social implications of specific response options or groups of options."

These many uncertainties do not argue for inaction (a point to which I shall return later). But they do make it exceedingly difficult to impose policies that may have large additional costs on specific sectors of society or on specific countries, because the affected sectors or countries can legitimately point to the uncertainties in arguing against the policies. The wrangling involved in getting a Clean Air Act

through Congress gives some indication, on a much smaller scale, of what will be involved in negotiations over global change.

At the same time, any discussion of uncertainties must acknowledge the fact that the unknowns cut both ways: climate models could understate as well as overstate the extent of the problem. For example, there is growing suspicion from the paleoecological data -- as yet unconfirmed -- that atmosphere-ocean interactions may harbor the possibility of surprises. If it should turn out, for example, that relatively small, and not as yet understood, mechanisms could shift ocean circulation patterns from one stable configuration to another, the potential impacts could be large.

A better known example of a climatic surprise was the development of the ozone hole over Antarctica. The ozone hole was not predicted or originally understood, although its detailed chemical mechanisms have now been explained at the molecular level. Nevertheless, the ozone hole has demonstrated that, contrary to long-held assumptions, our atmosphere is not so large, nor its inertia so great, that human activities cannot affect it under certain circumstances on human time scales. Human release of CFCs, combined with unique meteorological conditions, created the ozone hole in only a few decades at most.

**The need for research**

In the absence of a clearly identifiable signal of greenhouse warming -- which the IPCC deems unlikely for a decade or more -- there is only one way to reduce the uncertainties associated with global change: through concerted national and international research programs. In the United States, such a program has been organized by the Working Group on Global Change of the federal interagency Committee on Earth and Environmental Sciences. This U.S. Global Change Research Program -- a government-wide effort to monitor and understand the Earth system and predict global change -- is designed to significantly expand data gathering, research, and modeling activities. A significant component of the program is environmental observations and measurements from space.

The budget that President Bush sent to Capitol Hill last January -- reflecting the compelling case made by the Committee on Earth and Environmental Sciences for a comprehensive, national program -- called for a 57 percent increase in funding for the program, to a total of over \$1 billion. This is far more than any other nation is spending on global change research and in my view is a clear indication of this Administration's commitment to what President Bush has termed "global stewardship."

The committee has focused on three classes of key scientific questions: What global change has occurred in the past and is occurring now? What physical, chemical, biological, geological, and social processes are involved in global change? And how well can global change be predicted globally and regionally? To address

these questions, the committee has divided the research program into seven interdisciplinary scientific elements: climate and hydrologic systems, biogeochemical dynamics, ecological systems and dynamics, earth system history, human interactions, solid earth processes, and solar influences.

To take one important research area as an example, the committee has emphasized the need to better understand both natural and anthropogenic flows of greenhouse gases. According to the IPCC, a reduction of over 60 percent in carbon dioxide emissions would be needed to stabilize the concentration of the gas at current levels -- a restriction that would sharply reduce living standards around the world and cause widespread suffering in poorer nations. But the natural fluxes of carbon dioxide are approximately 20 times the anthropogenic ones, so the same net effect can be obtained through only a 2 to 3 percent increase in the gas's natural sinks. Innovative ideas on ways to draw carbon dioxide from the air -- such as macroalgal ocean farming and fertilizing microalgal blooms -- are now being proposed. Much more study of natural sources and sinks is needed, of course, to determine if proposals such as these are viable.

#### The economic factor

This scientific research will be an indispensable part of our response to the possibility of global change. But it is important to keep in mind that even if all of

the physical, chemical, and biological questions surrounding global change were answered tomorrow, appropriate policies would still be far from obvious. Global change is an inherently interdisciplinary problem, drawing not only on the natural sciences but on economics, sociology, and (especially in the last few years) politics. The full range of questions surrounding global change cannot be answered without input from the social sciences.

The most obvious intersection of global change with the social sciences involves future emissions. It is certainly possible to conceive of a world that supports an even larger population while releasing fewer greenhouse gases into the atmosphere (although the costs required to achieve such a world are likely to be very great). It is also possible to conceive of a world with global greenhouse emissions at least several times today's level, particularly if CFC's are not fully controlled and if countries begin to rely much more extensively on coal for increased energy needs.

The major social uncertainties revolve around population growth rates, the pace and nature of economic development, and the availability of new technologies. These uncertainties are particularly acute for the developing world. According to the World Resources Institute, developing countries already account for a substantial portion of total greenhouse emissions when all greenhouse gases are included; in fact, the top five greenhouse contributors in 1987 were the United States, the Soviet Union, Brazil, China, and India. Furthermore, the relative contribution of the developing countries is going to continue to increase as their industrialization proceeds.

Economics research will also be crucial in estimating the costs of either mitigating climate change by reducing greenhouse-gas emissions now or adapting to climate change after it occurs. Such research will enable sound comparisons of the costs of various policies aimed at mitigation with the benefits, in terms of reduced adaptation costs, that those policies would yield. Such comparisons, using discounting to reflect the earlier occurrence of mitigation costs, must be the basis for sound policymaking.

Several promising estimates of costs are already being developed, but no one doubts that these estimates will inevitably rest on numerous simplifying assumptions. One problem is that the nature of costs varies from place to place. In the developed countries, costs of lowering energy usage can be measured in terms of reduced economic growth, which causes economic hardships to substantial numbers of people. But in the developing world, reduced economic growth must be measured in more stark terms: lives lost, hunger increased, social instability heightened. Similarly, the costs of climate change in the developing world are likely to be higher and more disruptive than in the developed nations, where it is more likely that the resources to adapt to changing climates will be available.

The central role of economics research in global change was a major consideration in the White House Conference on Science and Economics Research Related to Global Change, which was held in Washington, D.C., on April 17-18, 1990. Hosted by Michael Deland, Chairman of the Council on Environmental Quality, Michael Boskin, Chairman of the Council of Economic Advisors, and myself, the

conference brought together delegations from 17 countries and from the European Community and the Organization for Economic Cooperation and Development to explore what we know and do not know about the scientific, economic, and policy questions surrounding global change.

The conference was organized around a straightforward but surprisingly unexplored question: How best can the results of both scientific and economic research into global change be integrated into the policymaking process? Although the format of the conference received some criticism, it achieved much of what it set out to achieve. In particular, several promising proposals on international cooperation emerged from the conference, including one to establish a series of research institutes devoted to the scientific, economic, and policy issues surrounding the global environment. The transnational and multidisciplinary nature of such institutes would provide an added dimension to national and international discussions of global change.

#### An insurance policy against climate change

After a year of intense involvement with this issue, I am convinced that, at present, no justification exists for imposing substantial new costs on society solely to lower greenhouse-gas emissions. But the climate models and paleoclimatic data cannot be ignored, and the United States and other countries cannot wait until all of

the facts are known to take action. Enhanced levels of research -- in many areas -- are one form of action, but they are not, by themselves, enough.

Thus, the Bush Administration has instituted a number of policies that will reduce greenhouse-gas emissions and that are justified for other reasons as well. I think of them as an "insurance policy" that will delay any possible adverse effects of climate change while research and technology development proceed. Among these policies are the following:

- o The United States is committed to phasing out the manufacture of CFC's by the year 2000 to protect the stratospheric ozone layer. Based on their greenhouse properties, CFC's accounted for 14 percent of all greenhouse-gas emissions in the 1980s, and if not controlled they could account for as much as 25 percent of the additional emissions over the next century.

- o The Clean Air Act now being debated in Congress will substantially reduce emissions of greenhouse gases by fostering more efficient use of energy. The Environmental Defense Fund has estimated that the acid rain provisions of this legislation alone, if implemented, will have an effect comparable to that of removing fully one fifth of the U.S. automotive fleet (22 million automobiles) from our highways for a period of 10 years.

- o The U.S. Department of Energy is developing a National Energy Strategy that will include an aggressive commitment to energy conservation and energy security. Energy conservation is the quickest and most effective way to reduce

greenhouse-gas emissions and can have a number of other benefits, including improved economic efficiency, reduced emissions of other pollutants, and less U.S. dependence on imported oil. In addition, technology development is a crucial hedge against the possibility of future warming, because it will ease the transition from processes that produce greenhouse gases (if substantial emission reductions prove necessary). Research and development on non-fossil-fuel technologies -- including nuclear energy and solar energy -- will be an important component of any national or international strategy to address global change.

These initiatives address the source component of the greenhouse gas question. Turning to the sink component, this country is again taking concrete steps.

- o The President has proposed a combined public and private sector initiative to plant a billion trees per year for five years on private land across America, trees that will eventually absorb 13 million tons of carbon annually. This is just part of the United States' current carbon emissions -- about 5 percent if such a program were continued for 20 years -- but these trees will provide additional benefits, such as recreational areas and heightened public awareness of environmental issues.

- o At the Houston Summit Conference in July, the President proposed that a global forestry convention be negotiated as soon as possible to curb deforestation, protect biodiversity, address threats to the world's forests, and promote actions that expand and strengthen forests.

All of these actions are justified for other reasons, yet together they can have a substantial impact on greenhouse-gas emissions. Preliminary estimates by the Environmental Protection Agency indicate that, using a measure of global warming potential that accounts for residence times in the atmosphere, these actions would hold U.S. greenhouse-gas emissions at 1987 levels until at least the year 2000. This would provide a ten-year window of opportunity to determine what future actions are necessary.

Insurance policies against the possibility of climate change are not limited to our own country. As in the case of deforestation, the United States can also influence the actions of other countries in ways that are mutually beneficial. I believe that this country now has a unique window of opportunity in which to provide Third World and Eastern European nations with technology, know-how, and financial assistance to permit them sustained economic growth with minimal damage to the global environment. If we do this on our own initiative, we will gain three benefits: we act to preserve the quality of the environment; we have the potential of substantial positive political fall-out; and we gain access for American industry to what will inevitably be a very large global market. If, on the other hand, we are pressured or are perceived to be pressured into taking such action, we will gain the first benefit but stand to lose the second and much of the third.

### A Framework Convention

These considerations will be very much a part of the next major step in the making of a greenhouse policy: the establishment of a Framework Convention on climate change. At the Malta summit last December, President Bush proposed that the first negotiating sessions leading to such an international agreement be held in the United States, an offer that he has repeated several times since.

In considering the outlines of a Framework Convention, a useful analog is the Vienna Convention for the Protection of the Ozone Layer, which was established by the United States and 20 other countries in 1985. The Vienna Convention established a framework for international scientific and technical cooperation on ozone destruction. It did not, however, set limits on CFC emissions. Rather, it included provisions to establish protocols as further research demonstrated the need for additional action. The 1987 Montreal Protocol on Substances that deplete the Ozone Layer was the result of this process.

A Framework Convention on global change could serve the same function, although CFC emissions and greenhouse-gas emissions are quite different phenomena. Such a convention would establish general principles and obligations, based on a negotiated international consensus, by which future steps can be taken. It would be designed to gain the adherence of the largest possible number of countries while permitting timely action to be taken. The United States is now in the process of

formulating its position for the negotiations, with coordination being provided by a White House Working Group on Global Change that I chair.

This negotiating position will reflect the extensive discussions that have been taking place within the U.S. government on environmental issues. As one example of these discussions, I might cite the Administration's work on emissions trading. If future restrictions on greenhouse emissions prove necessary, market-based approaches to implement those restrictions would be far preferable to command-and-control approaches. One such market-based approach involves a comprehensive system in which all sources and sinks of all greenhouse gases are treated on a common footing in terms of an appropriate greenhouse warming potential. Such a measure would include established scientific knowledge regarding the greenhouse effectiveness of individual chemicals and their average lifetime in the atmosphere.

Once such a comprehensive approach is adopted, it becomes easier to use market forces to achieve reductions in greenhouse gas emissions at minimum costs. This could well encompass bilateral and multilateral arrangements in which a given country might find it economically attractive to help another country achieve net global benefits at lower total cost than if each country were to act independently. This process of emissions trading has been successfully implemented in a number of situations, and it bears much promise for dealing with emissions of greenhouse gases.

Such innovative approaches are going to be essential to meet the main challenge of international agreements on climate change: establishing mechanisms that are both effective and workable. The negotiations leading to a Framework

Convention and any subsequent protocols will encompass an unprecedented range of national and international policies, and no country is likely to be coerced into actions that are not in its long-term interests. But ensuring a stable and predictable environment is in everyone's interest, and actions that genuinely help to achieve that end will carry great force.