Withdrawal/Redaction Sheet
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Doc. No. / Type	Subject/Title	Date	Restriction	Classification
01. List	Re: Global Change Task Force Group (2 pp.)	n.d.	(b)(6)	

Collection:

Record Group: Bush Presidential Records
Office: Economic Advisers, Council of
Series: Schmalensee, Richard, Files
Subseries:
WHORM Cat.:
File Location: Group on Global Climate Change #2 (IPCC - Intergovernmental Panel on Climate Change) and RSWG (Response Strategy Working Group) [Letters, Memorandums, Reports, and Other Information][2]

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P-2/P-5 Review Case #:

EXECUTIVE OFFICE OF THE PRESIDENT
COUNCIL OF ECONOMIC ADVISERS

Date: July 12, 90

Please deliver to: Linda Stuntz, Dep Und Sec for Policy, Plan & Analysis, DOE Room 7B-098

FAX number of addressee: 586-5313

Telephone number of addressee: 586-5316

From: RICHARD SCHMALENSEE, MEMBER

FAX number of sender: 202-395-6947

Telephone number of sender: 202-395-5036

Number of pages, including cover sheet: 6

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		TOTAL	0:02'51"	6	

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EXECUTIVE OFFICE OF THE PRESIDENT
COUNCIL OF ECONOMIC ADVISERS

Date: July 12, 90

Please deliver to: John Schrote, Dep Asst Sec, Policy, Budget, & Admin, Dept of Interior Room 6214

FAX number of addressee: 208 ~~343-3501~~ 5048

Telephone number of addressee: 208 ~~343~~-4123

From: RICHARD SCHMALENSEE, MEMBER

FAX number of sender: 202-395-6947

Telephone number of sender: 202-395-5036

Number of pages, including cover sheet: 6

TRANSMISSION REPORT

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HANDCARRIED TO:

Teresa Gorman
Associate Diretor for Environment,
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Policy
Office of Policy Development
Old EOB, Room 227

Robert E. Grady
Associate Director
Natural Resources Energy and
Science
Office of Management and Budget
Old EOB, Room 260

Barry McBee
Special Assistant to the Secretary
to the Cabinet
Office of Cabinet Affairs
Old EOB, Room 235

July 12, 1990

TO:

The Honorable D. Allan Bromley
Assistant to the President for
Science and Technology
Office of Science and Technology
Policy
Old EOB, Room 358

MEMORANDUM

COUNCIL OF ECONOMIC ADVISERS

July 23, 1990

TO: ALLAN BROMLEY

FROM: DICK SCHMALENSEE

SUBJECT: Report on Economics of Global Change

As Nancy has no doubt told you, the Task Force generally agreed with your judgement that publication of our report, scrubbed and updated, would be valuable. They also agreed that it should come out as a piece of analysis, not a statement of policy. To this end, it seemed desirable to have it appear in some already-established series, either well before or well after the Second World Climate Conference, which kicks off on October 25. The Task Force decided to try for September publication (to this end members agreed to prepare edits and updates within two weeks) and to defer to you the choice of report series.

The Department of Energy offered its National Energy Strategy White Paper series, and Bob Correl offered the CES Report series. I just heard from DOE that the publication lag in their series is "two weeks or less." I have not hear further from Bob Correl, but he had said "two to four weeks" and was uncertain regarding CES internal review.

I recommend that you decide now to go with DOE, for several reasons. First, the shorter lag gives us a better shot at coming out well before late October. Second, this paper is similar to others in the DOE series, while CES has not put out anything related to economics and hasn't put out much that is low-tech. (I don't know the CES series well, but the DOE series has a number of low-tech inter-laboratory review papers.) Third, the DOE series may well have less visibility internationally. Finally, a definite outlet decision will make it easier to put pressure on people to deliver edits and updates.

Needless to say, I'll be happy to discuss this matter with you, though once she reads the sentence above about the DOE publication lag, Nancy will know at least as much about this as I do...

cc: Howard Gruenspecht
Nancy Maynard

COUNCIL OF ECONOMIC ADVISERS
EXECUTIVE OFFICE OF THE PRESIDENT
WASHINGTON

August 3, 1990

MEMBER OF THE COUNCIL

MEMORANDUM FOR TASK FORCE ON THE ECONOMICS OF GLOBAL CHANGE

FROM: RICHARD SCHMALENSEE

SUBJECT: Science in our report

I would like to suggest a change in the focus of our final report -- a change that will, I think, both simplify our revision task and lessen any problems that might be caused by the report's public unveiling. Specifically, I propose to reduce substantially the space devoted to describing the state of the relevant science.

You will recall that we decided initially to include a fairly extensive discussion of the science both to lay out and justify a set of assumptions to be employed in the impact analysis and to make the document more or less self-contained. You will also recall how much effort our group, mainly composed of non-scientists, spent haggling over the description of the state of the science (particularly the description of the uncertainties), even though we agreed fairly easily on the range of plausible magnitudes that should be considered.

I propose that we draw on the considerable public discussion of the science that has occurred since March and stick more closely to our economic knitting. Thus I think we should have a one-age science section that mainly repeats ranges that the IPCC and others have made public, with full citation of all important sources, and cut out all discussions of GCMs, clouds, and oceans. Beyond numbers, I would merely note that considerable research is under way to resolve substantial uncertainties of various sorts and that all models suggest a considerable lag between changes in trace gas concentrations and warming of the earth system. These points seem both relevant to our discussion and (relatively) non-controversial.

If I don't get any howls of outrage early next week, I'll look to Bob Corell for a condensed science section. If there are production problems at Bob's end, CEA will attempt the task.

COUNCIL OF ECONOMIC ADVISERS
EXECUTIVE OFFICE OF THE PRESIDENT
WASHINGTON

MEMBER OF THE COUNCIL

July 30, 1990

MEMORANDUM FOR TASK FORCE ON ECONOMICS OF THE
WORKING GROUP ON GLOBAL CHANGE

FROM: RICHARD SCHMALENSEE

SUBJECT: Publishing our Report

I learned from DOE last week that they could turn out a White Paper based on our report in about 2 weeks. Such a short publication lag should enable us to get a revision of our report out by the end of September. Dr. Bromley has decided that we should go down this track.

At our meeting of July 19, all present agreed that they would do updates and revisions in two weeks, concentrating on the sections for which they had had primary responsibility. Accordingly, CEA will prepare and circulate a draft final report based on materials (please send WordPerfect files of large changes or inserts) sent to us by COB Friday, August 3 (and on our own work on our sections). We will attempt to do this in two weeks, to allow plenty of time for discussion...

If this timing causes you problems, please call me ASAP.

COUNCIL OF ECONOMIC ADVISERS
EXECUTIVE OFFICE OF THE PRESIDENT
WASHINGTON

MEMBER OF THE COUNCIL

April 23, 1990

MEMORANDUM FOR PETER A.J. TINDEMANS (fax 33-79-512-651)
GEBHARD ZILLER (fax 228-59-3601)

FROM: RICHARD SCHMALENSEE (fax 202-395-6947)

SUBJECT: Economics Research on Global Change/
Temporary Steering Committee

I enjoyed very much meeting both of you and your colleagues at the White House conference, and I look forward to our working together to develop ways to enhance economics research on global change and to integrate it more fully into the international policy process. The purpose of this memorandum is to tell you of a few events that have occurred since our conversation and to make sure we can communicate by fax. (If I hear nothing from you in response to this memo by early next week, I will assume you did not receive it and try to contact you by telephone.)

Since we had agreed that the Japanese should participate in our deliberations, I summarized our conversation to the Japanese conference delegation and asked them to tell me who our correspondent in Tokyo should be. When I receive a name and fax number, I will pass it along to you.

I also summarized our conversation to Chairman Boskin and to the relevant sub-Cabinet coordinating group. I was encouraged to work with you and the Japanese, to concentrate on the substance (getting economics integrated with science and policy-making at the international level), and to reserve judgement on the need for the new Institute the U.S. proposed at the conference. On the basis of our discussions, I led them to expect that there would be a relatively small (fewer than 18 countries, fewer than 10 people per country), informal meeting in Europe in around two months and that you and I and our Japanese correspondent would draw up the invitation list in the next several weeks. Please let me know if I misunderstood your intentions in any way.

MEMORANDUM

COUNCIL OF ECONOMIC ADVISERS

April 27, 1990

TO: MICHAEL BOSKIN
STEVE DANZANSKY

FROM: DICK SCHMALENSEE

SUBJECT: Global Change/ MITI Minister's Visit

I was told earlier this week (sorry for the delay) by a Japanese diplomat that the MITI minister, on his visit here next week, will raise the issue of possible U.S. (and broader international) participation in MITI's new Institute of Industrial Technology for the Global Environment. This possibility will be raised with Michael and, quite likely, with others on the Minister's itinerary. It would be good if the various responses he hears have some common elements. For what it is worth, my top-of-the-head reactions follow.

This Institute, you may recall, is a research operation that will concentrate initially on "carbon scrubbing" -- technologies to remove CO_2 from exhaust gasses and convert it into something useful -- and will go on to consider other environmentally benign technologies. Its agenda is thus broadly consistent with our endorsement of "research for action" at the White House Conference, though I am told that "carbon scrubbing" is not considered a promising approach by many U.S. scientists.

In my view we ought to be cautiously positive. We can hardly stress U.S. budget problems in light of the Conference, and we should support the general thrust of their effort. But there are some real issues about the nature of "participation" or even (their phrase) "co-sponsorship" that would have to be resolved before we could agree to play. These include:

- If this operation is to be internationalized, I think broad participation is important -- a purely U.S./Japan operation could easily be labeled another attempt to stall by our friends in Europe.

- What mechanism would be used to set the Institute's research agenda and to determine its staffing? We would presumably have little interest in passively funding Japanese scientists following a GOJ agenda.

- If patentable technology is developed, who holds the patents, and what licensing policy would be followed? The Europeans could easily view this Institute as PR cover for a Japanese attempt to attain dominance in technologies that will be important in the future. It seems unlikely to me that we want to be seen to be playing the same game.

MEMORANDUM

COUNCIL OF ECONOMIC ADVISERS

January 23, 1990

F
Work M
re
White
Chrono

TO: DICK SCHMALENSEE

FROM: HOWARD GRUENSPECHT HKG

SUBJECT: Presidential Speech to the IPCC

Attached is the memorandum from Admiral Watkins and Bill Reilly to Allan Bromley on the Presidential speech to the IPCC. Also attached are draft guidelines for the U.S. delegation to the IPCC Plenary.

Attached

THE ATTACHMENT TO THIS MEMO IS CLASSIFIED AND IS IN THE SAFE

COUNCIL OF ECONOMIC ADVISERS
EXECUTIVE OFFICE OF THE PRESIDENT
WASHINGTON

MEMBER OF THE COUNCIL

June 15, 1990

MEMORANDUM FOR D. ALLAN BROMLEY

FROM: RICHARD SCHMALENSEE

SUBJECT: Global Change Report

I appreciate your sharing with me Bill Reilly's letter of May 24, which concerned the Task Force report on the economics of global change. Most of the EPA comments are reasonable and deal with small matters of wording, though they do ask for some changes to which other agencies would object strongly. (I was amused in one case to learn that EPA now objects to language on which they had earlier insisted.)

Bill's letter raises an interesting (to me, at least) possibility. I had always assumed, though not happily, that our report would never be released. Bill's observation that "we will likely be updating this report" and his "hope" that the relatively minor comments he enclosed "will be helpful in preparing future versions of this report" suggest he contemplates revision and updating in the relatively near future. It is hard to see why it would be worthwhile putting the Task Force through another painful revision cycle anytime soon unless release of the report (presumably with its "Preliminary" label still affixed) is contemplated.

For what it is worth, I personally think that release of an updated and polished version of this report would serve the Administration well. If Bill agrees, perhaps the Working Group would be inclined to go along. The summer is a good time to do this sort of thing...

COUNCIL OF ECONOMIC ADVISERS
EXECUTIVE OFFICE OF THE PRESIDENT
WASHINGTON

MEMBER OF THE COUNCIL

June 7, 1990

MEMORANDUM FOR MARK KERRIGAN, DOE
DICK MORGENSTERN, EPA
DAN NEWLON, NSF
RAY SQUITERI, TREASURY

FROM: RICHARD SCHMALENSEE

SUBJECT: International Coordination of Economic Research on Global Change; Bonn, July 3-4

At the White House Conference, I initiated informal conversations on international coordination (and promotion) of economic research on global change with the Dutch and West German delegations. (In Working Group discussions, they had indicated a strong interest in an informal steering committee, as an alternative to the U.S. proposal, which I floated as instructed, for one or more international science/economics institutes.) The Dutch and Germans volunteered to handle scheduling, and they have set up a small, informal, agenda-setting meeting in Bonn on July 3 and 4, to be followed by a larger meeting in the Netherlands in September.

CEA is the U.S. contact point for discussions regarding the the promotion and coordination of economics research on global change. As your agencies have substantive interests in economic research on this subject, I would like to invite your participation in developing our agenda for these two meetings. Prior commitments preclude either Howard Gruenspecht or me from attending the Bonn meeting (the dates of which cannot practically be changed). I do, however, plan to attend the September gathering. My secretary will be calling your office to schedule a meeting early next week to (a) provide more background, (b) decide who should go to Bonn (my first impulse is to send Dick and Ray, but I'm fairly flexible), and (c) discuss what the U.S. agenda for that meeting should be.

cc: Steve Danzansky
Bob Corell
Chris Dawson
Lou Brown
Howard Gruenspecht

MEMORANDUM

COUNCIL OF ECONOMIC ADVISERS

June 5, 1990

TO: MICHAEL BOSKIN

FROM: DICK SCHMALENSEE (1:20 PM)

SUBJECT: Another Greenhouse Disaster

I was told this morning by (agitated) MITI personnel based in the US that Fred Bernthal yesterday informally told the Japanese delegation at the Geneva RSWG meeting that the U.S. will reduce CO_2 emissions by 25% over "business as usual" by 2000 -- thus producing approximate stabilization. This information was flashed to Tokyo and from there, early this morning with confirmation requests, to MITI people here.

Linda Stuntz has slightly different information. (There are 3 DOE people on the U.S. delegation, and DOE has an intelligence officer.) DOE understands Fred to have made this statement in a speech (probably at last night's dinner with RSWG officers) and to have spoken of near-stabilization of a comprehensive index of all greenhouse gasses, not of CO_2, by 2000. Either way, this reflects a process breakdown and is a substantive disaster.

- The Bromley strategy group, on which Fred sits and which discussed our RSWG position at length (I was there), did **not** authorize (or even discuss) any statement of this sort. (I have been unable to reach Steve Danzansky to find out if he knows who, if anyone, authorized this statement.)

- The (EPA) numbers that show near stabilization in 2000 on a comprehensive basis are questionable. (See Howard's attached memo of May 23.)

  -- They include the effects of regulations (on landfills in particular) that have not yet been seen outside EPA, let alone approved by OMB.

  -- The projections, assumptions, and calculations have apparently not been comprehensively reviewed by any other agency. (Though the EPA guy in charge is one of their best.)

    - CEA has not been included in this (Boyden-led) process.

- The Japanese are particularly exercised because Bernthal seems to be foreshadowing a softening in the U.S. position on "targets and timetables" for emissions reductions.

  -- The Japanese government is under strong domestic pressure to break with us on global warming and to push for CO_2 targets and timetables.

-- If we are perceived to be softening our position, this pressure may prove irresistible.

- The G-7 could be very ugly as a consequence, with the U.S. completely isolated -- unless we have (mistakenly) decided to soften.

-- If we do soften, the pressure on us to go well beyond "stabilize by 2000" will be intense, since Bernthal asserts that we would incur no costs up to that point.

o The Bernthal statement in either form gives a very misleading impression of the costs of stabilizing U.S. greenhouse emissions over the long haul.

-- Outside the U.S., everyone focuses on CO_2, and the EPA numbers evidently show significant CO_2 increases by 2000.

- The EPA exercise, even if correct, thus says nothing about the cost of CO_2 stabilization.

-- Many of the items on the EPA list are one-shot deals such as control of methane from landfills and phaseout of CFCs that will not reduce emissions after 2000.

- We would have to incur additional (probably very high) costs to avoid increasing greenhouse gas emissions after 2000 as the economy grows.

- That is, stabilization by 2000 may be easy, but stabilization beyond 2000 is unlikely to be.

-- Even within the Administration, many people resist counting CFCs in this context ("they're covered by the Montreal Protocol"); resistance will be stronger internationally.

o The RSWG meeting, which Bernthal chairs, continues through Friday, so there is time to attempt a fix. (See Howard's attached memo of June 5.) Bernthal should be instructed immediately to state from the chair that

-- He was simply sharing preliminary results of an ongoing emissions foreasting exercise dealing with a comprehensive index of all greenhouse gasses, not just CO_2 (in case the Japanese misunderstood).

-- He was neither making any promises nor signalling any change in any U.S. position in this area.

MEMORANDUM

COUNCIL OF ECONOMIC ADVISERS

May 23, 1990

TO: MICHAEL BOSKIN
RICHARD SCHMALENSEE

FROM: HOWARD GRUENSPECHT

SUBJECT: Stabilization of Greenhouse Gases

Speeches made by the President and Administrator Reilly at the White House Conference on Global Change suggested that the United States was already taking actions that would significantly reduce emissions of greenhouse gases (but not carbon dioxide) from the baseline path. The President specifically referred to a 15-percent reduction stemming from the CFC phaseout, the Clean Air Act, the tree planting program, and "other strategies."

Since the conference, the Administration (particularly Boyden Gray) has been looking into the matter. By some accounting, our existing measures will get us a 28-percent reduction from the "no action" baseline. The interesting point here is that EPA's preliminary analysis shows that the available emissions reductions considered comprehensively are apparently close to a stabilization of greenhouse potential over the next 10 years. (CO_2 would go up despite partial offset from trees, but methane and CFCs would go down).

EPA has been invited to brief Boyden again (probably next week) on their latest findings. I would bet my dollar to your dime that Bill Reilly will start pushing this greenhouse stabilization scenario hard within the Administration soon thereafter. This matter could well come up in developing a position on the environment for the Economic Summit.

The issue for the Administration to consider is whether (and when) we want to come out with a pledge to stabilize our comprehensively measured greenhouse contribution for 10 years while scientific and economic uncertainties are resolved.

In considering this and other environmental issues, it is important that the Administration get its act together. Instead of reacting viscerally to each individual proposal, we need to develop a strategy that achieves our real environmental objectives, achieves a creditable environmental record, and avoids large cost/no benefit blunders. This shouldn't be that hard to do, but we haven't managed to do it. The problem is our unwillingness of the Administration to hold its nose on some of the highly symbolic, smaller environmental issues that would help establish our environmental credibility. By taking the bait on

these small issues, like the CFC fund for LDCs, we are much less capable of holding the line when serious matters are at stake.

Greenhouse is clearly one of the big issues that we want to decide on purely substantive grounds. Pros and cons related to the idea of a stabilization pledge include:

- Coming out with such a pledge could get us some green stamps -- the same commodity that our recently announced policy on CFC reduction funding support for LDCs needlessly squandered.

- On the other hand, any commitment along these lines, even if incidental to currently planned actions, would legitimize the position that immediate action is called for. Once having engaged, we would be under enormous pressure to screw down tighter.

- A long-term commitment to "greenhouse stabilization" would be tantamount to a commitment to "CO_2 stabilization" at a future emission level. This is true because many of the steps in the EPA preliminary analysis are "one time only" actions. Once we phase out CFCs or impose methane control regulations on landfills, for example, opportunities for further reductions needed to offset growth in CO_2 look much less attractive.

- Reductions from a no policy baseline will be interpreted in the environmental community as something of a sham, since it is impossible to pin down the counterfactual with any accuracy. They will ridicule any attempts to count CFCs covered under the Montreal Protocol.

- Our foreign friends will not be satisfied by this gesture - they want carbon dioxide reductions, the real McCoy. It may make more sense to conserve whatever slack we may have for the negotiation process. The way things are looking now, we're going to need more than we have on hand.

- For reasons we have discussed before, it makes no sense in either environmental or economic terms to minimize the costs of environmental commitments.

If we decide not to make a stabilization pledge at this time, the dissemination of official documents suggesting that such a pledge is free could cause some embarrassment. We might want to look ahead to this possibility.

MEMORANDUM

COUNCIL OF ECONOMIC ADVISERS

June 5, 1990

TO: RICHARD SCHMALENSEE

FROM: HOWARD GRUENSPECHT

SUBJECT: RSWG Agenda

The RSWG meeting is scheduled for June 5 through June 8. The matter in question might have come up during Bernthal's dinner with the RSWG officers last night.

My understanding of the agenda is as follows:

June 5, 6	Editing Sessions on RSWG subgroup reports.
June 7	Editing RSWG Policymakers' Summary
June 8	Vote on RSWG report, begin to consider future RSWG workplan.

The schedule does not appear to contemplate new discussions of policy substance.

MEMORANDUM

COUNCIL OF ECONOMIC ADVISERS

September 18, 1990

TO: ALLAN BROMLEY

FROM: DICK SCHMALENSEE

SUBJECT: Global Change

I appreciate very much your kind memo of a few days ago, thanking Howard and me for our comments on your paper. We were, after all, just doing what they pay us the big bucks to do...

On a more substantive note, I offer two thoughts for your consideration.

It seems clear now that the ad hoc coordinating committee for research on the economics of global change that I initially triggered at the White House conference has been captured by the NSF and its sister agencies abroad. This means that movement has slowed (the next meeting will be in February, not this month), that the focus has broadened beyond economics to all social science (per the organizational structure of NSF and related agencies), and that the emphasis is on basic research that might be related to global change rather than on applied research that definitely is. This is by way of information, not complaint, since some coordination of this sort is clearly called for, and I don't know that I would undo what has been done even if I could.

But this development does cause me to wonder what international mechanisms might foster and coordinate economic research aimed specifically at global change policy concerns. The OECD's efforts will serve this purpose to a limited extent, but their focus is so far limited to a single question (costs of reducing CO_2 emissions), necessarily involves only the developed market economies, and will mainly be done by existing OECD staff. The only other possible venue that suggests itself is the regional institutes that were also born at the White House conference and that you are moving forward; these have the added virtue of potentially involving developing economies. To this end, I'd like to enter a plea that economics research not be neglected or (effectively the same thing) be assigned a clearly subordinate role in these institutes.

On the domestic front, I am beginning to share the unease of many of my professional colleagues around the Administration at having economic research on global change under the control of scientists rather than economists. (I do not mean by this usage to admit that economics is not a science, just that it is neither a physical nor a life science.) We had agreed to CEES control of

the economics research effort on the assumption that it would be in name only, with economists really in charge of the economics, and because we had no obvious better alternative. Dallas Peck's strong interest in the "ad hoc group of economic experts" he was asked by Bob Grady to convene, his absolute insistence that Bob Corell (fine fellow, but no "economic expert") co-chair that group, and a bit of introspection suggest we may have been too optimistic.

Whenever economic research (or social science research in general) is treated as a second-class adjunct to research in the sciences, it does not attract able researchers and thus does not produce results. I now fear that the structure of the CEES apparatus guarantees economics second-class status. However appropriate this might or might not be on intellectual grounds, it makes no sense in the policy context: the unanswered economic questions are not noticeably less important for policy purposes than the unanswered scientific questions. Moreover, we cannot function on a permanent basis with "ad hoc group[s] of economic experts"; we need a durable, workable governance structure. Thus I believe we should re-think the U.S. governance structure for economics research related to global change, with an eye to putting economists explicitly in charge, since many agencies will be involved in such research for some years to come, and interdisciplinary turf battles will not serve anyone well.

cc: Michael Boskin
Howard Gruenspecht
Kenneth Yale

EXECUTIVE OFFICE OF THE PRESIDENT
COUNCIL OF ECONOMIC ADVISERS

September 13, 1990

Howard:

Please re-read the attached and recall the following. We got agreement to publish this report contingent on getting it out by early October. Since it was clear that EPA would have a raft of delaying objections to almost anything we gave them, this effort was put on a fast track. If we get this report out for comment tomorrow, we will be 4 weeks late, and publication will be in doubt. If it goes out later, we are in deep trouble.

I know you have worked hard and well on many things since August 3. But until this job is done, unless Michael or I personally direct or approve specific other work, **you are to spend NO TIME WHATEVER on anything but the Dingell response (top priority), the global change report, and the economics research budget committee** (about which we should talk before your meeting). This means no meetings, no phone calls, no legislative referrals, nothing. Please see me if this is at all unclear.

Richard Schmalensee
Member

COUNCIL OF ECONOMIC ADVISERS
EXECUTIVE OFFICE OF THE PRESIDENT
WASHINGTON

MEMBER OF THE COUNCIL

July 30, 1990

MEMORANDUM FOR TASK FORCE ON ECONOMICS OF THE
WORKING GROUP ON GLOBAL CHANGE

FROM: RICHARD SCHMALENSEE

SUBJECT: Publishing our Report

I learned from DOE last week that they could turn out a White Paper based on our report in about 2 weeks. Such a short publication lag should enable us to get a revision of our report out by the end of September. Dr. Bromley has decided that we should go down this track.

At our meeting of July 19, all present agreed that they would do updates and revisions in two weeks, concentrating on the sections for which they had had primary responsibility. Accordingly, CEA will prepare and circulate a draft final report based on materials (please send WordPerfect files of large changes or inserts) sent to us by COB Friday, August 3 (and on our own work on our sections). We will attempt to do this in two weeks, to allow plenty of time for discussion...

If this timing causes you problems, please call me ASAP.

THE CHAIRMAN OF THE
COUNCIL OF ECONOMIC ADVISERS
WASHINGTON

July 24, 1990

Dear Chairman Dingell:

The issues raised by your letter of June 18 are important and complex. This letter provides a brief qualitative discussion of the economic costs of proposed clean air legislation. Secretary Dole and I will also provide answers to your specific questions (insofar as possible) and a copy of the Administration's latest cost analysis in a later response. Before turning to economic costs, let me make clear at the outset that the air pollution problems addressed by the President's proposal merit strong and swift attention.

The President has asked CEA to coordinate the Administration's evaluation of the costs of proposed clean air legislation. Speaking on behalf of my colleagues throughout the Administration, let me state emphatically that we do not share the view that a major extension of the clean air act can have low, zero, or even negative costs. Assertions in the media to the effect that expanded clean air programs would on balance create jobs, increase productivity, and make the U.S. economy more competitive in world markets are at best wishful thinking. They are as economically illiterate as other claims in the media that any clean air legislation must necessarily cripple the economy.

The President's strong clean air proposal was carefully crafted to make significant progress toward solution of important environmental problems--including acid rain, nonattainment of carbon monoxide and ozone air quality standards, and industrial air toxics--by setting sensible targets and making maximum use of flexible, incentive-based control mechanisms. It was thus designed to minimize costs and dislocations and to be compatible with strong economic growth. The President's support for this proposal was not premised on the view that its costs would be negligible; he is fully aware that any environmentally strong clean air bill will reduce real income growth and cause some temporary unemployment. Rather, the President believes that our Nation is able and should be willing to pay a reasonable price to clean its air.

But the President is not prepared to see American firms, workers, and consumers overcharged or to see economic growth slowed needlessly. From this point of view, the costs of both

the House and Senate bills are too high. Fortunately, the conference has the opportunity to produce an environmentally strong bill while avoiding needless costs.

Notwithstanding their significantly higher costs, the House and Senate bills provide, at best, only very slight additional environmental benefits as compared to the President's proposal. The President's original proposal would impose annual direct, quantifiable costs in the neighborhood of $20 billion in the year 2005, when its provisions would be fully phased in. Current estimates indicate that the bills passed by the House and Senate would each impose corresponding costs of around $25 billion. Taking the most costly features from each bill, and adding the costs of the Tier II tailpipe standards, could result in a total annual phased-in cost exceeding $35 billion.

While reasonable people may differ on the appropriate balance between economic and environmental concerns, it clearly makes no sense to squander our scarce human and investment resources in programs that are not expected to yield significant additional environmental returns. For example, the Senate bill requires strict additional cold start carbon monoxide controls at an annual cost of over $2 billion at a date when EPA projects that there will be few violations of the ambient carbon monoxide standard related to vehicle emissions. This provision simply imposes needless costs on American firms, workers, and consumers.

Moreover, detailed micromanagement of the economy, such as the prescription of particular fuel formulations by statute, limits flexibility and retards innovation without improving the environment, thereby adding to both cost and dislocation. Similarly, failure to provide local areas with the necessary authority and flexibility to solve local problems adds needless costs.

Simply put, the diversion of labor and capital investment resources that would otherwise be devoted to the production of conventional economic goods and services into expanded environmental programs will decrease economic output. Thus the direct compliance costs discussed above are manifested in and give rise to a number of adverse economic effects mentioned in your letter. The rest of this letter is devoted to a fairly detailed qualitative discussion of these effects.

First, if the Clean Air Act is significantly strengthened, future real consumption in the U.S. economy (excluding environmental benefits) will be somewhat lower than it would have been, and productivity growth will be reduced. Resources that must be devoted to reducing air pollution are simply not available to produce consumer goods and services or to make investments that would increase productivity. Growth in workers' average real income and in productivity will thus both slow.

Second, while the proposed legislation may stimulate exports related to pollution control expertise and technology, on balance our international competitiveness will be reduced. (Both effects reflect the fact that no other nation has developed an air pollution control program as sophisticated or as far-reaching as the proposals currently being considered by the conference.) The diversion of resources needed to comply with new mandates will occur in a global competitive environment in which our nation already suffers from shortages of skilled labor and a rate of investment in productive capital persistently lower than that of the other major industrialized countries. Any new regulatory mandates or permitting procedures that increase the time required to bring new products or new production facilities on line will hamper the ability of American firms to compete with their foreign rivals.

Domestic industries that are required to spend intensively on pollution control will definitely become less competitive in world markets, and some jobs will move offshore as a consequence. Demand for the output of other industries will increase, but these industries will not automatically become more competitive as a consequence. Demand growth does not automatically improve productivity or induce innovation.

Third, shifts in economic activity induced by the proposed clean air legislation will produce some temporary unemployment. If overall economic conditions are healthy and monetary and fiscal policies are sound, workers displaced by clean air legislation will find new jobs, just like the hundreds of thousands of U.S. workers who are displaced each year for other reasons, including changes in demands for particular products and advances in technology. As our flexible economy adapts to changes of all sorts, the number of jobs created every year substantially exceeds the net increase in employment, as workers who lose or leave jobs find new employment.

However, even though U.S. labor markets are generally quite flexible and efficient, and U.S. workers are generally mobile both geographically and occupationally, some displaced workers could endure substantial unemployment and suffer significant income losses. The President's proposal minimized these impacts by avoiding needless costs and preserving flexibility wherever possible. The House and Senate proposals, as they now stand, would needlessly amplify these temporary dislocations.

On the other hand, proposed clean air legislation is not likely to have important permanent effects on the aggregate level of U.S. employment. The levels of employment and unemployment in the economy as a whole are primarily determined by overall economic conditions, which the government mainly affects by monetary and fiscal policy.

Similarly, one should be skeptical of suggestions that forced investment in pollution abatement equipment can provide a stimulus to the economy as a whole. While this effect might operate in a deep, protracted recession, such recessions are rare historically. Since the proposed legislation mandates the timing of environmental investments, it would be an extraordinary coincidence if those outlays happened to occur under such adverse economic conditions.

Major clean air legislation will impose additional costs, which are difficult to quantify, via the permitting and enforcement process. Direct administrative costs may be particularly high for smaller firms that have had little contact with this process to date. These firms will likely need to devote considerable managerial attention to this process and to hire outside consultants, particularly under the major source definitions incorporated in the House bill. Indirect costs include the carrying costs, uncertainties, reduced innovation, and lost opportunities imposed by regulatory delays.

In conclusion, let me reiterate the Administration's view that the conference has the opportunity to make significant progress toward solution of important environmental problems while avoiding needless costs. The best way to ensure the compatibility of a healthy environment and a strong economy is to enact a clean air bill that achieves the President's strong environmental goals through flexible, cost-minimizing means.

Sincerely,

Michael J. Boskin

Michael J. Boskin

The Honorable John D. Dingell
U.S. House of Representatives
Washington, D.C. 20515

Action: RS + HL

U.S. House of Representatives
Committee on Energy and Commerce
Room 2125, Rayburn House Office Building
Washington, DC 20515

June 18, 1990

The Honorable Elizabeth H. Dole
Secretary
Department of Labor
200 Constitution Avenue, N.W.
Washington, D.C. 20210

The Honorable Michael Boskin
Chairman
Council of Economic Advisors
Old Executive Office Building, Room 314
17th and Pennsylvania Avenue, N.W.
Washington, D.C. 20500

Dear Secretary Dole and Chairman Boskin:

As you both know, as chief sponsor and supporter with Congressman Lent of the President's Clean Air Act bill, H.R. 3030, I have been concerned about the impact of the present law with the proposed amendments on the Nation's working force, particularly the manufacturing industries, and on productivity. Indeed, I have had an extensive exchange of correspondence with the Labor Department and the Environmental Protection Agency (EPA) concerning the impact on jobs in coal mining. That exchange is reflected in the enclosed Committee report on H.R. 3030.

Last year, with the help of the General Accounting Office, I initiated an investigation concerning wood furniture plant closings in Southern California and the movement of those plants to Mexico and other States under the Clean Air Act. I asked the EPA to investigate under section 321 of the Act, but EPA (in an April 24, 1990 letter to me) declined to do so. (A copy of that letter, together with a related letter from the Commerce Department is enclosed.) The GAO investigation is continuing. The EPA letter states:

> Although the measures required to attain the air quality standards will lead to alterations in the operations of some businesses, especially in the South Coast Basin, EPA believes that the decreased employment in some sectors will

> be offset by increased employment and business activity in other sectors. A comprehensive picture of these economic and social impacts is provided in an analysis by the South Coast Air Quality Management District of the impacts of their plan to attain the air quality standards. Enclosed are several relevant sections of that report. As shown in Enclosure 2, the District's plan is estimated to result in increased employment in the Basin by 2010 of some 80,000 jobs. Although there will be employment reductions in certain parts of the economy, this will be largely offset by new jobs in the pollution control and services industry. Clearly, the State and the South Coast District are aware of the employment impacts of the plan and, in fact, the State has directed the District to provide $1 million per year to assist small businesses in complying with the District's rules. (Underlining supplied.)

Also enclosed are relevant articles from The New York Times and The Washington Post and a letter to the National Association of Manufacturers.

I am troubled by the EPA statement that while existing manufacturing jobs will be lost, they "will be largely offset by new jobs in the pollution control and services industry." The statement fails to recognize or discuss the social impact of job loss or wage cuts on the existing wage earner and his or her family. It fails to recognize or discuss that the new jobs may be in other States, or miles away, or even Nations apart. It fails to recognize or discuss the impact on productivity and growth of the economy. It fails to recognize or discuss the wage differential of the jobs lost and those gained, or the time delay between jobs lost and jobs replaced. It fails to recognize or discuss the secondary effects on other industries. It fails to recognize or discuss the competition impacts. It fails to recognize or discuss the impact on minorities. It fails to recognize or discuss the impact on unemployment costs. Despite these failures, the EPA and environmental organizations have made this offset claim several times without explaining the basis for it and the Administration, in providing cost estimates of its proposal has, to my knowledge, never discussed these very relevant concerns. I request that you do so for the conference on S. 1630.

In particular, I request that you both discuss this so-called "offset" and address each of the failures just identified and explore the general nature of the jobs that may be placed "at risk" as a result of the implementation of the Clean Air Act with the new amendments and explore how those "at risk" jobs might compare to jobs that might be created as a result of such implementation. Enclosed are specific questions which should help address these important issues. I request your

response to each within your area of expertise. In responding, I particularly want the Chairman of the Council to explain to what extent these matters are reflected in the cost estimates of the various versions of the legislation.

I also understand that the Council has prepared drafts of memoranda analyzing the various versions of the Clean Air Act bills that passed the House and Senate. However, apparently those memoranda have never been made public. I request them.

I request your reply to all of the above matters by July 6, 1990. Please do not delay.

With best wishes.

Sincerely,

JOHN D. DINGELL
CHAIRMAN

cc: The Honorable Norman F. Lent, Ranking Minority Member
Committee on Energy and Commerce

The Honorable Dan Rostenkowski, Chairman
Committee on Ways and Means

The Honorable Augustus F. Hawkins, Chairman
Committee on Education and Labor

The Honorable Robert A. Mosbacher, Secretary
Department of Commerce

The Honorable William K. Reilly, Administrator
Environmental Protection Agency

The Honorable Richard G. Darman, Director
Office of Management and Budget

The Honorable Charles A. Bowsher, Comptroller General
General Accounting Office

Mr. Jay Power, Legislative Representative
AFL-CIO

Mr. Alexander Trowbridge, President
National Association of Manufacturers

Mr. Carter V. Fox, President
American Furniture Manufacturers' Association

Questions by Chairman John D. Dingell
Regarding Job Loss, Dislocations, Wage Cuts,
and Offsets Re Clean Air Act

1. A 1982 study provided to me by the Congressional Reference Service by H & W Management Science Consultants (enclosed) attempts to categorize the types of job created by the Air Pollution Control industry (APC). Please comment on the adequacy of the study which admittedly is now several years old.

2. According to that report, 46 percent of the employment produced by the APC industry is direct employment related to the fabrication, design, and installation of APC equipment; 19 percent is associated with materials and auxiliary equipment, including monitoring and testing; and 35 percent is for services, including government regulation. Examining the breakdown of jobs created by the industry as shown in table 1 from the report, please provide the Committee with the average wage and benefit package for each category of jobs. Any specific examples you have would be appreciated.

3. The study assumes that the jobs created by the APC industry are located in the area making the expenditure. How reasonable is this assumption? Based on the categories listed in table 1, what are the most likely areas of the country for these jobs to be created under the proposed amendments to the Clean Air Act? To what extent are the jobs likely to be located in a foreign country?

4. Pollution abatement equipment includes several sets of components, including: the basic technological device; auxiliary equipment such as fans, switches, valves, etc.; support and housing facilities, such as foundation, walls, roofs, bracing, ducting, etc.; and operating aspects, such as monitors, controllers, repair parts, and maintenance. For each component for each industry affected by the amendments, what is the likelihood that the equipment/technology will be supplied from domestic suppliers? What is the likelihood that the equipment/technology will be supplied from overseas suppliers? What is the likelihood that the equipment/technology will be produced under license to an overseas source?

5. Most attempts to estimate potential job losses from enactment of the Clean Air Act Amendments of 1990 have focused on deriving a net gain-lost number. The Committee is interested in the types of jobs that are at risk from implementation of the Clean Air Act with the Amendments of 1990. Are they primarily resource extraction (mining), manufacturing, service, government, or other category? Are they the same job categories most likely to be gained from such legislation? Please explain. What is the affect on productivity and growth? How do the new jobs improve productivity?

6. What are the average wage and benefit packages of the categories of jobs identified in response to question 4? How do they compare with the wage and benefit packages of jobs identified in table 1?

7. How does the timing of the jobs that the Amendments "create"--identified in table 1 -- compare to that of jobs possibly lost from the Amendments -- those identified as at-risk in the response to question 4? Are there notable gaps or overlaps between job creation and job elimination? Please explain.

8. Much has been made of the multiplier effects of jobs on other jobs in a community. Please explain it. Does the multiplier differ according to the type of job created (manufacturing, mining, service) or the location of the job (urban versus rural)? For the jobs associated with the categories listed in table 1, what are their relative employment multipliers? How do they differ according to location?

9. What, if any, are the multiplier effects of the job categories identified in response to question 4? How do they compare with the multiplier effect of the jobs identified in table 1?

10. For the at-risk job categories identified in response to question 4, what are the racial, ethnic, age, and sex profiles? How do those patterns compare to the patterns associated with the categories of jobs created that are identified in table 1? Similarly, how do the educational requirements for the at-risk job categories compare to the educational requirements of the created jobs?

11. It is well understood that compliance with Clean Air Act Amendments will result in shifts in coal mining employment between different regions. Are the jobs per ton of coal mined and the multiplier effects substantially different between these various coal mining regions? Between high and low sulfur coal mining areas?

12. The enactment of these Amendments may result in the consolidation of certain service industries, such as dry cleaning, in order to accommodate increased costs of pollution controls. Are there examples from other regulatory actions that would indicate the magnitude of job attrition from such consolidations? For example, the shrinkage in numbers of service stations during the energy crisis of the seventies.

13. Many argue that the U.S. air pollution control industry will benefit substantially from tighter air pollution regulations. Please describe and identify more clearly that industry and its various segments. Is there any reliable analysis to suggest that the various segments of this industry can meet sharply increased demand without incurring bottlenecks or other dislocations? If not, will foreign suppliers such as Japan and West Germany make substantial inroads into U.S. markets partially offsetting the

putative domestic employment benefits of pollution control expenditures?

Table 1

Overall Summary of Employment in the APC Industry

Labor Associated with:	Man-Years of Employment	Share, %
1. Fabrication, design & installation of APC equipment	40,787	36.7
2. Direct and Auxiliary Materials and Equipment	14,988	13.5
3. Government	13,780	12.4
4. Services	11,825	10.6
5. Operation, Maintenance & Repair	10,500	9.4
6. Architects & Engineers	8,269	7.4
7. Monitoring & Testing Equipment	6,150	5.5
8. Manufacturer's Representatives	1,684	1.5
9. Independent Attorneys	1,600	1.4
10. Additional Support Staff	1,500	1.3
11. Other R & D	300	0.3
Total	111,383	100.0

SOCIO-ECONOMIC AND HUMAN DIMENSIONS RESEARCH RELATED TO GLOBAL CHANGE

(Final 4.7.1990)

A procedure for strengthening and implementing of national and international socio-economic and human dimensions research activities

Background

Problems of Global Change have now come to the forefront of discussions between scientists as well as politicians. A number of internationally coordinated programmes exist, which focus in particular on issues addressed by the natural sciences. Most notable in this respect are the WCRP and IGBP of WMO and ICSU. However, Global Change implies major consequences for society and the economy. Therefore, recent conferences have stressed the need to stimulate research on human aspects related to Global Change on an international level and to integrate these aspects in other ongoing research activities. The HDGCP of UNU, IFIAS, ISSC and UNESCO and the initiatives of OECD, IEA, ESF and EC on economics, environment and energy should be noted.

Aim

Efforts should be undertaken to strengthen existing activities for socio-economic and human dimensions research in order to increase the orientation towards problems directly related to Global Change.As a first step, a summary description of existing national and international research activities should be prepared. This will enable us to identify existing research gaps. Endeavors to assess the current status of socio-economic and human dimensions research, e.g. as provided by the IPCC, will also be taken into account. Within an international framework the activities will build upon and be financed on a national level. However, there is the intention to establish better links between them and, in particular, with the natural sciences programmes. The contents of the activities should be defined by a bottom-up approach, in particular by groups of scientists in an analogous process, as e.g., in the IGBP and national Global Change programmes.

In addition, these programmes should be responsive to policy needs (e.g., IPCC). There is a need for coordination of the activities in the sense of an effective exchange of information and an informal consultation between governments with respect to emerging trends in research and resource needs in the social and economic sciences.

Procedure

To implement the above-mentioned activities, the following steps are proposed:

- Preparation of a short overview per country on existing activities, involved agencies and funding commitments, etc. in socio-economic and human dimensions research related to Global Change. These overviews should follow a common formatted structure to achieve comparability. In addition the same kind of information should be assembled on international research activities in this field. The reports should also identify gaps and areas where special initiatives could be taken.

- Continuation of the informal meeting between governmental agencies active in Global Change research, (hereafter called the "Working group on social and economic science research") as started with the first meeting in Bonn (3 July 1990). The number of countries invited to participate will be enlarged to include at least the members of the international group of funding agencies.

- The meetings will focus on particular research topics. In addition to governmental agencies' representatives leading scientists in the appropriate field will be invited to look at the state-of-the-art of the respective scientific disciplines as well as a discussion of general aspects such as funding requirements, capacity building, training and involvement of Third World countries.

- The UK offered to host the next meeting in February 1991, in conjunction with the next meeting of the group of funding agencies. This meeting will focus inter alia on the topic of environmental economics.

Summary notes on the
Joint Meeting of the "Working group on Socio-Economic and Human Dimensions Research related to Global Change" and the "Representatives of National Funding Agencies for Global Change"
(4 July 1990)

During the joint meeting on July 4th 1990, in Bonn, the following topics were dealt with:

- the result of the meeting of the "Working Group..." on 3 July 1990

- the role of ICSU in the field of Global Change research

- the background and intention of the work for the group of Representatives of National Funding Agencies for Global Change.

It was agreed upon:

- Socio-economic and human dimensions research related to Global Change and analysis of the interactive links between social, economic and human issues and global environmental changes comprise an important and inherent part of the overall Global Change research Program.

- To further these research efforts it is understood that an informal working group, hereafter called "International Group of Funding Agencies" for Global Change Research (IGFA) is initiated. The group will be formed by the two former groups present at this joint meeting.

- The concept of a "High Level Governmental Group" which will receive and discuss reports from the IGFA was postponed at that time. It should be discussed in more detail at the next meeting in London, February 1991, on the basis of a draft outlining the task, mandate and composition of this "High Level Group".

- The London meeting will be prepared by a group of four countries (UK, US, NL, D); additional comments, suggestions from all participants are welcomed.

3 July 1990

WORKING GROUP ON SOCIO-ECONOMIC AND HUMAN DIMENSIONS RESEARCH OF GLOBAL CHANGE RESEARCH

- experts from five countries

- agreed on need for coordination of activities
  (coordination = effective exchange of information and consultation among national funding agencies re: emerging trends in research and resource needs in social and economic sciences)

- brief overviews on national activities to be prepared and discussed at next meeting in February 1991

- next meeting will focus inter alia on environmental economics

4-6 July 1990

INTERNATIONAL GROUP OF FUNDING AGENCIES FOR GLOBAL CHANGE RESEARCH

- **participants from national funding agencies in ten countries and Commission of European Communities**

- **scientific leaders of seven international projects under IGBP and WCRP gave presentations**
  - **highlighted research needs**
  - **comparisons made with national commitments of resources**
  - **identification of areas of action**

- **agenda for next meeting (4-6 February 1991, London) including joint meeting with IGBP National Committee Chairs**

4 July 1990

JOINT MEETING OF WORKING GROUP ON SOCIO-ECONOMIC AND HUMAN DIMENSIONS RESEARCH AND THE INTERNATIONAL GROUP OF FUNDING AGENCIES FOR GLOBAL CHANGE RESEARCH

(Scient. Ass.)

- merge interests under an informal working group "International Group of Funding Agencies for Global Change Research" 1
- group will serve as information exchange for all aspects of national and international global change research efforts
- meet again 4-6 February 199[illegible] (London)
- participants briefed on ICSU activities in global change
  - IGBP Scientific Advisory Council
  - "Global Change Forum"

4-6 February 1991
INTERNATIONALGROUP OF FUNDING AGENCIES FOR GLOBAL CHANGE RESEARCH

- o environmental economics (FRG lead, Netherlands, Canada, US)
- o long-term observational system and data management (US lead, Japan, France, Canada)
- o joint meeting with IGBP National Chairs (IGBP Secretariat, US)
- o developing country participation (IGBP Secretariat, Canada)
- o agency funding for international secretariats/offices which support global change research programs, including WCRP and IGBP
- o update of 4-6 July 1990 resource review of global change research activities (US)
- o "High level forum" idea (Netherlands lead, FRG, US)
- o Report on ICSU Forum (ICSU)
- o Second World Climate Conference/Intergovernmental Panel on Climate Change (France, Finland, US)
- o Regional Research Centers (IGBP Secretariat, France)
- o Scientific Committee on Antarctic Research (SCAR) -IGBP activities in Antarctica

DOE/PE-0096P

The Economics of Long-Term Global Climate Change

A Preliminary Assessment

Report of an Interagency Task Force

September 1990

United States Department of Energy
Office of Policy, Planning and Analysis

DOE/PE-0096P

The Economics of Long-Term Global Climate Change

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United States Department of Energy
Office of Policy, Planning and Analysis
Washington, DC 20585

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EXECUTIVE SUMMARY

This report is intended to provide an overview of economic issues and research relevant to possible, long-term global climate change. It is primarily a critical survey, not a statement of Administration or Department policy.

There are substantial gaps in current knowledge about the economics and physical science of global climate change. In fact, almost all the quantitative projections in this report, as well as many of the qualitative assertions, are controversial. Projections of climate effects and costs in the distant future are inherently less reliable than forecasts of climate and policy costs in the short run.

The Task Force recommends that a coordinated economic research program be undertaken, similar to that in the climate sciences, that would evaluate the economic effects of possible future climate change and the benefits of slowing such change, the costs and effectiveness of various adaptive and emissions reduction measures, and the effects of such measures on U.S. and world trade and capital flows.

The remainder of this Executive Summary provides a brief outline of our main findings. Readers with an interest in a particular topic, such as the impact of possible climate change on agriculture or estimates of the economy-wide impacts of measures to limit carbon dioxide (CO_2) emissions, should note that the main report, while lengthy, is structured to allow for a selective reading.

Background

Greenhouse Gas Emissions

Possible climate change is not a one-gas or one-nation problem. Carbon dioxide, chlorofluorocarbons (CFCs), methane (CH_4), and nitrous oxide (N_2O) have accounted for about 87 percent of the increase in radiative (greenhouse) forcing in the 1980's. Projections of future emissions of these gases are uncertain, and comparisons of the effects of those emissions are not completely straightforward.

Carbon Dioxide. Given the projected expansion in fossil energy use throughout the world, CO_2 is expected to account for a larger share of increased radiative forcing in the future than in the past. The United States now accounts for about 21 percent of total anthropogenic CO_2 emissions, but that share is expected to shrink to around 12 percent by the middle of the next century.

Methane. Emissions rates of major sources of CH_4 are subject to significant uncertainty. Over half of total anthropogenic emissions of methane are produced by domestic animals (enteric fermentation) and rice cultivation. Centrally planned and developing nations account for the bulk of these emissions.

Chlorofluorocarbons. The United States and other developed nations now account for well over half of emissions of CFCs and related gases, but the shares of developing nations are expected to increase sharply as reductions and phaseouts are implemented in accord with the Montreal Protocol.

Nitrous Oxide. Most N_2O emissions are associated with agricultural activity and animal husbandry. Data

on natural and anthropogenic sources of nitrous oxide emissions are poor.

Scientific Background

While this report provides a brief discussion of the scientific background to this issue, that discussion should not be interpreted as an attempt to address or evaluate the scientific uncertainties surrounding possible climate change.

Projections of future emissions of greenhouse gases are highly sensitive to future rates of population growth, economic growth, and development of new technologies for energy production and use. The inability to place narrow bounds on any of these factors necessarily places very wide bounds on any forecast of future emissions.

Even if future emissions are assumed to be known, considerable uncertainty attaches to the climate changes that would result from increased atmospheric concentration of greenhouse gases. The effects of greenhouse gases on global climate are forecast by climate models, a relatively new tool. Present climate models predict that a doubling of the concentration of carbon dioxide relative to the preindustrial atmosphere—or its equivalent in terms of a combination of greenhouse gases—would result in an eventual global average warming of between 2°F and 9°F. If the atmosphere begins to warm, a transfer of heat from the air to the oceans is expected to slow the rate at which air temperature actually rises. This effect could delay the full impact of any given increase in the concentration of greenhouse gases on observed air temperature for decades or even centuries, with wide variations by region.

Some models suggest a marked soil moisture decrease in mid-latitude continental regions during summer. Global sea-level increases by the year 2050 of 25 to 40 centimeters (a recent estimate of the Intergovernmental Panel on Climate Change, or IPCC) could occur if warming of 2°F to 8°F occurred by the middle of the next century.

Although the public discussion and most of the initial scientific work has focused on the assessment of changes in mean global surface temperature, many of the impacts of possible climate change considered in this report could be more dependent on other climate variables. Examples of such variables include changes in soil moisture, in summer precipitation or extreme temperature by region, and in the number of days in a row when the temperature exceeds a threshold value important to particular activities or natural processes. A greater focus on these variables will be important in the effort to refine current impact estimates and develop new ones.

Policy Alternatives

Planned adaptation involves actions taken in recognition of anticipated warming to deal with its effects. Unplanned adaptation involves short-run responses to actual warming as it takes place. Mitigation policies are aimed at reducing the rate of possible warming by reducing net emissions of greenhouse gases. Mitigation policies must generally be implemented well before adaptation policies. They must also be implemented on a global scale. The important economic implications of differences in timing between adaptation and mitigation costs can only be revealed by discounting.

Most studies of impacts and adaptation costs considered in this report provide estimates for at most a small set of climate change scenarios. Differences in methods and assumptions preclude addition of costs across studies. Impacts and costs are almost always estimated relative to a baseline of no climate change. Such estimates necessarily overstate the reductions in impacts and adaptation costs associated with mitigation strategies, such as those considered in this report, that do not stabilize atmospheric concentrations of greenhouse gases and thus, under the assumptions of current climate models, do not forestall climate change entirely.

Given that the implications of global warming are still unclear, additional research is certainly called for. Uncertainty also increases the attractiveness of

relatively inexpensive, flexible policies that can easily be reversed or expanded, and policies that can be justified for reasons other than climate change.

Adaptation: Living With Global Warming

Climate and the Economy

The direct economic effects of climate change would be concentrated primarily in agriculture, forestry, and possibly fisheries, which currently account for about 2 percent of U.S. gross domestic product (GDP) and about 5 percent of world GDP. In addition, a rise in the sea level could inundate valuable dry land. Apart from agriculture and sea-level rise, little quantitative research on climate impacts or adaptation costs has been done.

The indirect effects of climate change will create winners and losers throughout the United States and global economies as demand shifts occur. For example, demand for air conditioners and summertime electricity could rise, while demand for space heating equipment and fuels and could fall. Tourism might also be affected. The costs of adaptation would depend critically on how rapidly warming occurs relative to the economic lifetimes of major immobile assets.

Agriculture

Climate change could affect agricultural yields both positively and negatively through variations in regional temperature, seasonality, precipitation, and soil moisture. Estimates of these effects are very uncertain. While increased CO_2 concentrations alone would likely have a direct positive effect on efficiency of photosynthesis and water use, the effects of higher temperatures could reduce yields. Estimates of the impact of future global change on U.S. cereal crop yields range from an increase of 10 to 15 percent to a decrease of about the same magnitude.

Net economic effects on any country's agricultural sector depend on global yields and consequent impacts on market prices and trade flows as well as on regional yield effects. Analysis by the U.S. Department of Agriculture of a scenario in which the U.S. grain and oilseed crop yields decrease by between 10 and 15 percent shows slightly increased overall U.S. welfare once the effects of increased export prices are factored into the analysis. This analysis suggests that climate-induced changes in agriculture would not produce major positive or negative economic effects by the middle of the next century. Yet, there could be significant regional dislocations in crop production.

Sea-Level Changes

The adverse effects of possible sea-level rise on coastal infrastructure, recreation, and coastal ecology could be either large or small, depending on the rate and magnitude of any sea-level rise and on the extent of planned adaptation. While densely developed shoreline areas in the United States could be protected against sea-level rises that might occur by 2050 for less than $10 billion (present value), significant net losses of drylands and wetlands could occur.

Human Health

The impacts of a possible warming on human health are extremely controversial, and the scope for planned adaptation is unclear. Some studies show significant possible increases in heat-related deaths, while others argue that cities with appreciably different climates show no climate-related differences in health risk. Global warming would likely cause some vector-borne tropical diseases to spread northward, but the magnitude of this problem is unclear. On the other hand, there could be a decline in cold-related deaths.

Other Potential Effects

Forestry. If significant warming occurs, changes in U.S. forests could be apparent in 30 to 80 years. Significant changes in forest range are possible. Changes in forest distribution and composition could have major impacts on timber production, runoff from forests, and recreational opportunities. Without human intervention, rapid warming could move natural habitats of mid- and high-latitude forests poleward faster than natural rates of forest migration could accommodate. Today's forest management decisions

could have long-term impacts on the composition and location of forests.

Fisheries. Fishery resources are known to be sensitive to climate variation. However, the qualitative effects of warming on fisheries are highly uncertain, and no quantitative economic analysis has, to our knowledge, been attempted. Absent human intervention, ocean species are likely to be less affected by any climate change than freshwater species, since oceans would respond to atmospheric warming more slowly than smaller bodies of water. Both the need and the opportunity for planned adaptation in the commercial fishing sector appears to be limited.

Water Resources. In general, it is difficult to predict the impacts of climate change on water resources with confidence because of uncertainties about regional precipitation. If significantly higher temperatures occur, water supplies in California and the lower Great Lakes could be reduced.

Biodiversity. The impacts of climate change on natural communities are difficult to predict. Possible global warming could result in a decline in biodiversity stemming from the loss or change of habitats that result in the decline or loss of some animal and plant species.

Mitigation: Limiting Greenhouse Gas Emissions

The costs of reducing carbon dioxide and CFC emissions are under active study. Available estimates of CO_2 abatement costs remain preliminary and controversial. Relatively little is known about the costs of reducing emissions of other greenhouse gases. A revision of this section of the report a year or two from now could rely on a much stronger research base (particularly as regards CO_2) and might well have different policy implications.

Background

Global Action and Differential Impacts. Global action is essential if meaningful reductions in the expected growth of any of the greenhouse gases are to be obtained without bringing economic growth to a halt. Even dramatic unilateral cuts by member states of the Organization for Economic Cooperation and Development (OECD) would not be sufficient to achieve widely discussed global CO_2 emissions goals unless most other countries participate fully in emissions reduction efforts. For example, even the *total* elimination of OECD emissions over the next 15 years would be insufficient to obtain a 20-percent global emissions reduction by 2005 if the USSR and Eastern Europe only stabilize emissions at their current levels and developing countries take no action to curb CO_2 emissions growth. Global action would also be necessary to control methane and nitrous oxide emissions, which result primarily from agricultural and energy activities.

Differences in costs and benefits among nations may make it difficult to obtain global agreement on specific goals and policies. For example, countries planning to rely heavily on coal, which contains a relatively high amount of carbon per unit of energy, may have greater CO_2 emissions than countries planning to rely more on nuclear energy. These issues will have important implications for energy security and trade balances.

Incentives and Market Failures. An approach to limiting net anthropogenic greenhouse emissions that encompasses all important greenhouse gases and gas sinks as well as gas sources is preferable to one that considers each source of greenhouse gases individually. Also, any set of nations should be free to develop a joint strategy to meet their pooled ceilings, as long as net global emissions are not thereby increased and existing treaty obligations are not thereby violated. An approach incorporating these elements was outlined in a U.S. concept paper introduced at the IPCC.

All analysts agree that some reductions in greenhouse gas emissions can be obtained at low cost. The phaseout in CFCs recently agreed to at the June 1990 meeting of the parties to the Montreal Protocol falls into this category. Current research has not been sufficient to detail the extent of low-cost opportunities for limiting other greenhouse gases.

Command-and-control efficiency standards have several significant disadvantages in comparison to incentive-based systems—such as charges, user fees,

and tradable emissions rights—or approaches that address perceived market failures directly. When market failures limit the power of such approaches, those failures can be addressed directly. The costs of efficiency standards are often hidden rather than explicit.

Carbon Dioxide

Economy-Wide Analyses of Emission Limitation Costs. Several studies of carbon dioxide reduction costs using economy-wide models have recently been completed or are now in progress. These papers use a variety of modeling approaches, consider different policies, and employ different baseline emissions growth assumptions. These differences have important effects on cost estimates. All these results must be considered preliminary.

In general, work to date finds that the costs of stabilization or reduction of CO_2 emissions by 2005 will be high—at least 1 percent of the gross national product (GNP) per year for widely discussed objectives, such as stabilizing CO_2 emissions at the present level or securing and maintaining a 20-percent reduction from that level. Some estimates suggest that achievement of such objectives would involve significant reductions in long-term growth. During the 1973-85 oil shock period, CO_2 emissions were constant but economic growth was slow. This experience offers a useful reference for comparison of likely impacts of policies to curtail fossil energy use sharply on output and productivity growth.

Some recent analyses consider the use of a charge on the carbon content of fossil fuels to reduce CO_2 emissions. This research generally concludes that charges on the order of $100 per ton (which would amount to roughly a 180-percent increase in the delivered price of coal and a 70-percent increase in the price of oil) would be needed to have a significant effect on emissions. Much lower carbon charges may be of some value in the near term to compensate for known external effects of energy use, to test the sensitivity of CO_2 emissions to incentives, and to lay the foundations for higher future charges if they are found necessary.

The aggregate economic effects of CO_2 emissions reduction policies would not be felt evenly throughout the U.S. economy. The relative cost of energy would increase substantially, increasing the relative price and decreasing the consumption of energy-intensive products. It is impossible to construct a scenario for substantial CO_2 emissions reduction without a major adverse impact on the coal industry. General equilibrium modeling suggests that an effort to limit CO_2 emissions significantly would cause large changes in the sectoral composition of the U.S. economy. Such sectoral changes, if gradual, might occur without a drastic impact on the value of existing assets. However, a policy that resulted in rapid sectoral changes could have a significant impact on the value of assets in impacted industries and on the value of immobile assets, such as residential housing, in impacted communities.

Because the United States relies heavily on coal (the fossil fuel with the highest amount of carbon per unit of energy) for electricity generation, U.S. electricity rates would be likely to rise more than those in other industrialized countries if concerted action were taken to curb CO_2 emissions. Unless energy-intensive U.S. industries were able to increase their energy efficiency, they could be disadvantaged relative to major foreign competitors who would be less affected by electricity rate increases.

Regulatory Adjustments. There are a number of reasons why total U.S. investment in energy efficiency may be suboptimal. Many analysts have called for a variety of regulatory initiatives to increase the efficiency of energy use and, thereby, to reduce CO_2 emissions.

The elimination of electricity pricing distortions would be as likely to yield increases in consumption and emissions as decreases. Many analysts have called for reform of electric and gas utility regulation to give utilities incentives to remove impediments to efficient investment in energy conservation. While the desirability of regulatory changes of these sorts is apparent, estimates of potential reductions in CO_2 emissions vary widely.

Energy-efficiency standards for buildings, appliances, and automobiles represent another approach to limiting energy consumption, and thus CO_2 emissions. However, any information problems, institutional

rigidities, or market failures that may exist can be addressed directly, rather than through efficiency standards that can impose significant hidden costs on consumers and the economy at large.

A number of changes in agricultural programs that would have other benefits can be expected to assist in reducing greenhouse gas emissions. These include reducing commodity price support levels, encouraging additional tree planting, and expanding conservation programs.

New Technologies. While new technologies offer significant CO_2 emissions reduction potential after the year 2000, there is no simple "technological fix" to this problem. A variety of technologies for generating electricity are in various stages of development. The next generation of nuclear reactors, based on simplified and standardized designs and passive safety features, may come into use after the year 2000. Advanced energy-use technology seems to have the potential to contribute significantly to reducing CO_2 emissions, but estimates of the extent of the contribution vary widely.

Increases in research and development budgets for end-user energy-efficiency improvements and for programs that provide financial and technical assistance to States, both of which have declined in recent years, would enhance conservation efforts. Most studies have found that the potential gains from widespread use of available "best practice" technology are significant, possibly up to 15 percent of current consumption.

Forestation. Reforestation is a (comparatively) short-term approach that could generate a substantial decrease in net CO_2 emissions for at least three to five decades. Cost estimates in one study of a global strategy ranged from $4.29 to $8.03 per metric ton of carbon removed, while those in another study for the United States ranged from $17.71 to $102.63 per metric ton depending on program size. The net ecological and recreational benefits of forestation would depend on the type of forest planted and the current use of the land. The efficacy of forestation as a carbon management tool depends importantly on how the stock of accumulated carbon in mature forests is managed, but the costs and carbon removal potential of alternative management strategies have not been systematically analyzed.

Methane

Because the developed countries account for only about 25 percent of anthropogenic methane emissions, significant, cost-effective reductions in CH_4 emissions will require global action. Feasible reductions in the areas of animal waste, sizes of livestock herds, coal mining, natural gas production, transmission, and distribution, landfills, and livestock and rice production add up to more than enough to stabilize atmospheric CH_4 concentrations. While a number of approaches to controlling these emissions are available, no systematic policy design or costing analysis has been performed.

Chlorofluorocarbons

The Montreal Protocol has been ratified by nations that account for over 90 percent of global consumption. The Protocol was renegotiated in June 1990 and now provides for a phaseout of all CFCs by the year 2000. With widespread participation, this phaseout will significantly reduce the increase in radiative forcing attributable to greenhouse gas emissions during the next century. The costs of eliminating the use of CFCs in the United States will be approximately $3 billion (present value) over the next 10 years.

Nitrous Oxide

No systematic attention seems to have been devoted to the design or cost of policies to reduce N_2O emissions from fertilizer use or other sources, in part because the relevant science base is weak. The relationship of N_2O emissions to energy production and use have been questioned by recent research findings. Resolution of uncertainty in this area is a high priority.

INTRODUCTION

Work on this report began in the fall of 1989, when an interagency task force was instructed to "identify, review, and inventory" work on the economics of climate change in order to inform policy discussions. (The task force included representatives from the Council of Economic Advisors; the Departments of State, Treasury, Commerce, Interior, Agriculture, and Energy; the Environmental Protection Agency; the Office of Management and Budget; and the Office of Science and Technology Policy.) A preliminary report was presented in March, 1990. The present document represents a refinement and limited updating of that report. It is intended to provide an overview of current knowledge and key facts and is not a statement of Administration or Department policy.

This report should serve to indicate that *economic analysis of global change is in its infancy; few assertions about costs or benefits can be made with confidence*. The state of the literature precludes any attempt to produce anything like a comprehensive benefit-cost analysis. (But see Nordhaus (1990a) for a crude but interesting attempt.) Moreover, *almost all the quantitative estimates regarding physical and economic effects in this report, as well as many of the qualitative assertions, are controversial.*

Section I provides background on greenhouse gas emissions and their likely climatic effects and on available policy instruments. Section II considers the costs of living with global change, assuming no substantial efforts to reduce greenhouse gas emissions. Section III considers costs of reducing those emissions, though the available literature does not contain estimates of the costs of policies that would, on the assumptions of current climate models, prevent climate change altogether. The individual sections are not entirely compartmentalized, but can be read independently if necessary.

I. BACKGROUND

This section provides background material on current and projected future greenhouse emissions and on scientific opinion regarding the effects of those emissions on the global climate. The final subsection provides a brief, general discussion of adaptation and mitigation strategies, which serves as an introduction to the analysis of these strategies in Sections II and III, respectively.

A. Greenhouse Gas Emissions

Increases in the atmospheric concentrations of at least 25 trace gases contribute directly or (via chemical reactions) indirectly to the retention of solar radiation by the earth (radiative forcing). *Five greenhouse gases, described in Table I.1, have accounted for about 87 percent of the increase in radiative forcing in the 1980s and about 92 percent of the increase over the 1880–1980 period* (Ramanathan, et al., 1985; Hansen, et al., 1988). These gases are, accordingly, the focus of the rest of this subsection and of the mitigation strategies considered in Section III. The emissions projections for these gases in Tables I.2 to I.5 are based on the Rapidly Changing World scenario in Lashof and Tirpak (1989); they should be treated as providing rough orders of magnitude, not precise estimates.

Comparisons of the effects of future emissions of various greenhouse gases are not completely straightforward. Differences in atmospheric lifetimes lead to different time patterns of effects, so that decisions regarding discounting may be important (Lashof and Ahuja, 1989). (Note also the uncertainty attached to the lifetime of nitrous oxide (N_2O).) And, while the radiative forcing effects of changes in atmospheric concentrations of any trace gas are apparently easy to calculate, the effects of changes in

Table I.1 — Main Greenhouse Gases

Gas	Percentage Share of Increased Radiative Forcing in the 1980s	Atmospheric Lifetime (years)	Forcing Index (molecular)
Carbon Dioxide (CO_2)	49	250	1
Methane (CH_4)	19	10	30
Chlorofluorocarbons (CFC-11 & CFC-12)	14	60 & 75	22,000 & 25,000
Nitrous Oxide (N_2O)	5	100-175	200

Sources: Hansen, et al. (1988); Department of Energy; Wuebbles and Edmonds (1988).

emissions on atmospheric concentrations depend both on preexisting concentrations and on various imperfectly understood geophysical feedbacks, which also affect atmospheric lifetimes.

1. Carbon Dioxide

Measurements of carbon dioxide (CO_2) levels show atmospheric concentrations increasing from somewhere between 250 and 295 parts per million (ppm) at the beginning of the 19th century to 346 ppm in 1986. Good data are available on fossil fuel CO_2 emissions and (the far smaller) emissions from cement production; data on the impacts of land-use changes (primarily tropical deforestation) are fair to poor. *It is important to keep in mind that natural flows of carbon into and out of the atmosphere are roughly ten to twenty times larger than the (anthropogenic) flows associated with human activity.*

Table I.2 provides historical and projected anthropogenic emissions data by region and by source assuming no mitigation. These projections are uncertain because of uncertainties about future population and economic growth, sectoral composition of gross national product (GNP), and sector-specific energy efficiencies. Nonetheless, it is important to note that because energy-related sources of CO_2 emissions are expected to grow comparatively rapidly, and chlorofluorocarbons (CFCs) are expected to be controlled significantly, *CO_2 is expected to account for a larger share of increased radiative forcing in the future than in the past.*

The U.S. now accounts for about 21 percent of total anthropogenic CO_2 emissions, but that share is expected to shrink to around 12 percent by the middle of the next century. Despite the attention paid to

Table I.2 — Carbon Dioxide Anthropogenic Emissions (Percentage Shares)

		Projections		
Source	1985	2000	2015	2050
Countries				
United States	21	19	16	12
Rest of OECD	22	19	16	12
SSR & Eastern Europe	22	22	19	18
Centrally Planned Asia	10	13	161	
Other Developing	25	28	32	37
	100	100	100	100
Sectors				
Commercial Energy	86	87	89	92
Tropical Deforestation	12	11	9	6
Other	2	2	2	2
	100	100	100	100
Total Scenario Emissions (10^9 metric tons of carbon)	5.99	8.05	10.27	16.95
Average Annual Growth Rate		1.6%		

Source: USEPA (1989) Rapidly Changing World Scenario

tropical deforestation, *most anthropogenic CO_2 emissions are and will be the result of combustion of fossil fuels*. The United States has comparatively high CO_2 emissions per capita from fossil fuel consumption and cement production, in part because it makes relatively heavy use of coal. In the United States, coal burned by electric utilities accounts for 31 percent of total fossil fuel CO_2 emissions; the entire utility sector accounts for 37 percent, and the transportation and industrial sectors account for 29 and 21 percent, respectively.

2. Methane

Atmospheric concentrations of methane (CH_4) were relatively constant prior to the middle of the last century at about 700 parts per billion (ppb); by 1987 CH_4 concentrations had increased to 1,675 ppb. Recently, atmospheric concentrations of methane have been increasing at an observed rate of about 1.1 percent annually. The contributions of the different sources of methane that together account for aggregate emissions remain uncertain. Anthropogenic emissions of CH_4 are thought to account for roughly two-thirds of all emissions. Table I.3 contains estimates of anthropogenic emissions; they should be treated as uncertain.

The United States now contributes about 12 percent of anthropogenic emissions of CH_4; this share is predicted to decline to about 8 percent. *Over half of total anthropogenic emissions of methane are produced by domestic animals (enteric fermentation) and rice*

Table I.3 — Methane Anthropogenic Emissions (Percentage Shares)

		Projections		
Source	1985	2000	2015	2050
Countries				
United States	12	11	9	8
Rest of OECD	13	12	12	10
USSR & Eastern Europe	13	14	14	15
Centrally Planned Asia	17	16	17	19
Other Developing	46	47	49	48
	100	100	100	100
Sectors				
Fuel Production	18	22	26	32
Enteric Fermentation	23	24	23	22
Rice Cultivation	34	31	29	24
Landfills	9	10	10	14
Tropical Deforestation	6	6	5	4
Other	9	7	7	5
	100	100	100	100
Total Scenario Emissions (10^6 metric tons of CH_4)	320.1	399.5	476.8	710.5
Average Annual Growth Rate		1.2%		

Source: USEPA (1989) Rapidly Changing World Scenario

cultivation. The centrally planned and developing nations account for the bulk of these methane emissions. Energy-related methane emissions occur in coal mining, and when natural gas is gathered, transmitted, distributed or vented.

3. Chlorofluorocarbons

CFCs are entirely man-made and were invented during the 20th century. The concentrations of CFC-11 and CFC-12 were 226 parts per trillion (ppt) and 392 ppt, respectively, in 1986 and have been rising at 4 percent annually. Table I.4 gives projected regional emissions of these two gases assuming implementation of the Montreal Protocol (aimed at reducing stratospheric ozone depletion) as it existed prior to June, 1990, with 100 percent participation by developed countries and 75 percent participation elsewhere. In June 1990, the parties agreed to a total phaseout of CFCs by the year 2000 in place of the 50-percent emissions reduction reflected in Table I.4.

Note that global emissions of CFC-11 and CFC-12 were projected to increase under the terms of the Montreal Protocol as they existed prior to the June 1990 revision. Emissions of related greenhouse gases (particularly CFC-22 and methyl chloroform) were also projected to increase quite rapidly, but the revised Protocol now covers some of these gases; for example, methyl chloroform, which had earlier been expected to see increasing use, is now to be phased out by 2005. Considering these related gases does not alter the message of Table I.4: *the United States and other developed nations now account for well over half of emissions of CFCs and related gases, but, even under the original terms of the Montreal Protocol, the shares of developing nations would have been expected to increase sharply.* The recent revisions to the Protocol will reduce the emissions of signatory nations by a substantial further amount. The extent of developing country participation in the phaseout of CFCs is uncertain and will significantly affect future shares and quantities of emissions.

Table I.4 — Chlorofluorocarbon (CFC-11 + CFC-12) Emissions (Percentage Shares) Assuming No Further Controls Beyond *Original* Montreal Protocol

		Projections		
Source	1985	2000	2015	2050
United States	24	18	17	12
Other Developed	41	24	24	21
USSR & Eastern Europe	16	14	14	13
0.2Kg Nations*	6	14	15	19
Other Developing	12	30	30	36
	100	100	100	100
Total Scenario Emissions (10^3 tonnes CFC)	642.1	837.8	755.1	828.5
Average Annual Growth Rate		0.4%		

*Nations with CFC use between 0.1 and 0.2 kilograms per capita and likely to reach the 0.3 kilogram per capita limit in the Montreal Protocol prior to 1999.

Source: USEPA

4. Nitrous Oxide

Atmospheric concentrations of N_2O averaged about 285 ppb from 1600 to 1800, began to rise slowly at the start of this century and more rapidly after 1940, and are now around 310 ppb. *Data on natural and anthropogenic sources of N_2O emissions are poor*, and the data in Table I.5 should be considered as approximate at best. The Department of Energy believes that N_2O emissions associated with energy processes may be overestimated by an order of magnitude.

As in the case of methane, *most N_2O emissions are associated with agricultural activity and with developing nations*. Increased fertilizer use has both raised N_2O emissions and dramatically increased food supplies in many developing nations. The U.S. share of world N_2O emissions is only about 14 percent and is expected to fall below 10 percent by mid-century.

B. Potential Climate Changes

Formulating a realistic and responsible outlook on possible climate effects associated with increasing atmospheric greenhouse gas concentrations requires providing answers to a sequence of increasingly complex questions.

1. Uncertainties

It is first necessary to project future emissions of greenhouse gases. As noted above, such projections are inevitably quite uncertain. *Economics research has an*

Table I.5 — Nitrous Oxide Anthropogenic Emissions (Percentage Shares)

		Projections		
Source	1985	2000	2015	2050
Countries				
United States	14	12	11	9
Rest of OECD	13	14	14	12
USSR & Eastern Europe	14	15	14	13
Centrally Planned Asia	13	16	14	15
Other Developing	46	47	47	52
	100	100	100	100
Sectors				
Coal Combustion	25	26	29	36
Fertilizer Use	38	43	44	41
Gain of Cultivated Land	10	8	8	6
Tropical Deforestation	13	11	10	9
Fuelwood & Ind. Biomass	5	4	3	2
Agricultural Wastes	10	8	7	6
	100	100	100	100
Total Scenario Emissions (10^6 tonnes N_2O)	4.21	5.85	6.87	8.85
Average Annual Growth Rate		1.2%		

Source: USEPA

important role to play in refining emissions forecasts. It is then necessary to predict how much of the assumed emissions will remain in the atmosphere after accounting for the effects of natural processes. Typical tentative scenarios, like those underlying the projections of emissions shares in Tables I.2 to I.5, assume that emissions will be sufficient to result in the radiative equivalent of a doubling of atmospheric carbon dioxide (the combined effects of CO_2 and other trace gas increases) between 2030 and 2070.

Once the greenhouse gas levels in the atmosphere are projected, the next step is to project associated changes in heating of the earth system as a whole. Such projections are highly sensitive to the treatment of feedback mechanisms that can either reduce or amplify the effects of a greenhouse gas buildup. Potentially important positive and negative feedbacks which are not fully understood are an important additional source of uncertainty in projections of earth system warming. For example, the role of clouds is still in dispute.

The next question is more subtle and complex: At what rate is the observed mean global surface temperature likely to change? The role of the ocean as a heat sink is a key element in the linkage between earth system warming and global surface warming. Recent computations with one of the world's leading coupled ocean/atmosphere models indicate that a 1-percent-per-year carbon dioxide buildup (doubling by 2040; redoubling by 2120) would produce a warming of 3.8°F at the equator by 2050, increasing to around 7.2°F at high northern latitudes. But in this computation, the southern latitudes hardly warm at all because the high-latitude southern ocean absorbs virtually all the heat from greenhouse warming (ocean temperatures increase slightly). Under this model, the earth system would clearly warm, but air temperatures would scarcely be affected in the Southern Hemisphere. The particular configuration of the ocean, atmosphere, and land surface in the Southern Hemisphere is responsible for this outcome. More generally, *observed increases in air temperatures will lag behind equilibrium temperature increases (those that would eventually occur with given atmospheric concentrations of greenhouse gases) for decades or even centuries.*

2. Projections

Because of these multiple, compounding uncertainties, quantitative model projections of greenhouse gas warming are subject to change as understanding progresses. *All current climate models predict that doubling the concentration of CO_2 relative to the preindustrial atmosphere would result in an eventual global average warming.* Present quantitative predictions for actual (realized) average warming by 2050 vary over the range of 2°F to 8°F. (The low (high) end of this range corresponds roughly to the annual average difference between Washington, D.C. and Sacramento (Dallas).) However, some recent results from models using specifications of cloud behavior believed to be more realistic have reduced equilibrium warming projections by half. Modelers generally agree that *seasonality will decrease*, with winter temperatures rising more than summer ones.

Possible changes in worldwide sea level are also subject to considerable uncertainty. Warming could raise sea level by thermal expansion of the upper layers of the ocean and by the melting of land-based ice. However, recent measurements have found that Greenland and Antarctic ice cover is currently increasing, not melting away. An American Geophysical Union panel recently suggested a range of global sea-level increases by 2050 of between 10 and 70 centimeters. The present consensus within the science group of the Intergovernmental Panel on Climate Change (IPCC) is that *a warming within the range projected by climate models might be accompanied by a global sea-level rise of between 25 and 40 centimeters by 2050.*

While the public discussion and most of the initial scientific work has focused on the assessment of changes in mean global surface temperature, many of the economic impacts considered in this report could be more dependent on other climate variables. Examples of such variables include changes in soil moisture, summer precipitation, or extreme temperature

by region, and in the number of days in a row when the temperature exceeds a threshold value important to particular activities or natural processes. There is general agreement among climate modelers that, while precipitation would increase globally in a global warming scenario, regional patterns of precipitation would probably change, leaving some areas considerably wetter or drier. Translating these precipitation changes into changes in soil moisture is yet another question, since soil moisture is a function of soil and vegetation characteristics as well as precipitation, temperature, and humidity. Differences in soil moisture and temperature could also affect the soil's capacity to absorb greenhouse gases. *Some models suggest a marked soil moisture decrease in midlatitude continental regions during summer.* Coordination between climate modelers and experts in impact assessment is required to assure that the efforts of the former are directed towards the development of refined projections of those climate variables that are most critical to the refinement of current impact estimates and the development of new ones.

C. Policy Alternatives

The next two sections of this report consider the two basic types of policies available to deal with global change: adaptation and mitigation.

Adaptation policies, which seek to lower the costs of global warming, come in two forms: planned and unplanned. *Planned adaptation involves actions taken in advance of anticipated warming*; examples include development of heat-resistant plant strains and decisions not to undertake new construction on land that may be inundated by sea-level rise. *Unplanned adaptation involves reactions to actual warming*, such as the use of more air conditioning. For the most part, effective planned adaptation policies can be designed and implemented at the local or national levels, while unplanned adaptation mainly reflects decisions of individual firms and households. If global warming occurs over time, adaptation would also be a continuing process.

Mitigation policies are aimed at reducing net emissions of greenhouse gases. This can be done either by reducing gross emissions (by reducing the use of CFCs or the burning of fossil fuels, for instance) or by increasing the removal of greenhouse gases from the atmosphere by natural processes (by reforestation, for instance).

Because some greenhouse gases have long atmospheric lifetimes, and because any changes in climate are predicted to lag changes in net emissions by many decades, *mitigation policies must generally be implemented well before adaptation policies.* Using a 5-percent real discount rate, $100 billion spent on adaptation in 2050 is equivalent in terms of cost to $4.2 billion spent on mitigation today. (If an investment yields a 9-percent rate of interest in dollar terms, but prices rise at 4 percent per year, the real purchasing power of invested funds grows by 5 percent annually.) A 5-percent real discount rate is used throughout this report, but the economic literature contains arguments for both higher and lower rates.) Because the time scales here are longer than in most issues, *the important economic implications of differences in timing between adaptation and mitigation can only be revealed by discounting.*

The estimates of impacts and adaptation costs discussed in this report reflect a wide range of analytic methods, assumptions regarding the magnitude and timing of possible climate change, and time periods over which impacts are considered. These disparities rule out meaningful summation of estimated impacts across studies. In general, impacts and adaptation costs are estimated for either one or a small set of assumed climate-change scenarios, with the latter characterized in terms of factors such as the change in mean temperature or mean sea level. Costs and other impacts are almost always estimated relative to an implicit or explicit baseline involving no climate change. Such estimates could in principle be used to measure the benefits of entirely forestalling climate change. However, they necessarily overstate the benefits of mitigation policies that merely slow climate change. the available literature on mitigation costs does not

even consider policies stringent enough to rule out climate change entirely.

Effective policy design must reflect the fact that there are great uncertainties about future emissions, implied climate changes and their effects, and the costs of reducing net emissions. It is of course important to support scientific and economic research to close the many gaps in our knowledge. But it is also important to recognize that policies adopted today may vary significantly in their attractiveness as uncertainty is reduced in the future. The benefits and costs of proposed policy actions should be evaluated under a broad range of outcomes that reflect the significant uncertainties that pervade the global climate issue. *Flexible policies that can easily be reversed or expanded, and policies that can be justified for reasons other than climate change should be highly valued.* This approach has been promoted by the United States in the international community since Secretary Baker's February 1989 address to the Response Strategies Working Group (RSWG) of the IPCC.

II. ADAPTATION: LIVING WITH GLOBAL WARMING

This section considers the economic costs of global warming as described in Section I.B, above. We begin with an overview of the general effects of climate change on the economy. The rest of this section then considers the specific effects and related planned adaptation policies on which most attention has been focused, concentrating on the period between now and the middle of the next century.

A. Climate and the Economy

Climate change can affect economic activity both *directly*, by altering production possibilities, and *indirectly*, as adaptation to change and its direct effects alters demands for and supplies of particular goods and services. For example, warming would directly affect operators of ski areas and indirectly affect manufacturers of ski equipment.

The direct economic effects of climate change would be concentrated primarily in agriculture, forestry, and fisheries, which currently account for about 2 percent of U.S. gross domestic product (GDP) and about 5 percent of world GDP. These effects are not all negative since, for example, the construction industry would benefit directly from reduced seasonality. Hydropower production would be affected by changes in precipitation and runoff. The subsections that follow focus on the most-discussed *direct* effects of global warming. Because of gaps in both science and economics, *we have comprehensive impact cost estimates only for agriculture and comprehensive adaptation cost estimates only for sea-level rise.*

The indirect effects of climate change will create winners and losers throughout the United States and global economies. If energy use is not curbed to reduce greenhouse emissions, for instance, electric utilities and their suppliers could face significantly higher demands. (The Environmental Protection Agency (EPA) estimates that a summer temperature increase of 6.7°F would require an increase in electric generating capacity of between 25 and 50 percent of current capacity.) Demand for air conditioners and heat exchangers would rise, benefiting producers of these products. Producers and distributors of space heating equipment, heating fuels, and winter clothing would likely face decreased demand. Using existing econometric models, it is not generally possible to translate qualitative assessments of this sort into quantitative estimates.

The costs of adaptation would depend critically on how rapidly warming occurs. Useful lives of plant and equipment tend to be substantially less than 50 years, so that even a steady change in climate over the next century would permit considerable change in the location and composition of economic activity without major disruptions. If sudden changes were required, the values of some immobile assets would drop sharply, and disruptions would occur. Sudden population shifts, for instance, would lead to the abandonment of buildings, roads, and infrastructure in some areas along with the need for major new investments in other areas.

B. Agriculture

Climate change could affect U.S. agricultural markets directly through changed domestic yields and indirectly through changed world prices and trade flows brought about by changed crop production abroad. While a number of possible planned adaptation policies have been identified, their likely costs and effects have not been fully analyzed.

1. Potential Yield Effects

Unfortunately, as noted in section I.B, even given an assumed level of global warming, *available predictions of regional temperature, seasonality change, precipitation, and soil moisture vary greatly, leading to highly uncertain agricultural projections.* In addition, agricultural effects would vary over time if climate continued to change with gradual increases in atmospheric trace gas concentrations.

Recent studies of the effects of climate changes on crop yields include Smith and Tirpak (1989), Parry, et al. (1988a, 1988b), and Santer (1985). These studies suggest that, in general, middle-latitude yields would fall and northern-latitude yields would rise with a doubling of CO_2 levels and consequent warming. Most results point to 10 to 20 percent declines in yields in the Southern United States and slight increases in the Northern United States.

These estimates do not incorporate important factors such as farm management response with existing technology, the development of new crop varieties better suited to new climate and ambient CO_2 conditions, and changes in hydrology and in the distribution of agricultural pests and diseases. The literature suggests that these factors are likely to be important in determining the net effect of climate change on agriculture (Hansen 1990; Rosenberg et al. 1989). A recent workshop (National Climate Program Office, 1989) that discussed some of these factors concluded that the net effect of trace gas doubling would be to *increase* yields in all countries by 15 to 40 percent. On the other hand, some argue that the workshop assumed an optimistic change scenario (3.8°F warming and a 15-percent increase in precipitation) and did not consider changes in pest activity or possible summer droughts.

2. Economic Implications

Because national agricultural markets are linked by international trade, *the net effect of climate change on any country will depend on how changes in regional climates affect global agriculture, and how these changes affect agricultural prices and trade flows.* Because the United States is a large net agricultural exporter, economic losses associated with domestic declines in crop yields could be partially, fully, or more than fully offset by producer gains from the higher agricultural prices that would occur if world supply tightened. The same mechanism would, of course, operate to offset the economic gains stemming from yield increases that some believe could follow from increases in atmospheric concentrations of CO_2.

Kane et al. (1989) used the primary international agricultural trade model of the U.S. Department of Agriculture's (USDA) Economic Research Service (Roningen, 1986) to estimate the economic effects of changes in agricultural yield induced by climate change. That analysis, which deals only with major grain and oilseed crops and does not consider fruits, vegetables, poultry, or livestock, has been updated by USDA for this report. The range of crop yield estimates used reflects a synthesis of recent suggestions (Parry, et al. 1988a, 1988b; Santer, 1985; Smith and Tirpak, 1989; United Nations, 1989). These estimates (summarized in Table II.1) are largely illustrative because of the high degree of uncertainty concerning the regional yield effects of climate change; note in particular that, in contrast to the National Climate Program Office exercise discussed above, the impact on U.S. yield is negative.

This analysis predicts a climate-induced increase in world corn and soybean prices of about 10 percent, since most production of these crops occurs in mid-latitude countries that may be adversely affected by climate changes. The prices of all other primary agricultural commodities are estimated to decline, though prices of oil and meal would rise.

As Table II.1 shows, these estimated price changes would lead to small *increases* in net U.S. and global welfare. Global welfare rises because decreased production in some regions is more than offset by increases in others. From the perspective of an individual country, large domestic yield effects do not necessarily translate into large welfare effects; welfare

effects depend on prices determined in world markets and on flows of imports and exports. Thus, even though yields are assumed to fall in the United States, U.S. net welfare is estimated to increase by just under $200 million in 2050. (These estimates do not consider adaptation costs, such as the possible need to increase irrigated acreage.)

When these welfare effects are discounted to the present, they are seen to be even less important than Table II.1 might suggest. At a 5-percent annual rate of discount, the present discounted value of the estimated $1.51 billion of net climate change benefits in *world* agriculture in 2050 is just $81 million. Assuming linear growth in net benefits to 2050, the present discounted value of all net benefits over the next 60 years is only $8.1 billion. To put these numbers in perspective, another application of the model used here found that trade-distorting agricultural policies imposed worldwide costs in 1986 alone of $31 billion.

Kane, et al. (1989) provide an informative sensitivity analysis. Only when assumed yield reductions in the United States, Canada, and the European Community (EC) are set at very high levels (greater than 40 percent), do welfare effects become greater than 1 percent of GDP in the countries studied. Thus, even with minimal planned adaptation, *it appears that climate-induced changes in agriculture should not produce major national-level economic effects, positive or negative, by the middle of the next century. However, the possibility of substantial variation in regional impacts cannot be ruled out.*

3. Adaptation

U.S. agriculture can improve its resilience to climate change through several adaptive strategies. These include increasing irrigation and water-use efficiency, developing and planting heat- and drought-resistant crop varieties, enhancing soil and water retention through use of low tillage and crop rotation practices, maintaining and enhancing the genetic and technological diversity of agricultural systems, and

Table II.1 — Estimated Economic Welfare Effects in 2050 of Climate-Induced Agricultural Yield Changes

Country/Region	Assumed Percentage Changes in Yields of Major Crops	Estimated Net Welfare Change (1986 $millions)
United States	-10% to -15%	+194
Canada	-10% to +5%	-167
European Community	-5% to -10%	-763
Northern Europe	+10% to +30%	-51
Japan	-5% to +15%	-1,209
Australia	+10% to +15%	+66
China	+10%	+2,882
USSR	+10% to +15%	+658
Brazil	No change	-47
Argentina	No change	+95
Pakistan	No change	-50
Thailand	No change	-33
Rest of the World	No change	-67

improving pest control techniques in anticipation of possible northward migration of pests. Agricultural policies and programs, such as price support and acreage control policies, should be reviewed to determine whether there exist modifications that would help ensure timely and efficient adjustment to possible climate change and that would contribute to trade and other policy goals.

C. Sea-Level Changes

The adverse effects of possible sea-level rise on coastal infrastructure, recreation, and coastal ecology could be either large or small. The severity of these effects will be determined by the magnitude and rate of any sea-level rise and whether planned adaptation policies are instituted. Unfortunately, only a few estimates of the costs of sea-level rise or of adaptation policies are available.

1. Possible Impacts

A foot of sea-level rise can erode a typical beach 100 to 300 feet; a 40-inch rise could translate into 900 feet of erosion. The U.S. coastline, as that of most other industrial maritime nations, has been extensively developed, with buildings often within 100 feet of the sea. Even if currently densely developed areas were protected, losses of dryland and coastal wetlands could be substantial if rates of rise were rapid.

The loss of land by erosion and flooding due to accelerated sea-level rise would translate into lost economic services. Gibbs (1984) estimated that the present value (using a 3-percent discount rate and in 1980 dollars) of lost economic services to Charleston, South Carolina, due to an 83 centimeter rise in sea level could be $1.3 billion. However, planned adaptation could reduce this loss by 65 percent to $0.4 billion. The amount of rise considered in this analysis is more than double the high end of the most recent IPCC estimate of likely sea-level rise by 2050 if significant warming occurs.

Other nations could also face losses from any sea-level rise. A 1-meter rise would inundate 7 percent of the land (occupied by 5 percent of the population) in Bangladesh. Egypt would lose 12 percent of its habitable land, affecting 14 percent of its population. The cost to each nation could exceed 2 percent of GDP. No estimates are available for the effects of the 25- to 40-centimeter sea-level rise considered most likely to occur by 2050 if significant warming occurs.

A higher sea level would allow the saltfront of rivers to travel further upstream than before and could also allow high salinity water to contaminate groundwater. Hull and Titus (1986) found that with a 1-meter rise in sea level, reservoir capacity would have to be significantly increased to allow Philadelphia to continue withdrawing its drinking water from the Delaware River. New York City, which withdraws water from the Delaware headwaters, would also be affected. Less than $1 billion ($180 million to $908 million) in present-value capital outlays would be needed to compensate for this possible reduction in water supply following from climate change. (The present values are derived from estimates of $2.8 to $14 billion in undiscounted 1986 dollars cited by the EPA, assuming a 5-percent real discount rate with all expenditures incurred in 2050.)

Without significant changes in its water management plans, Miami's primary source of drinking water would be rendered unusable by salinity increases if a one-meter rise in sea level occurred. Even with action, the city would face reduced supply. Many other communities along the coast could feel similar effects on their drinking water supplies if such a large sea-level rise were to occur.

Storm surges would be likely to increase in height by the amount of sea-level rise, making flood damages more frequent and severe. The size of flood plains would likely increase. As a result, flood insurance costs would probably go up, even with anticipatory policies.

2. Adaptation

It would not make economic sense to protect the entire U.S. coastline against any substantial sea-level rise. If the sea level were to rise gradually and predictably

substantial costs could be avoided by discouraging additional development or replacement construction in low-lying areas (perhaps in part by altering Federal flood insurance policy). Particularly for less developed areas, discouraging development would allow beaches to maintain their natural form, wetlands to migrate landward if rates of sea-level rise are moderate, and flood and storm damage to be minimized.

It might, however, also be necessary to nourish recreational beaches with sand and to use levee systems to protect some densely developed shoreline areas. Estimates from Smith and Tirpak (1989) of the costs of these actions through 2100 under alternative sea-level rise assumptions, along with the resulting loss of drylands and wetlands, are shown in Table II.2. (To put the estimated dryland losses in perspective, the land area of Florida, which would be particularly hard-hit by substantial sea-level rise, is about 54,000 mi^2.) As this table suggests, *while densely developed shoreline areas could be protected against likely sea-level rises at moderate (present value) cost, significant losses of drylands and wetlands would occur.*

D. Human Health

The impacts of global warming on human health are extremely controversial, and the scope for planned adaptation is unclear.

1. Possible Impacts

The consensus view of a recent National Research Council Workshop (1987, p. 19) was that "...long-term climatic changes in temperate latitudes are unlikely to have major health implications." Others have noted that even though Atlanta's climate is much warmer than New York's, there is no evidence of a climate-induced difference in health risk.

On the other hand, a recent EPA report (Smith and Tirpak, 1989) finds that warming could lead to increases in summertime morbidity and mortality in the United States and the rest of the world. The report notes that any such effects would be more pronounced in some regions than in others and that the extent of acclimatization will play a large role in determining the effects of any actual warming on health. The apparent

Table II.2 — Protecting Densely Developed Shoreline Areas from Sea-Level Rise

	Sea-Level Rise by 2100			
	Baseline*	50cm	100cm	200cm
Cumulative Costs to 2100 (1986 $billions)				
Present Value**	0.6 to 0.8	3.9 to 5.3	9.0 to 13.7	20.8 to 38.1
Undiscounted Sum	4.8 to 6.2	32 to 43	73 to 111	169 to 309
Dryland Lost (mi^2)	1,500 to 4,700	2,200 to 6,100	4,100 to 9,200	6,400 to 13,500
Current Wetland Lost (percent)	9 to 25	20 to 45	29 to 69	33 to 80

*Assumes current rate of sea level rise, 12cm per century.
**Assumes rate of spending rises 1 percent per year; uses 5 percent real discount rate (continuous time).

absence of a climate-related difference in health risk between northern and southern cities and the lesser effect of current heat waves on mortality in southern cities suggests that human populations could acclimatize, especially if warming occurred over several decades. The EPA report also notes that any warming would probably reduce the number of weather-related deaths in winter months regardless of the degree of acclimatization. The report concludes that it is not clear what the net effect of these two offsetting trends may be, but one of the underlying papers suggests that an overall increase in mortality is most likely.

Several vector-borne diseases, such as yellow fever, dengue fever, and malaria, have the potential to spread northward if the climate warms. For example, the vector of dengue fever breeds year-round in the United States only in southern Florida, but it could move northward by several hundred miles. The National Research Council Workshop (1987, p. 19) concluded that the expansion of ranges of tropical disease vectors "would mostly affect developing countries." Public health facilities in these nations could not readily handle a dramatic increase in infectious disease with their current resources. Their future ability to cope would depend largely on the rate of improvement in living standards.

2. Adaptation

A national watch/warning system could be developed (much like the systems that now warn of hurricanes and severe snowstorms) to advise people when stressful weather conditions are imminent. Immunization programs could be conducted in anticipation of the spread of certain vector-borne diseases into new areas. An improved health-screening program could be developed for immigrants. Finally, improved surveillance systems could provide better data on the incidence and spread of infectious diseases.

E. Other Potential Effects

This subsection considers the implications of possible global warming for forestry, fisheries, water resources, and biodiversity. While a variety of possible adverse impacts have been identified in each of these areas, little quantitative analysis has been attempted to date.

1. Forestry

Climate changes could have a significant impact on the forestry industry. Unfortunately, no attempts have yet been made to quantify the economic impact of such changes on producers or consumers. As in agriculture, both yield and price effects are relevant.

a. Possible Impacts. *If significant warming occurs, climate-induced changes in U.S. forests could be apparent in 30 to 80 years.* Forest ranges could shrink considerably. The southern boundary of forests in the eastern United States could move several hundred to one thousand kilometers north under plausible global change scenarios. The potential northern range could shift by as much as 600 to 700 kilometers over the next century under these scenarios, but slow rates of natural forest migration could limit the actual movement to as little as 100 kilometers. Northward migration may also be limited by less fertile soils and decreased sunlight availability in the North. These projections do not account for the favorable effects of CO_2 on water-use efficiency and rates of photosynthesis, reductions in freeze damage, or human intervention in the forest migration process.

Changes in forest distribution and composition could have major impacts on timber production, runoff from forests, and recreational opportunities. Dieback along the southern limits of U.S. forests could result in productivity declines in present dominant species of 46 to 100 percent under some plausible scenarios. This estimate does not account for human intervention, such as species transplantation. The response of forests to climate change could also modify runoff patterns and increase the potential for soil erosion.

Forests in other regions of the world would also be affected by significant warming. A recent analysis for the IPCC (Government of Finland, 1989) suggests that boreal forests will become *more* productive if significant warming occurs. Others believe that these

same forests would be especially hard hit, since most climate models suggest that any warming that occurs would be greatest in high latitudes. While temperature increases may be smaller in the tropics, tropical forests could be significantly affected by changes in rainfall and land-use pressures that may impede forest migration to more suitable locations.

b. Adaptation. *Today's forest management decisions could have long-term impacts on the composition and location of forests.* Planned adaptation measures that could be considered include maintaining forest diversity and extensiveness to enhance the ability of forests to respond to a range of climatic conditions; developing and testing fast-growing and heat- and drought-resistant species; preparing for dieback along southern boundaries with plans for rapid harvesting and removal of dead trees and replacement with better adapted species or nonforest systems; improving capabilities for monitoring changes in forest growth and composition; and modifying pest and fire control strategies to reflect likely changes in the frequency and nature of these disturbances.

2. Fisheries

The effects of global warming on fisheries depend primarily on changes in regional climates and ocean circulation and on the pace at which they occur. *The qualitative effects of warming on fisheries are thus highly uncertain, and no quantitative economic analysis has, to our knowledge, been attempted.*

a. Possible Impacts. The impacts of any significant change in temperature on fish populations would vary across species. Some would experience increased habitat and associated expansion of range. Adaptation would be easier for fish in large bodies of water, including the oceans, than for those constrained in small water bodies. Total productivity of fishing grounds in the Great Lakes and oceans could increase. Under some scenarios, phytoplankton and fishery productivity could increase in the Great Lakes by 1.6 to 2.7 fold, but there is the potential for a decrease in diversity due to intensified species interactions. Climate change effects on the ocean are particularly uncertain due to the complexities surrounding ocean circulation, which until recently has not been explicitly considered in climate models, heat uptake by the ocean, and future patterns of nutrient upwelling. One study found that many Gulf Coast fish and shellfish would be unable to tolerate much higher temperatures.

If there is rapid sea-level rise and resulting saltwater intrusion and wetlands loss, changes in the distribution and size of many estuarine species would be possible. Any losses of coastal wetlands would adversely affect fish. Species that are less salt-tolerant would tend to migrate upstream towards suitable habitat, ceding present habitats to species that are more salt-tolerant. In lakes, streams, and estuaries, declines in water quality due to reduced dissolved oxygen levels at the higher temperatures in some scenarios could adversely affect many recreational species.

In the tropics, species dependent upon coral reefs could experience significant adverse effects. Coral reef ecosystems could be vulnerable both to increased thermal stress and to sea-level rise, if it were rapid enough to inundate and kill the coral species.

b. Adaptation. *Both the need and the opportunity for planned adaptation appears to be limited.* Commercial fishing occurs primarily in the ocean, where effects of possible climate changes are especially uncertain. Changes in species location and composition could require some adjustments, but commercial fisheries now make similar adjustments in response to overfishing and the natural movement of species. Travel time to specific commercial fisheries may rise or fall, and changes in available species may raise or lower equipment cost. If equipment adjustments were made gradually, as durable assets were replaced, their costs would be relatively small.

Management of water flow to lakes and streams could affect fish populations in those water bodies. Restocking, which already plays an important role in recreational fisheries, and new species introduction could aid in adaptation to climate change. Reducing

water pollution could offset adverse warming impacts on some species.

3. Water Resources

Even if an assumed rise in regional temperature is taken as given, it is difficult to predict the impacts of climate change on water basins with much confidence because of uncertainties about regional precipitation. The quantitative estimates that follow assume a U.S. temperature increase of 5.4°F to 9°F and an annual precipitation increase of 1 to 3 inches.

a. Possible Impacts. Such higher temperatures would likely reduce snowpacks by shortening the snow season and causing more precipitation to fall as rain. This could have a significant effect on the operation of such water systems as the Central Valley Project and the State Water System in California. With no change in infrastructure, earlier snowmelt would raise flood probabilities in the winter. Management response to this would reduce annual deliveries by 7 to 16 percent. Similar problems could be expected in other Western water management systems.

Because of uncertainties about rainfall, it is hard to estimate the direction of change in water supply in many regions. This is especially true for rivers that are not fed by snowpacks, such as many rivers in the Southeast. Higher temperatures could lower many lake and reservoir levels through the effects of increased evaporation that was not offset by increased rainfall. For example, the levels of the Great Lakes could fall by an average of 0.5 to 2.5 meters, which could, among other things, reduce dilution capacity. On the other side of the coin, the Great Lakes would benefit from a longer shipping season and a reduction in water pollution due to reduced use of salt and other chemicals to cope with ice and snow.

If adverse developments occur, future costs would be incurred. For example, the future costs of building additional reservoirs for the California systems could be over $500 million (undiscounted) and the costs of dredging harbors and making other adjustments could cost $270 to $540 million (undiscounted) along the Illinois shoreline alone. (Note that a $500 million outlay required in 2020 could be financed from the proceeds of an investment of only $116 million today, assuming a 5-percent real rate of return on invested funds.)

The implications for water quality are mixed. Dissolved oxygen levels could be lower because oxygen is less soluble in higher temperature water and because higher temperatures may increase primary aquatic productivity, which increases the demand for oxygen. Summer stratification could be lengthened in some lakes, which, combined with higher demand for oxygen, would reduce dissolved oxygen levels and harm aquatic life. These factors could lead to lower water quality in some basins. However, reduced use of chemicals to cope with ice and snow would contribute to improved water quality in some northern areas.

b. Adaptation. A number of measures could be taken to increase the resiliency of water resources to climate change. Water conservation could be promoted by reducing or eliminating subsidies for water use or allowing trading of market rights. Water resource managers could be encouraged to explore ways to transfer water between neighboring systems during droughts and to consider plausible climate change in sizing new long-lived facilities. New drought-resistant species could be developed to help cope with any water shortages in agricultural areas.

4. Biodiversity

Other effects of possible global warming include a possible decline in biodiversity stemming from the loss or change of habitats that result in the decline or loss of some animal and plant species. While the relevant mechanisms can be described, their effects under different climate change scenarios have not been estimated.

a. Possible Impacts. Changes in climate would harm some species but benefit others. The ability of a natural community to adapt to changing climatic conditions would depend on the rate and character of climate change, the size of species ranges, the dispersal rates of

individual species, and whether or not barriers to migration are present. A species' ability to adapt to changing climatic conditions would be heavily influenced by dependencies upon or competition with other species within the ecosystem. For this reason, *the impacts of climate change on natural communities are difficult to predict.*

In general, communities near the edge of a species range and arctic communities would be at particular risk from significant climate change, as would species that migrate slowly, that are already threatened or endangered, that are specialized to small and isolated environments (such as montane and alpine communities) or that have narrow habitat requirements. In some cases, man-made barriers may limit migration: examples include mammals isolated in refuges and prairie species blocked by expansive agriculture.

b. Adaptation. Existing programs that focus on the protection of endangered species and preservation of genetic diversity could be adjusted if the number of species at risk grows. Expansion of reserves and creation of migratory pathways between areas of suitable habitat could enhance our ability to preserve species. It may be useful to develop forest management practices that allow product extraction while minimizing any reductions in an area's future use as wildlife habitat. Areas that may become suitable future habitat for threatened and endangered species, such as lowland areas adjacent to current wetlands, could be identified and considered for protection.

III. MITIGATION: LIMITING GREENHOUSE GAS EMISSIONS

As indicated in Section I, the analysis of mitigation strategies must consider emissions of multiple gases arising from many different economic activities in many nations. The first subsection provides some basic assumptions and principles about alternative policies for reducing greenhouse emissions. Estimates of the costs of reducing emissions of each of the main greenhouse gases are then discussed. *The costs of reducing carbon dioxide and chlorofluorocarbon emissions have received the most attention. Estimates of carbon dioxide abatement costs remain preliminary and controversial. Relatively little is known about the costs of reducing emissions of other greenhouse gases.* Major studies of mitigation policies are under way within the Federal Government (in DOE, EPA, DOI, and OTA; a CBO study will be published in August 1990), within foreign governments, and in the private and nonprofit sectors (work is under way at EPRI, Harvard, MIT, and Stanford). *A revision of this section a year or two from now could rely on a much deeper research base and might have different policy implications.*

A. Background

Two points are basic to any discussion of mitigation policies. First, *global action is essential if meaningful results are to be obtained without bringing economic growth to a halt in some regions.* Second, as in other regulatory arenas, *mitigation policies should minimize costs by relying on incentives to the maximum possible extent and by providing flexibility.*

1. Global Action

Table III.1 summarizes some key data from Section I. Anthropogenic emissions of methane and nitrous oxide are mainly agricultural in origin and are mainly produced by the developing nations; *it is clear that global action, concentrating on agriculture, would be necessary if a decision were taken to control CH_4 and N_2O emissions.* While current CFC emissions are mainly produced by the Organization for Economy Cooperation and Development (OECD) member states (which have already pledged significant reductions and are likely to commit to a near total phaseout), CFC emissions of other nations are predicted to rise rapidly in the future if no additional controls are put in place.

Table III.1 — Anthropogenic Greenhouse Gas Emissions

Gas	Percentage Share of Radiative Forcing in the 1980s	Percentage Share of 1985 Emissions		
		OECD Nations	USSR/East Europe	CP Asia/ Developing
Carbon Dioxide (CO_2)	49	43	22	35
Methane (CH_4)	19	25	13	66
Chlorofluorocarbons (CFCs)	14	65	16	18
Nitrous Oxide (N_2O)	5	27	14	59

Finally, while the OECD nations are now the single largest source of anthropogenic carbon dioxide emissions, emissions of other nations, which already account for more than half of total emissions, are expected to increase rapidly absent serious mitigation efforts. The OECD share of CO_2 emissions is projected to fall below 25 percent by 2050. *Taking account of expected future emissions patterns, the need for global action is evident for these gases as well.*

Table III.2 considers the effect on global CO_2 emissions in 2025 of the *unilateral* adoption by the U.S. or by all OECD nations of four frequently discussed emission limitation targets: reduction of emissions growth by 50 percent, stabilizing emissions at 1985 levels by the year 2000, reducing emissions 20 percent below 1985 levels by 2005, and reducing emissions 50 percent below 1985 levels by 2025. Though the underlying global and regional emission scenarios on which the calculation is based are necessarily uncertain, the basic message of this table is fairly robust: *even drastic reductions by all OECD nations cannot prevent substantial increases in world CO_2 emissions by 2025*. Unilateral actions by the U.S. have even smaller effects.

Table III.3 considers the implications of meeting the emission policy targets of Table III.2 on a global basis if nations outside the OECD take actions that are significant but less than proportional to the targets. The table shows that *without full participation by other nations, the OECD member states would have to make dramatic or impossible cuts to meet widely discussed global CO_2 emissions goals.*

2. Differential Impacts

While global action may be essential for effective mitigation, *differences in costs and benefits among nations may make it difficult to obtain global agreement on specific policies*. Table III.4 shows that CO_2 emissions per capita and per dollar of GNP vary substantially. Among those countries for which GNP estimates are available, higher-income nations tend to have higher emissions per capita but lower emissions per dollar of GNP. The USSR and Eastern European countries have particularly high emissions. These variations make it easy to imagine an international replay of the "clean states v. dirty states" debates that have marked Congressional consideration of acid rain proposals. The stakes for oil-exporting nations may be particularly high (Whalley and Wigle, 1989).

Table III.2 — Global Effects of Unilateral Carbon Dioxide Emissions Reductions by the United States or the OECD (Global Emissions in 1985=100)

	Global Carbon Dioxide Emissions in 2025 if Policy Adopted by	
Emissions Policy	U.S. Only	All OECD
Base Case (No intervention)	207	
Reduce Growth by 50%	203	198
Stabilize by 2000	203	198
Reduce 20% by 2005	194	182
Reduce 50% by 2025	188	169

Note: Based on RCW scenario in Lashof and Tirpak (1989), using 1985 emissions as the baseline.

The United States has a relatively high per capita CO_2 emissions rate for two reasons. First, U.S. energy intensity (as measured by British thermal units consumed per constant dollar of GNP) is higher than that of most of our major competitors. It is double that of Japan and 75 percent above than of Western Europe. Second, coal provides about 27 percent of total U.S. energy requirements. Among major industrial countries, this share is exceeded only by the U.K. (32 percent) and West Germany (29 percent). The United States also relies less heavily on nuclear power than do many other industrialized countries.

Because the United States relies heavily on coal (the fossil fuel with the highest amount of carbon per unit of energy) for electricity generation, U.S. electricity rates would be likely to rise more than those in other industrialized countries if concerted action were taken—for example, by imposing the same charge on the carbon content of fossil fuel—to curb CO_2 emissions. Unless energy-intensive U.S. industries were able to greatly increase their energy efficiency, they could be disadvantaged relative to major foreign competitors who would be less affected by electricity rate increases.

In addition, because the United States has an abundance of coal reserves, and very little undeveloped economical hydroelectric potential, limits on coal use would likely result in larger imports of oil and gas, which will have implications for our balance of trade and energy security. All of this presents a marked contrast to the 1973 and 1979 oil shocks, where our greater self-sufficiency in energy provided an advantage relative to most other industrialized nations. On the other hand, our more energy-efficient competitors may find it relatively harder to reduce emissions in the future, since they have already undertaken cheap efficiency measures that we have not.

Since adaptation costs are likely to vary substantially among nations, so may interest in investing in mitigation. Existing models suggest greater warming in high northern latitudes, and less warming in latitudes where most developing nations are located. There is likely to be considerable regional variation in

Table III.3 — OECD Carbon Dioxide Emissions Reductions Required To Achieve Global Emission Goals When Other Nations Take Lesser Actions (Base case global emissions = 100 in 1985, 207 in 2025)

Global Goal	Action Assumed Taken by		Required OECD Reduction
	USSR/E. Europe	Developing Nations	
Cut Growth 50%	Growth cut 25%	None	98% by 2025
	Growth cut 25%	Growth cut by 25%	33% by 2025
Stabilize by 2000	Growth cut 50%	Growth cut by 25%	41% by 2000
	Growth cut 50%	Growth cut by 50%	29% by 2000
Cut 20% by 2005	Stabilize	None	Exceeds 100%
	Stabilize	Stabilize	46% by 2005
Cut 50% by 2025	Cut 20% by 2025	None	Exceeds 100%
	Cut 20% by 2025	Cut 20% by 2025	89% by 2025

Notes: Based on RCW scenario in Lashof and Tirpak (1989), using 1985 emissions as the baseline. Developing Nations include Centrally Planned Asia.

Table III.4 — Carbon Dioxide Emissions Per Capita and Per Dollar of GNP, 1986

Country	Per Capita (metric tons of carbon per capita)	Per Dollar of GNP (kilograms of carbon per dollar)
United States	5.005	0.28
Canada	4.094	0.29
Japan	2.109	0.16
West Germany	3.066	0.25
Australia	3.853	0.32
France	1.794	0.17
United Kingdom	2.938	0.33
Italy	1.655	0.19
Spain	1.284	0.26
Poland	3.321	1.60
Mexico	0.909	0.49
South Africa	2.785	1.51
Brazil	0.379	0.21
China	0.527	1.76
India	0.187	0.64
East Germany	5.499	n.a.
Czechoslovakia	4.212	n.a.
USSR	3.593	n.a.
Romania	2.408	n.a.

Notes: From Department of Energy and *World Bank Development Report, 1988*. Top set of countries listed from highest to lowest GNP per capita. Includes emissions from fossil fuel combustion and cement production only. n.a.= means GNP not available in the sources employed.

agricultural effects. Nations differ substantially in their vulnerability to sea-level rise. A higher share of GNP originates in climate-sensitive activities in developing nations, but these nations generally lack resources for adaptation. In short, *while global action is essential to limit greenhouse emissions significantly, differences among nations may make it difficult to find universally acceptable emissions targets or ways of sharing the costs involved.*

3. Incentives and Market Failures

Consistent with its approach to domestic regulatory issues, this Administration feels that *an approach to limiting net anthropogenic greenhouse emissions that encompasses all important greenhouse gases and gas sinks as well as gas sources is more promising than one that considers each source of greenhouse gases individually.* An international limitation agreement based on the comprehensive approach, for example, would allow each nation to devise a strategy that reflects its own situation regarding opportunities for emissions reduction and sink enhancement. The Administration also feels that *any set of nations should be free at any time to develop a joint strategy to meet their pooled ceilings, as long as net global emissions are not thereby increased.* An approach incorporating these principles was outlined in a U.S. concept paper introduced at the IPCC.

Even if a comprehensive approach with provision for pooling were accepted, opinions are divided on how individual nations—in particular the United States—should set domestic policy to meet net emission limitation targets. *Most economists argue that primary reliance should be placed on incentive-based approaches—including charges, user fees, and tradable emissions rights.* This view follows from the presumption that households and firms generally respond rationally to incentives, so that regulatory goals are met at least cost by providing proper incentives and maximal flexibility to respond at all points along the production-consumption chain.

A second school of thought tends nonetheless to favor the use of efficiency standards and other command-and-control techniques. Adherents of this school point to apparent widespread deviations from best practice in energy use and to reports of large payoffs from utility conservation programs as indications of market failure. They contend that government regulation can reduce CO_2 emissions, in particular, at low or even negative cost by helping or forcing individuals to take actions that are, in fact, in their own self-interest.

Market failures do not, of course, provide an automatic justification for regulation. Market failures, where they exist, can be addressed directly. For example, since utility profits under traditional State rate regulation are often linked directly to the level of electricity sales, a utility faced with capacity constraints would usually prefer to increase supply rather than reduce demand. Regulatory changes at the State level could be made to place the alternatives of demand reduction and supply augmentation on a more even footing. Public information programs, promotion of efficient appliances by utilities, and changes in mortgage qualification rules to reflect appliance operating costs are other steps that could be used to deal with market failures directly.

Efficiency standards and other command-and-control regulations have several significant disadvantages relative to incentive-based systems or approaches that address perceived market failures directly. First, the burden of meeting standards cannot be reallocated across industries or across the different greenhouse gases in private cost-saving transactions. Second, in the absence of price increases for fossil fuels, standards can increase the demand for energy-using services. Finally, standards reduce the range of products available to meet diverse consumer needs.

The costs of efficiency standards are often hidden rather than explicit. For example, a higher average fuel economy standard might be met by forcing consumers to buy only the more fuel-efficient and generally cheaper vehicles in the existing product line, actually reducing their purchase and gasoline costs. However, out-of-pocket costs do not reflect costs imposed on consumers by denying them the option to purchase other valued attributes such as safety, performance, and spaciousness. Higher fuel efficiency without higher fuel prices also lowers the per-mile cost of driving, encouraging additional trips, fuel consumption, and emissions. Since fuel economy labels already provide good information to auto purchasers, and there are few apparent institutional rigidities in this market, the economic rationale for stringent vehicle efficiency standards is doubtful at best.

More generally, assertions that efficiency improvements are cost saving or nearly costless raise the classic question of why these improvements are not automatically taking place. Such assertions must be examined to see if the claimed efficiency gains involve tradeoffs with other product attributes that were excluded from the analysis.

Efficiency standards based on national average values may actually serve to restrict the choices of only those consumers who face low energy prices or have low usage rates (and thus energy consumption) for the product. Those with high usage rates or those who face high energy prices would purchase high-efficiency products even in the absence of mandatory standards. Taking this self-selection into consideration, an efficiency standard that appears to save money on the national level may actually impose costs on many consumers.

Economic models populated by perfectly rational firms and households participating in perfect markets that are always in equilibrium clearly do not provide a fully realistic characterization of the U.S. economy. But the alternative extreme assumption, of widespread private waste easily corrected by regulation but untouchable by market incentives or direct correction of market failures, seems at least as far off the mark. The question of where truth lies between these extremes is ultimately empirical, and it cannot be answered here.

It is important, however, to point out that essentially all analysts agree that *some reductions in greenhouse gas emissions can be obtained at low cost.* Disagreements focus on how fast the marginal cost of abatement rises and on how the initial, low-cost reductions can best be obtained.

B. Carbon Dioxide

Carbon dioxide accounted for about 49 percent of the increase in radiative forcing in the 1980's and is expected to account for a larger share in the future. The Administration's acid rain proposals, by providing incentives to conserve electricity, will reduce CO_2 emissions from electric utilities by around 2 percent—and will thus reduce total U.S. fossil-fuel CO_2 emissions by around 0.7 percent. The higher corporate average fuel economy (CAFE) standards adopted last spring will be likely to slow the increase in CO_2 emissions from automobiles.

Below, we begin by considering the estimated costs of CO_2 emissions reductions produced by economy-wide models. These models generally assume that markets work well, so that incentive-based approaches minimize the costs of emission reduction. We then consider analyses of the ability of regulatory initiatives to reduce emissions. These analyses tend to be sector specific and focus on market or policy failures. The final two subsections focus on the potential of new technologies and of forestation policies.

1. Economy-Wide Analyses of Emissions Limitation Costs

Several recent studies, and work now in progress on which we have been briefed, attempt to estimate the costs of efficient reductions in CO_2 emissions levels, using three distinct economy-wide modeling frameworks. *Energy/economic balance analysis* focuses on the long-term relationship between energy use and output, without explicit consideration of substitution possibilities within the energy sector or the economy as a whole. *Energy policy models* also focus on the long run but explicitly incorporate substitution possibilities among fuels and the responsiveness of overall energy demand to changes in energy prices and income levels. These models often incorporate a crude feedback from energy to GNP, but the main causality runs from the economy to the energy sector rather than vice versa. *Energy-economic models*, which exist in both short-and long-term variants, attempt to incorporate a fuller two-way link between the energy sector and the economy at large, but they tend to include less detailed treatment of energy production and consumption. While all of these approaches have clear weaknesses that point out the need for further research and the development of more comprehensive models, each provides some useful information, and all are considered here.

Costs are estimated in models of the latter two varieties by comparing economies with and without emissions reductions. *Assumptions about emissions growth in the no-policy baseline case vary widely and contribute to the diversity of results obtained.* Assumed annual growth rates in CO_2 emissions through 2050 vary from 0.61 percent (Edmonds, et al., 1986) to 2.27 percent (Edmonds and Reilly, 1983). Even small differences in baseline annual emissions growth rates (BAEGRs) can have a major effect on levels of emissions over the long time intervals considered in global climate analysis. For example, an increase of average annual emissions growth from 0.6 percent to 1.6 percent translates into a 43 percent increase in annual emissions levels by 2050. Higher BAEGRs translate

into higher, sometimes much higher, costs of meeting particular target emissions levels.

For high BAEGRs, even quite draconian policies do not significantly shift the date at which atmospheric CO_2 concentrations double from preindustrial values. For lower BAEGRs, policies to stabilize emissions appear to be more feasible. The different scenarios evaluated in the models considered below are best thought of as illustrative scenarios—possible sets of internally consistent future developments—rather than as definitive forecasts.

While the studies discussed below differ in many respects, and their shortcomings point up the need for further economic research, they all suggest that *the costs of stabilization or reduction of CO_2 emissions will be high—at least 1 percent of GNP per year for commonly discussed goals such as the indefinite stabilization of emissions between 80 and 100 percent of present levels. One percent of current world GNP is about $150 billion; if world GNP grows at an average annual rate of 3 percent, the total cost to 2050 (discounted at 5 percent) of 1 percent of GNP per year would come to about $5.2 trillion. If economic growth is significantly slowed, costs could be much higher.*

a. Energy/Economic Balance Analysis. Kaya (1989) and Kaya, et al. (1989) work from the following identity:

Growth rate of CO_2 emissions =
growth rate of CO_2 emissions per unit of energy use
+ growth rate of energy use per unit of output
+ growth rate of output

A –1.0-percent growth rate of energy use per unit of output is assumed, along with a growth rate of CO_2 per unit of energy use of between –0.4 and –1.0 percent. The former estimate may be viewed as somewhat pessimistic, especially if a substantial rise in energy prices occurs. The latter estimate is rather optimistic given the likelihood of increasing reliance on coal and coal-based synthetic fuels that are highly carbon intensive.

Under these assumptions, a CO_2 emissions growth rate of –1.0 percent, which is necessary to implement a 20-percent cut in emissions by 2005, is associated with world output growth of 0.4 to 1.0 percent per year. Over the last several decades, output has grown at 4 to 5 percent annually, and population has grown at a 2-percent rate. *Thus, these calculations suggest a drop in output growth of 3 to 4 percentage points per year, leading to an almost certain decline in per capita income.* The long-run effect on the world economy of a drop in output growth of even a tenth of the size suggested by Kaya's work would be staggering.

Fortunately, our experience following the 1973 and 1979 oil shocks indicates that the relationship between economic growth and energy use may be less rigid than Kaya's framework suggests. Between 1973 and 1985, the price of energy rose by 47 percent relative to nonenergy products at the consumer level and by 80 percent at the industrial level. Partly as a consequence, the ratio of energy use to real GNP fell by 2.4 percent annually in the United States and 1.9 percent annually in the OECD countries. CO_2 per unit of energy also fell during this period, as usage of natural gas and nuclear power increased rapidly, and *U.S. and OECD CO_2 emissions were essentially constant between 1973 and 1985.*

This was not a period of economic boom, however; growth rates of U.S. output and productivity over the 1973–85 period, 2.3 percent and 1.0 percent respectively, were far below the corresponding rates of 3.7 percent and 2.9 percent for the 1948–73 pre-shock period. While most of the slowdown in growth can be attributed to other factors, higher energy prices played an important role. The rise in energy prices led to a substitution of other inputs for energy and a diversion of investment that might otherwise have been used to increase labor productivity.

Moreover, part of the decline in the energy/GNP ratio during 1973–85 reflects the increased relative importance of the service sector. One cannot count on comparable increases in the future, especially as the United States moves from being a large net importer of

manufactured products to a large net exporter in order to balance its current account and repay international borrowing.

While the use of natural gas could continue to expand in the near term, the absence of nuclear projects in the pipeline and current strong public resistance to this form of power in the United States suggest it will be harder to substitute nuclear for fossil energy in the future than in the 1973–85 period. On the other hand, many have argued that macroeconomic policies and energy regulation contributed significantly to the poor economic performance of that period and that some of these mistakes could be avoided in the future. Moreover, revenues from a carbon charge (discussed below) could be used to lower other taxes, while much of the increased spending on oil in the 1973–85 period flowed abroad.

Despite these caveats, *the period of the oil shocks provides a useful reference for consideration of the likely impact of CO_2 emission-reduction policies on output and productivity growth.* Energy remains a major input to the U.S. economy, and studies discussed below suggest that energy price increases at least as large as those experienced between 1973 and 1985 would be required to achieve widely discussed targets for CO_2 emissions reduction. *On balance, there is no reason to believe that any attempt to reduce energy use significantly today would be substantially less economically disruptive than were the oil shocks of the 1970's.*

b. Long-Term Energy and Energy-Economic Policy Models. These models allow for explicit analysis of policies that raise the price of fossil fuels to discourage their use. The most natural (and easily analyzed) policies of this sort involve imposition of a *carbon charge*.

A charge levied on the carbon content of primary fossil fuels at their first sale or entry into the distribution system would provide an administratively simple means of reflecting the social undesirability of greenhouse emissions in fossil fuel prices. Because end-users cannot significantly alter the relationship between fuel carbon content and CO_2 emissions, and an economical carbon scrubbing technology is not anticipated in the near future, there is no efficiency advantage in applying the charge to end users. Sellers in long-term energy contracts (especially coal contracts) should not be forced to absorb the charge to fulfill their existing contracts. This problem can be avoided by imposing the charge on the buyer in the first transaction. Depending on other nations' mitigation actions, coal destined for export might be exempted from the charge, and a refundable credit for petrochemical and other uses of fossil fuels that sequester verifiable amounts of carbon could be considered. In principle, imports of electricity generated from fossil fuels should pay a charge based on the carbon content of the input fuel, though this could conflict with our free trade agreement with Canada.

Unlike an ordinary tax, which distorts private decisions such as the choice between work and leisure, an appropriate carbon charge can actually improve resource allocation and raise welfare by closing the gap between the private and social costs of carbon-emitting activities. A carbon charge would affect decisions ranging from the choice among alternative technologies for generating electricity, to the energy efficiency of cars, buildings, and industrial equipment, to the demand for automobile travel and products made from steel. Because a carbon charge provides incentives that affect decisions at all points along the production-consumption chain and across all industries, it automatically focuses on those activities where CO_2 emissions reductions can be achieved at least cost. The least-cost property of charges when markets work well is useful in placing a lower bound on the economic implications of particular greenhouse gas emissions targets, even if other tools would actually be used for implementation. A carbon charge does not, of course, provide the full flexibility and efficiency of a comprehensive charge system applied across all greenhouse gas sources and sinks.

Existing economy-wide studies generally imply that carbon charges on the order of $100 per ton or more would be needed to have a significant long-run effect on carbon dioxide emissions. At current prices, and not allowing for fuel market responses, a carbon charge of $100 per metric ton would increase the average price of coal delivered to electric utilities by 178 percent, the average price of natural gas by 49 percent, and the average price of oil by 70 percent. These impacts are comparable on average to the energy price increases caused by the oil price shocks of the 1970's. Electricity rates would immediately rise by up to 30 percent, 15 times the average increase that would be produced by the Administration's controversial acid rain proposals.

Nordhaus (1990a) provides an explicit (albeit necessarily crude) analysis of the costs and benefits of reductions in greenhouse gas emissions. His highly uncertain point estimate of the future costs of warming, based on selected EPA estimates of its effects on sea level, electricity demand, and agricultural productivity is 0.25 percent of future GNP. Even this small impact is sufficient to justify low cost measures, such as significant curtailment of CFCs and a small $3 per ton carbon charge. At the high end the range of effects that is likely to contain the true effect (anywhere from a benefit of 1.75 percent of GNP to a cost of 2.25 percent of GNP), a carbon charge of as much as $30 per ton might be justifiable. Both of these estimates are for a real discount rate 1 percent higher than the output growth rate. The optimal taxes are higher (lower) at lower (higher) discount rates. This analysis suggests that if carbon charges are found desirable in principle, *serious consideration should be given to using charges substantially lower than those employed in the modeling exercises discussed here.* Once a carbon charge system is in place, the rate can be raised—or lowered—as scientific and economic uncertainties are resolved in the future.

Manne and Richels (1989) simulate policies capable of stabilizing U.S. CO_2 emissions at their 1990 level through 2000 and then reducing them to 80 percent of this level by 2020. Their policy is a charge that begins at $29 per ton of carbon but rises sharply after the year 2000 before stabilizing at $250 per ton by the middle of the century. Initially, the emissions limit is met by fuel switching from coal to natural gas. Natural gas, which accounted for 12 percent of electricity generation in 1985, accounts for 27 percent by 2010. The rapid runup in charge rates after 2000 reflects the difficulty of securing a 20-percent emissions reduction by 2020 in the face of exhaustion of natural gas supplies and prior to the large-scale deployment of advanced technology alternatives to fossil fuels. Costs build to about 5 percent of GNP by 2030 and maintain that value through 2100.

However, the costs of meeting the emissions target are significantly reduced if the BAEGR turns out to be lower than the 1.7 percent they assume. For example, a 1-percent autonomous (not linked to prices) improvement in energy efficiency reduces losses to about 3 percent of GNP. The further addition of an optimistic forecast of future energy technology lowers estimated losses to a little more than 1 percent of GNP.

The autonomous rate of increase in energy efficiency (AEEI), and the cost difference between carbon-producing technologies and carbon-free replacements are key inputs to the model. Hogan and Jorgenson (1990) argue that, because technological advance as a whole has been energy-using rather than energy-saving, the AEEI is negative. Williams (1989, 1990) argues that the availability of low-cost conservation and alternative energy technologies implies both a higher AEEI and a much lower required carbon tax than that assumed by Manne and Richels. As noted in Section III.A.3, assertions that available efficiency improvements are cost-saving or nearly costless raise the classic question of why these improvements are not automatically taking place. The availability of low-carbon technologies that were truly attractive to consumers would, of course, significantly lower carbon emissions in the absence of any policy action.

Another Manne and Richels paper (1990) applies the same basic framework on a world scale. The policy

simulation holds emissions beyond 2020 to 80 percent of 1990 levels in the OECD countries, Eastern Europe, and the Soviet Union. Emissions in China and the developing world are stabilized at twice the present level. Autonomous efficiency increases in the OECD and China are set to 0.5 percent and 1.0 percent respectively prior to 2050; worldwide convergence to a 0.5-percent annual AEEI rate after 2050 is assumed. GDP losses from the carbon constraint over the 2030 to 2100 period average 3 percent for the U.S. and 1 to 2 percent for other OECD countries. Eastern Europe and the Soviet Union losses are slightly higher than those for the U.S. GDP losses for the developing countries are largest, with China facing GDP losses ranging from 9 to 11 percent between 2040 and 2100.

In an early paper, Edmonds and Reilly (1983) use an energy policy model to consider the application of carbon charges in the United States alone and to the entire world. These cases may be viewed as bracketing the outcomes under an international agreement with special provisions for developing countries and/or incomplete participation. The application of stiff carbon fees throughout the world (100 percent charge on coal, 78 percent on oil, 56 percent on natural gas, and 115 percent on synfuels, roughly reflecting the different carbon content of the different fuels) beginning in 1985 is found to reduce global carbon emissions by 40 percent from base case levels by 2050. However, given the high BAEGR employed (2.27 percent) global CO_2 emissions are still three times the current level in 2050. A fee program in the United States alone is much less effective, reducing 2050 global emissions by only 15 percent. *Carbon charges in the United States alone depress the world market prices of fossil fuels, leading to an increase in fossil energy use overseas that significantly offsets the greenhouse benefits of reduced energy demand and fuel switching in the United States.*

In subsequent work, Edmonds (1989), Reilly and Edmonds (1985), Reilly, et al. (1987), and others have used the same model with a lower BAEGR. Cline (1989) finds that a somewhat higher global charge (approximately $100 per ton of carbon) than that considered in the original Edmonds-Reilly paper is sufficient to stabilize CO_2 emissions at or slightly below current levels in the second half of the 21st century with a 0.95-percent world BAEGR. The Congressional Budget Office (CBO) analysis of carbon charges (CBO, 1990, forthcoming) presents runs with a 2.0-percent world BAEGR. In these runs, a global $100-per-ton carbon charge cuts a baseline 350-percent increase in CO_2 emissions by 2050 to a 250-percent increase. The difference between these results and Cline's highlights the importance of the BAEGR in driving the results regarding effectiveness of taxes in meeting a target emissions level.

Some general observations apply to all runs of this model. First, while some substitution among primary energy sources does occur, the primary mechanism for cutting emissions is a reduction in overall energy use. Second, the burden of greenhouse policy always falls heavily on the coal sector and on net exporters of fossil fuels (and, by implication, energy-intensive products). For example, in Cline's runs, coal use increases between 2000 and 2050 in the baseline case but falls by more than two-thirds when the global charge is applied. Third, while global policies are clearly preferable in CO_2 limitation terms, they are likely to put much more pressure on the world savings-investment balance. Crowding out of other productive investment becomes a larger problem as more countries attempt to increase investment in energy efficiency at the same time. Indeed, for developing countries with limited access to capital markets, concern over crowding out could pose a serious barrier to any participation in CO_2 limitation efforts. Finally, the Edmonds-Reilly model is not useful for estimating the effects of greenhouse policy on GNP, since the role of energy in the production function and tradeoffs between energy and nonenergy investment are not explicitly modeled.

Ongoing work at the CBO will also report on runs of the Jorgenson general equilibrium model with a unilateral $100 per ton carbon charge imposed in the year 2000 (CBO, 1990, forthcoming). This policy is estimated to reduce real GNP by 1 percent. The

Jorgenson model essentially involves a "de novo" solution that does not take into account constraints imposed by current fixed assets and labor force skills on the composition of the economy 10 years from now. The Jorgenson model solution entails radical shifts in the composition of electricity supply and large interindustry shifts in the composition of the economy. Sectors such as textiles, agriculture, and leather grow, while chemicals, mining, and plastics decline.

Because Jorgenson's model describes an economy in 2000 that is very different from today's economy and because adjustments involve costs, such radical shifts are unlikely to occur over this time interval. Such shifts would necessarily entail significant dislocations. *Because of these adjustment costs, actual structural changes and thus actual emissions reductions, would likely be lower than these results indicate. Alternatively, much higher economic costs, including significant labor force dislocations and sharp reductions in the value of existing immobile assets, would be required to achieve the level of emissions reduction obtained in the Jorgenson model solution.*

The sectoral shifts envisioned by Jorgenson would nonetheless occur over time if significant policies to discourage CO_2 emissions were adopted. These large distributional effects are thus a reminder that *the aggregate economic effects of CO_2 emissions reduction policies*, variously estimated at between 1 and 5 percent of GNP for carbon charges in the $100 per ton range, *would not be felt evenly throughout the economy.*

c. Short-Run Economic/Energy Models. A recent detailed analysis considered the cost to Australia of achieving a 20-percent reduction in CO_2 emissions by 2005 (Marks, et al., 1989). In some respects, such as the significant use of coal in electricity generation, the Australian situation is similar to that of the United States. Using very conservative methodology, *attainment of a 20-percent emission reduction is estimated to slow economic growth and cause GNP in 2005 to be at least 1.2 percent below the no-policy baseline GNP levels.* Since Australia is a small economy with an open capital market, the investments needed to achieve the emissions target may be possible without driving up interest rates or crowding out other investment.

Short-run economic modeling for the U.S. economy shows that a carbon charge of $100 per ton would have a significant effect on both CO_2 emissions and economic growth rates even if it were phased in over a 10-year period (CBO, 1990, forthcoming). One widely used macroeconometric model shows a depression of 2 percent in real GNP from baseline levels over the next decade; effects on the overall price level are approximately 2 percent during the phase-in period.

The same study notes that the transition could be much more difficult if carbon charges were imposed suddenly. This is true even if the full amount of the carbon charges was returned to the economy through reductions in other taxes. (At 1988 energy consumption levels, a $100 charge would raise approximately $130 billion annually. However, additional debt service costs and higher federal expenditures for cyclically sensitive programs would almost fully offset this additional revenue in the near term.) Reductions in other taxes would lose some of the CO_2 reduction benefits associated with a weaker economy.

Morris et al. (1990) use a linear programming model to consider the potential for short-term CO_2 reductions in the United States. Energy-saving technologies are applied based on engineering estimates of their cost-effectiveness (comparing higher initial cost and lower operating cost) evaluated at a 7-percent real discount rate. Many low- or no-cost technologies are identified using this criterion, which does not consider other relevant product attributes. Some of these technologies, such as improved insulation retrofit options, represent one-time reductions—emissions growth continues from a lower base once they are installed. All chosen technologies are assumed to be applied from 1985 onwards, but no mechanism for implementing the technologies selected by the model either prospectively (or retrospectively) is identified.

The marginal cost of a 20-percent reduction in emissions from 1990 levels, assuming significant new investment in nuclear power, is $39 per ton. Without new nuclear power, the marginal cost of a 20-percent reduction is $130 per ton.

d. Energy Sector Impacts. Because coal is at the same time this country's (and the world's) most abundant fossil fuel, as well as the fossil fuel with the highest carbon emissions per unit of energy, *it is impossible to construct a plausible scenario for substantial CO_2 emissions reduction without a major adverse impact on the coal industry.*

The Department of Energy provided some rough calculations of possible impacts. They find that halving CO_2 emissions growth could produce a 25-percent decline in coal industry employment (relative to baseline assumptions) by 2025, while stabilizing emissions could require a 40-percent decline over this 35-year period. Global commitment to a 20 percent emissions cut could lower employment by about half; unilateral OECD commitment to this global goal would eliminate the U.S. coal industry, as would global or OECD-only commitment to a 50-percent reduction in CO_2 emissions.

It is important to recognize, however, that *elimination of coal-mining jobs gradually over time does not necessarily imply increased general unemployment*, in the case of an expanding economy though there may be persistent regional problems. A shift to other energy sources would create jobs. In the short run, jobs will likely be created in the natural gas industry. In the longer run, three regional studies of biomass energy use sponsored by the Department of Energy's Regional Biomass Energy Program (Council of Great Lakes Governors, 1985; Chamberlin and High, 1986; Tennessee Valley Authority, 1989) suggest that a shift from fossil to biomass energy would on balance create jobs. Similarly, a study conducted for the California Energy Commission (1986b) suggests that renewable energy technologies are generally more labor-intensive than oil and gas.

2. Regulatory Adjustments

There are a number of reasons why total U.S. investment in energy efficiency may be suboptimal. First, many costs associated with the production, transportation, and conversion of fuels—including air and water pollution, storage of nuclear wastes, and reduced energy security—are not fully reflected in retail prices for fuels and electricity. Second, electricity prices tend to be based on average cost rather than on marginal cost, which is often higher. Third, it is often difficult for buyers to acquire or analyze information on available energy-efficiency options. It has been argued that this difficulty leads industrial buyers to ignore energy use implications of relatively small purchases—such as lighting. Similarly, since it is difficult to estimate future utility bills, it has been argued that builders and homeowners tend to focus excessively on the initial capital costs of appliances and space heating systems, rather than on discounted life-cycle costs. At least one often-cited econometric study (Hausman, 1979) finds that, consistent with this hypothesis, consumers act as if they have abnormally high discount rates when making appliance purchase decisions.

Based on these and related arguments, and on studies that suggest that cost-effective conservation could reduce U.S. energy use by 20 percent or more (Pirkey and Scheer, 1988), *many analysts have called for a variety of regulatory initiatives to increase the efficiency of energy use and, thereby, to reduce CO_2 emissions.*

a. Reform of Electric Utility Ratemaking. It must be understood at the outset that average cost is not always below marginal cost and that electricity prices are not always set by simply averaging costs. The prospect of self-generation by some large industrial customers, in particular, may serve to keep industrial prices near marginal cost.

The literature on this issue is thin, but a recent study by Wenders (1986) provides an instructive empirical analysis of electricity prices charged by five major utilities throughout the United States. Using 1980 and 1981 data, he finds that prices were on average below marginal cost, but the pattern of deviations from marginal cost was complex. Prices were above (long-run) marginal cost in peak periods and below

marginal cost otherwise; residential prices were below marginal cost, while some utilities charged commercial and industrial customers prices above marginal cost.

This complexity, the likelihood that price elasticities vary by customer class and between peak and off-peak periods, and the variability of rate structures within Wenders' small sample suggests that *the elimination of electricity pricing distortions would be as likely to yield increases in consumption and emissions as decreases*—though such reform would on balance improve resource allocation.

b. Utility Demand-Side Management. *Many analysts have called for reform of electric and gas utility regulation to give utilities incentives to remove impediments to efficient investments in energy conservation.* The basic rationale is that existing regulation discourages utilities from promoting energy efficiency, because lower demand generally reduces earnings, and that there are information-related entry barriers to third-party providers of "energy services" (Moskovitz, 1988). Two approaches to reform have been widely discussed.

The first approach is to permit utilities to increase their earnings by making cost-effective investments in conservation—even if those investments are on their customers' premises. Programs of this sort are newly in place or under development for eight New England electric utilities, which account for about 75 percent of the region's power demand (Foy, 1989). A key feature of these efforts is close attention to evaluation and monitoring; this should result in a rapid accumulation of useful data. Based on preliminary experience, the Conservation Law Foundation estimates that programs of this sort could reduce annual U.S. anthropogenic CO_2 emissions by between 0.7 and 0.8 percent (Foy 1989, 1990).

A second, complementary approach is to integrate conservation into the competitive bidding process for meeting new electricity supply requirements, which has been adopted in 18 States and is under active consideration in at least 15 more. Cicchetti and Hogan (1989) describe an economically efficient approach to doing this; see also Joskow (1990). The beginnings of such a comprehensive program can be found in such diverse States as Maine, Massachusetts, New York, California, and Wisconsin. Bidding selection criteria could also include environmental externalities to allow environmentally clean projects to compete favorably with lower cost but less environmentally attractive proposals. A step in this direction has recently been taken in the New York State Energy Plan (1989).

While the desirability of regulatory changes of these sorts is apparent, *estimates of potential achievable savings of electricity range from 4 percent to 75 percent.* Industry sources such as the Electric Power Research Institute (1989) estimate potential savings of 20 percent between 1977 and 2010. The uncertainty surrounding these estimates is evident from the size of the range. According to the Northwest Power Planning Council, which has extensive experience in demand-side efforts, hard quantifiable experiences are extremely limited." The New England efforts discussed above may remedy this in a few years.

c. Research and Information. *During the past 8 years, DOE's R&D budgets for end-user energy-efficiency improvements have declined significantly.* DOE's 1989 conservation budget in constant dollars is less than a third of its 1980 level. However, DOE's budget for supply efficiency has increased. As a proportion of the total national energy R&D budget (including expenditures by DOE, NRC, EPRI, and GRI), energy efficiency accounts for only 9 percent. Expanded funding would permit DOE to work more closely with industry to demonstrate new energy-efficient technologies, assess the long-term performance (durability) of energy-efficient technologies, and revive research on the patterns and determinants of energy-related decisionmaking and the barriers to adoption of energy-efficiency actions.

Similarly, *funding for DOE programs that provide financial and technical assistance to States has decreased by two-thirds in recent years.* (These programs include the State Energy Conservation Program, the Energy Extension Service, and a small Least-Cost Utility Planning Program.) There are a number of areas where DOE could sponsor demonstration of energy-efficient equipment and work with trade associations to encourage dealers to stock energy-efficient systems and building managers to install them.

d. Building and Appliance Standards. *Experience with energy-efficiency standards throughout the country (especially in California and the Pacific Northwest) shows that they can reduce energy consumption, and thus CO_2 emissions.* If imposition of Federal standards is deemed inappropriate, DOE could assist State and local governments on code development and training and could assist builders on design and construction techniques aimed at cost-effective conservation. These and related objectives would be furthered by increasing DOE's budget for building standards and guidelines, currently only $700,000 a year.

The National Appliance Energy Conservation Act of 1987 requires DOE to review appliance efficiency standards on a regular basis and to promulgate more stringent standards where technically and economically feasible. The pace of the statutorily required review could be accelerated. DOE could also review the feasibility of expanding efficiency standards to other products, including incandescent and fluorescent lamps. However, as noted above, incentives or direct correction of market failures provide attractive alternatives to the imposition of command-and-control standards.

e. Transportation. The corporate average fuel economy law was enacted in 1975 and established a fleet-average goal of 27.5 mpg for 1985 and beyond. That goal has been achieved, and the average fuel economy of the new car fleet has been quite stable at around 28 mpg for several years. Increases in fuel economy have produced essentially proportional reductions in CO_2 emissions per vehicle mile. The CAFE program is controversial and was opposed by the previous Administration, though the standard was increased by this Administration in the spring of 1989.

Further increases in the CAFE standard are technically feasible and would likely reduce CO_2 emissions; estimates of the costs of such increases are controversial. It seems clear that widespread use of currently available and likely future technologies would permit increases in the average fuel economy of the new car fleet without reducing performance below recent levels (but perhaps below levels planned in the absence of tighter CAFE standards). The Office of Technology Assessment (OTA) (Plotkin, 1989) considered standards in the 32- to 33-mpg range for model year 1995 to be feasible in this sense. The Department of Energy (Stuntz, 1989) points to a 29- to 31-mpg range for that year, and 36 mpg by 2000. The OTA estimates that by 2010 a 33-mpg standard would reduce U.S. fossil fuel CO_2 emissions by 0.5 percent (and world emissions by 0.1 percent) and U.S. fuel use by 5 percent. Oil imports would also be cut.

The difficulty of assessing the costs and benefits of increases in the CAFE standard was discussed in Section III.A.3, above. Benefits will be reduced if higher prices than would otherwise obtain reduce new car sales and thus slow the improvement in fleet-average economy. Benefits will also be reduced if lower per-mile costs lead to more miles per car. Cost analysis must also consider impacts on diverse consumers, not just on national averages, and must take into account foregone performance improvements as well as the reductions in safety and spaciousness that could occur if manufacturers meet higher standards in part by downsizing. Since fuel economy labels provide good information, it is not clear that CAFE standards would remedy any market failure that could not be addressed more efficiently by employing a carbon charge or gasoline tax.

f. Agricultural Policy. *A number of changes in agricultural programs that would have other benefits can be expected to assist in reducing emissions of greenhouse gases. These include reducing commodity price support levels, encouraging additional tree planting, and conservation cross compliance.*

This and the preceding Administration have sought to reduce price support levels for program crops in order to increase the efficiency of resource use within the agricultural sector. Reducing agricultural subsidies will tend to reduce total acreage in program crops and change the mix of crops grown. Corn and wheat, the two most widely grown program crops, account for 57 percent of nitrogen fertilizers used. As is discussed in Section III.E, below, the use of these fertilizers is associated with emissions of N_2O, a greenhouse gas with a relatively high radiative forcing index. Reducing income support can be expected to reduce the acreage devoted to corn and wheat and, possibly, to increase the acreage devoted to soybeans, which fix their own nitrogen from the air. In addition, reducing income

support is likely to reduce per-acre use of all inputs, including nitrogen fertilizers (Miranowski et al., 1989).

Reducing agricultural support prices should also slow the rate of conversion of forest and woodlands to cropland. It should also encourage the conversion of marginal cropland into forestland, particularly in areas where commercial forestry opportunities exist. This could result in a significant increase in CO_2 removal from the atmosphere. *The key point is that less support would allow farmers to respond to market changes induced by climate change.*

Conservation Compliance denies farm program payments to farmers who cultivate highly erodible land who fail to have a Soil Conservation Service approved conservation plan by 1990 or fail to fully implement the plan by 1995. These plans for the most part require the use of conservation tillage, which reduces mechanical soil preparation and mechanical cultivation. Consequently, the number of tractor passes through the field and the total tractor operating hours per acre are reduced. This should result in a reduction in CO_2 and N_2O emissions. But it also could mean increased use of herbicides and pesticides, leading to other potential problems.

3. New Technologies

This section considers the role of advanced technology in reducing CO_2 emissions in the electric generation and energy end-use sectors. Of particular interest is how much can be gained by broader use of currently available technologies that enjoy only limited commercial use because they are new and/or expensive, as well as advanced technologies that only require modest additional development for widespread application. *While new technologies offer significant CO_2 emissions reduction potential after 2000, there is no simple "technological fix" to this problem.* Regulatory barriers may affect the economics and introduction of some technologies.

At any given time, a combination of technological, behavioral, market, regulatory, and macroeconomic factors interact to determine patterns of energy use, the introduction of new technologies into widespread acceptance, and the further deployment of technologies already in use. Even in the analysis of high-quality historical data, it is difficult to identify the portion of actual energy use that is due to any single causal factor, including new technology. Thus *the discussion below can only be indicative of the likely role of new technology*; further research may well change its conclusions.

Progress in reducing CO_2 emissions depends on installing and using new technologies in a host of applications. Key determinants of the penetration of new technologies are sectoral rates of growth and average economic lifetimes of capital assets. Lifetimes vary considerably, from motor vehicles (8 to 14 years) to residential (30 to 80 years) and non-residential (31 to 48 years) structures. Electric generating equipment (10 to 55 years), other transportation equipment (16 to 28 years), and industrial equipment (14 to 27 years) have intermediate lifetimes. Moreover, it can take years for economical new technologies to become accepted. Thus new energy technologies may not come into widespread use even in new installations for years—or even a decade or more—after they are commercially available.

a. Electricity Generation. By 2010 an estimated 400 gigawatts (GW) of new electric generating capacity may be needed to meet demand increases and to replace existing capacity that will retire. New technologies can, therefore, play a significant role in limiting CO_2 emissions from new electric generating sources. But it must be recognized that only 65 GW of this total will replace retired capacity; about 655 GW (91 percent) of existing capacity will not retire until after 2010. CO_2 emissions may also be reduced as existing generating units are repowered and reboilered with more efficient technologies or with equipment designed to burn fuels with lower carbon content.

A variety of new technologies that produce electricity from coal, oil, natural gas, and methane with improved efficiency in the conversion of fossil energy into electrical energy are in various stages of development. By reducing the amount of fossil fuel burned to generate a given amount of electricity, these technologies can reduce CO_2 emissions per unit of electricity produced. Renewable resources, primarily hydropower and wood, provided 8 percent of the nation's energy in 1988. Newer renewable resource technologies, including wind, solar thermal electric, geothermal electric, photovoltaic, and biomass

technologies, will make increasing contributions in coming decades.

The future use of nuclear power both worldwide and in the United States will continue to depend on many factors, including relative cost, national security considerations, third world development, progress in dealing with nuclear waste disposal and nuclear weapons proliferation, continued safe operation of existing nuclear plants, and establishment of a stable and certain licensing process. The goal of the DOE nuclear reactor program is to develop nuclear reactors with simplified and standardized designs and passive safety features, designs which hold the promise of revitalizing the nuclear power industry through the simplification of the licensing process and resulting reduction in costs and financial risks. In addition, an NRC rulemaking procedure is in place to preapprove standardized nuclear plant designs so that parties interested in purchasing a plant have assurance that there will be no intractable licensing problems. Final designs will be ready for demonstration or commercialization in the 1990's and, if public attitudes and regulatory changes reduce business risks, *the next generation of reactors may come into use after 2000.*

On balance, while important gains in generation efficiency are possible, they are not likely to penetrate the market substantially in the near term based on market forces alone. *The potential for advanced technology to reduce generation-related CO_2 emissions appears to increase substantially after 2000*, but this potential has wide uncertainty bounds.

It is technically possible to "scrub" carbon from combustion waste gases, but it is very expensive. One study concludes that collection and disposal of powerplant CO_2 emissions would at least double the cost of coal-fired electric power (Steinberg, 1983). There has also been some discussion of methods of utilizing only the hydrogen in fossil fuels (Steinberg and Cheng, 1987). These ideas are in their infancy and are many years away from commercial application.

b. Energy End-Use Technologies. Many estimates of conservation potential indicate that new technologies could produce significant savings over expected energy use, even by the year 2000. These estimates are buttressed by analysis of historical data, which indicates that over the 1972–86 period, technology improvements have played particularly significant roles in reducing energy use in all sectors, particularly industrial and transportation but also including commercial and residential buildings.

The contributions from new technology to energy-efficiency gains are potentially substantial, particularly after 2010. Of course, the eventual levels of application depend heavily on fuel prices and the economic lifetimes of capital stock. Because of lower lifetimes, the prospects for near-term stock turnover are highest for transportation vehicles, appliances, and some light industrial equipment. Most residential, commercial, industrial and utility structures and large equipment technologies require much longer time periods to be replaced.

On balance, *advanced energy use technology seems to have the potential to contribute significantly to reducing CO_2 emissions, but estimates of the extent of the contribution vary widely.* For example, a recent study (EPRI, 1990) found that instantaneous replacement of the entire stock of electric end-use equipment with the most energy-efficient alternatives available could reduce electricity use by 24 to 44 percent from projected levels in the year 2000. Exclusion of technologies that are not cost-effective and relaxation of the instantaneous replacement assumption, which does not seem to approximate any feasible policy, would significantly change these estimates. Most energy projections indicate that energy efficiency gains on the order of 12 percent can occur by 2010 through the operation of market forces if fuel prices rise as projected. Substantial additional gains in energy efficiency could occur by more widespread application of "best practice" technologies, but extensive policy interventions or much higher fuel prices are essential to achieve them. Significant technical potential for efficiency improvements and fuel switching beyond 2010 exist, but increased efforts to develop and commercialize new technology are required in the near term to achieve these gains.

4. Forestation

Reforestation and afforestation policies may remove CO_2 from the atmosphere and store the carbon in the woody parts of living trees. By preventing the release of such carbon, policies that limit deforestation reduce

net emissions of CO_2. However, reforestation may affect microclimates and the soil's ability to absorb CO_2. As a forest grows, an annual flow of carbon is removed, but it is generally assumed that carbon release from decay balances carbon uptake from new growth in mature forests. *Reforestation is a (comparatively) short-term approach that may cause a substantial decrease in net CO_2 emissions for three to five decades* (Sedjo and Solomon, 1988). After this period, a large effort would be required to keep the absorbed carbon sequestered. However, even short-term sequestration could allow time for the development and adoption of new technologies that emitted less carbon, possibly including the substitution of timber-based fuels for fossil fuels to create a zero net carbon energy cycle with continuous replanting.

a. Cost Analysis. Sedjo and Solomon (1988) provide cost estimates for a global reforestation plan designed to sequester the entire flow of net additions of carbon to the atmosphere. Carbon absorption is highest for recently planted fast-growing species on tropical sites. Plantations with these characteristics are estimated to sequester 2.3 metric tons of carbon annually per acre. If such sites were used, an estimated 1.1 trillion acres of land would be required, while if slower growing trees were planted on sites in temperate zones, over 7.4 trillion acres would be required. These are large requirements; 1.1 trillion acres is 50 percent greater than the current forested area in the United States and more than 15 percent of the forested areas in the world. A forestation program on this scale would require a worldwide search for suitable and inexpensive land.

Estimated total costs of absorbing global net carbon emissions range from $372 to $697 billion. Based on total program costs and assuming a 30-year rotation, *the cost ranges from $4.29 to $8.03 per metric ton of carbon removed.* In addition, future harvest of the large quantity of trees required for significant carbon sequestering could disrupt timber markets and dramatically reduce incentives for planting on private forestland.

Moulton and Richards (1989) examine a more modest carbon sequestering program in the United States. They conclude that *marginal costs per-ton range from $17.71 to $102.63 per metric ton depending on program size.* The lower estimated per ton costs for the larger worldwide sequestering program flow from more optimistic assumptions about both carbon absorption and land costs. These assumptions may be justified on the availability of less expensive land outside the United States and faster forest growth rates on tropical sites. However, the smaller program with more pessimistic assumptions is probably a more reliable guide to costs for U.S. reforestation programs.

Forestation programs of moderate size can be implemented in a wide variety of ways to minimize impacts on land costs. Several options have been outlined by the U.S. Forest Service (1989), including volunteer urban tree planting programs, cost-sharing and technical assistance programs, and land leasing programs. For example, enhancing forest growth on sparsely forested land would not increase competition for land but would increase carbon uptake. Urban tree planting would not raise land costs and, by providing shade, may reduce fossil fuel consumption by reducing demand for air conditioning. Land leasing forestation programs or programs that only involve cost sharing in the costs of planting, improving, and managing lands for timber production are two alternatives for increasing forestation on private nonurban land. On a large scale, such programs could reduce expected stumpage prices and thus lead to reduced forestation in current commercial forests.

The net ecological and recreational benefits of forestation would depend on the type of forest planted and the current use of the land. All types of forest would tend to have soil erosion benefits when established on erodible cropland. However, fast-growth forest plantations, with repeated harvest of small trees for fiber or energy, would have few recreational benefits and offer habitat for limited species of wildlife. Frequent harvests and replanting of fast-growth stands might result in added erosion if such forests replaced natural forest land or grasslands. Grassland, sparse forest land, mixed-use forest (including grazing use), and old growth forests offer diverse and unique wildlife habitats and ecosystems. Because the greatest intake of CO_2 occurs in young, fast-growing stands, enhancing the carbon storage properties of land in such current uses would dramatically change the ecosystem, and widespread

forestation with the sole goal of carbon storage could significantly decrease biodiversity.

b. Management. Because new forests represent a growing stock of carbon, *the efficacy of forestation as a carbon management tool depends importantly on how the stock of accumulated carbon in mature forests is managed.* If new forests are allowed to mature, significant carbon removal would occur only over a 30 to 40 year period. To continue carbon removal through forestation would require forest establishment on increasingly large areas of the Earth's surface.

If forest land is cleared for other uses in the future, the carbon stored during forest growth is then released to the atmosphere. If forest carbon is somehow stored so that decay and release to the atmosphere does not occur, a continuous flow of carbon can be removed. (Solidwood products are estimated to contain only about 0.5 percent of the carbon in living trees, however (Rotty, 1986).) More plausibly, forests might be used as an energy source. In this case, net carbon removal would occur while new forest growth is established, and a continuing carbon reduction benefit would occur to the extent that biofuels replaced fossil fuels. Since biomass and other renewable energy programs can also produce large demands for land, analysis of afforestation programs requires careful coordination with energy system analysis.

Each of these management options has quite different effects on economic cost and on carbon removal. Unfortunately, the costs and carbon removal benefits of these options have not been systematically analyzed.

C. Methane

Methane accounted for about 19 percent of the increase in radiative forcing in the 1980s. The rise in atmospheric CH_4 concentrations over the last century is due to a relatively small imbalance between sources and sinks. Current assessments indicate that atmospheric stabilization will require only a 10- to 20-percent reduction in annual emissions.

As Table I.3 showed, the developed countries account for only about 25 percent of anthropogenic CH_4 emissions, in part because over half these emissions are produced in agriculture. *Thus significant, cost-effective reductions in CH_4 emissions will require global action. While a number of approaches to controlling these emissions are available, no systematic policy design or costing analysis seems to have been performed.* There are ongoing efforts within the Administration to better quantify the costs of methane reductions and to develop, refine, and demonstrate best management practices within the areas discussed below: animal waste, coal mining, landfills, livestock, and rice.

1. Animal Waste

Animal wastes are estimated to generate about 4 percent of anthropogenic CH_4 emissions. In developed countries, where these wastes are managed in lagoons, the most promising technology for abatement of this methane is decomposition in anaerobic digesters to produce methane gas, which, like natural gas, can be used to produce electricity and/or shaft power or be burned in boilers as a heat source. This approach is most promising at sites with large animal herds such as feedlots and dairy farms. Full recovery at these sites would reduce these emissions by over 50 percent. USDA estimated in 1978 that approximately 50 million tons of "economically collectable" livestock and poultry residue, when converted through anaerobic digestion, could generate CH_4 equal to 7 percent of the natural gas consumed in the United States in 1988.

Fewer than 100 anaerobic digesters currently are operating on farms in the United States, however. Most of these are producing electricity to power farm equipment. Excess electricity often is sold to the utility grid system. Poor economics, management problems, and infrastructural barriers have restricted widespread adoption of this technology. Most of the plants are one of a kind and expensive. Typical costs of electricity generated are 5 to 7 cents per kilowatthour (kWh). Additional research should enable the development of standardized facilities that are substantially cheaper and more efficient. Currently, farmers receive 2 to 3 cents per kWh for electricity they provide to utilities except in a few areas, notably California where 9 to 11 cents per kWh is paid. Many power companies are reluctant to accept power from farmers and establish major road blocks adding to the cost of an intertie.

2. Coal Mining

Methane from coal mining is estimated to contribute 13 percent of anthropogenic emissions. This methane is pipeline quality and can be recovered as a resource, thereby both reducing CH_4 emissions and use of other fossil fuels. It is technically feasible to reduce 60 percent of these methane emissions through premining degasification. This recovery would be performed at a limited number of sites, since about 10 percent of the world's mines generate most of the methane. These mines are concentrated in the 9 countries that produce the bulk of the world's coal.

Economic assessments show that methane recovery can be profitable with existing technology. Indeed, several recovery operations are running profitably in the United States. An important limitation to more recovery in the United States is that gas companies typically own the rights to the methane in coal mines. The coal companies can only profit from methane recovery by buying rights to this methane or setting up some sort of joint venture operation.

Preliminary assessments also show that mining methane could be profitable in countries such as China and Poland. For example, analysis suggests that it is less expensive for China to derive energy from mining methane than coal. Much of China's coal is deep-mine coal that is expensive to bring to the surface, and gas pipelines are less expensive to build than the railroads necessary to transport the coal. Despite these analyses, methane mining has not been implemented on a large scale, and a continued rise in coal mining activity is planned to meet China's growing energy needs. Since the USSR, China, East Germany, and Poland are major coal producers, transfer of methane recovery and methane mining technologies to these countries could produce substantial benefits.

3. Landfills

Landfills, mainly in developed countries, are estimated to contribute 10 percent of anthropogenic CH_4 emissions. Of the 6,584 municipal solid waste landfills in the United States, only 123 (1.9 percent) now recover methane for energy use. Under current market conditions, methane recovery is only viable for large sites with a suitable gas user nearby or at which electricity can be generated and sold into the grid. Regulatory barriers also exist in many areas. Ongoing research aims at enhancing the economic viability of methane recovery.

EPA hopes to promulgate regulations limiting CH_4 emissions from large landfills in the United States. EPA believes that these regulations have the potential to reduce total anthropogenic CH_4 emissions by about 1.5 percent. Controls applied in other countries could produce further reductions.

4. Livestock

Livestock generate about 20 percent of anthropogenic CH_4 emissions. Intensive (grain-fed) animal production systems used in developed countries result in significantly less methane per unit of output than do extensive (grass-fed) systems prevalent in developing countries. Production methods that enhance efficiency of livestock enterprises also reduce methane emissions per unit of output. Through changes in diet and management of smaller herds due to increased productivity, emissions may be reduced by 25 to 75 percent. Other options for methane reduction include increased use of hormones and lower price supports. The costs of these changes will be small.

In developing countries, many of the cattle are nutrient deficient. By supplying nutrient supplements, methane emissions can be reduced, but the costs and potential benefits of this approach are not well understood. In general, while it is possible to reduce methane emissions from intensive livestock production systems, relative gains will be small and may not be achieved without significant technological advance. Further development of best-practice livestock management systems and diffusion of those systems into practice seem the most promising steps in this area.

5. Rice

Rice cultivation accounts for about 34 percent of anthropogenic CH_4 emissions. Recent work shows that methane emissions may be reduced by decreasing use of animal manures as fertilizer, but there is still considerable uncertainty regarding the cost and volume of reductions that can be achieved in this manner.

D. Chlorofluorocarbons and Related Substances

Chlorofluorocarbons accounted for about 14 percent of increased radiative forcing in the 1980s. In the absence of any control measures, CFCs would account for a much larger share of future increases. However, the Montreal Protocol on Substances that Deplete the Ozone Layer represents a commitment to significant controls. While primarily aimed at limiting CFCs and halons because of the threat they pose to the ozone layer, this treaty also results in substantial benefits in terms of greenhouse gas emissions. The Montreal Protocol has now been ratified by 49 nations and the European Community. These nations account for over 90 percent of the global consumption of CFCs.

In response to recent scientific evidence that the risks of ozone depletion from CFCs and other ozone-depleting substances are greater than previously thought, the Protocol was amended in June 1990 to expand its coverage to additional ozone-depleting substances and to provide for the complete phaseout of CFCs by 2000. *The CFC phaseout will significantly reduce the increase in radiative forcing in the next century.*

Significant technological advances made during the past several years make such a phaseout feasible. In the near term, substantial emission reductions are being achieved through increased recycling and improved housekeeping (particularly by electronics companies in their use of CFC-113). Development of chemical and process substitutes has also progressed rapidly and has allowed major firms and industries to establish goals for eliminating their use of CFCs ahead of the likely Montreal Protocol schedule. For example, IBM and AT&T have a phaseout goal by 1994 and the electronics industry as a whole, through its major trade association, has established the goal of an 80 percent reduction by 1997 and a phaseout by 2000. Similarly, the rigid foam insulation industry has established a goal of a complete phaseout by 1995.

The costs of eliminating the use of CFCs and halons will be approximately $3 billion over the next ten years (1989 dollars, discounted at 5 percent). These costs could be substantially reduced, along with CO_2 emissions, if industry can move to more energy-efficient refrigerants. For example, if the use of HFC-152a as a refrigerant proves acceptable, cost savings from improved energy efficiency could reduce the costs of a phaseout in these applications by 57 percent over the next 10 years. EPA and other agencies are working with several industry groups to examine technological, environmental, and institutional issues related to the use of a wide array of more energy-efficient, low-greenhouse alternatives.

E. Nitrous Oxide

Nitrous oxide accounted for about 5 percent of the increase in radiative forcing in the 1980s. As Section I noted, data on sources of N_2O emissions are quite poor. The primary anthropogenic source seems to be the use of nitrogenous fertilizers, which is increasing at 1.3 percent per year in industrialized countries and 4.1 percent per year in developing nations.

From the point of view of policy design, it is unfortunate that the nitrogen content of fertilizer is *not* the primary determinant of N_2O emissions. Emissions of N_2O vary by one to two orders of magnitude among different types of nitrogenous fertilizers. Other factors affecting emissions include the rate and timing of fertilizer application, the placement of fertilizer (deep or shallow), water management (particularly in rice cultivation), tillage and herbicide use, and the use of legumes as a nitrogen source. *No systematic attention seems to have been devoted to the design or cost of policies to reduce N_2O emissions from fertilizer use or other sources, in part because the relevant scientific base is weak,* though some of the agricultural policy changes discussed in Section III.B.2.g., above, would likely reduce N_2O emissions from U.S. farms.

New technologies that improve fertilization efficiency also tend to reduce N_2O emissions, but little appears to be known about their cost-effectiveness. Advances in biotechnology, particularly the development of weed-resistant crop varieties and nitrogen-fixing cereal crops, may reduce N_2O emissions in the future.

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UNITED STATES
DEPARTMENT OF ENERGY
WASHINGTON, D.C. 20585

PE-3

THE WHITE HOUSE

WASHINGTON

July 18, 1990

MEMORANDUM FOR FRED BERNTHAL
STEVE DANZANSKY
CHRIS DAWSON
MIKE DELAND
THERESA GORMAN
BOB GRADY
BOYDEN GRAY
HENSON MOORE
BILL REILLY
DICK SCHMALENSEE
DICK STEWART

FROM: D. ALLAN BROMLEY

SUBJECT: Global Change Strategy Task Force Meeting

The Global Change Strategy Task Force will meet on Friday, July 20, at 10:00 in Room 180 of the Old Executive Office Building.

We will focus our attention on the upcoming IPCC meeting in Sundsvall, Sweden, which begins on August 27. That meeting will take up the final IPCC report. Copies of the draft IPCC executive summary and draft overview and conclusions document accompany this memorandum. Although I do not believe we will be able to go through the documents in any great detail on Friday, please begin your review of them and provide comments to Nancy Maynard of my staff by the close of business on Friday, July 27.

We will also discuss the IPCC's future after the August meeting. A paper on this issue prepared by the State Department following interagency discussions will be distributed at the meeting.

Also accompanying this memorandum is a draft of the ministerial declaration for the Second World Climate Conference, which begins in Geneva on November 6. We need to discuss the U.S. strategy for this meeting and for the other upcoming meetings on climate change, which include a meeting in Geneva from September 24 to 26 to begin preparations for the negotiations of a framework convention, expected to start in the U.S. in February 1991.

We also hope to hear from Dick Stewart on the status of research being conducted on the comprehensive greenhouse gas approach and a possible emissions trading system by the OECD and by CEES.

Please contact Linda Ricci at 456-6630 and advise her whether you will be able to attend the meeting.

Attachments

THE WHITE HOUSE

WASHINGTON

GLOBAL CHANGE STRATEGY
TASK FORCE MEETING

July 20, 1990

AGENDA

1. **IPCC Meeting - Sundsuall, Sweden (August 27, 1990)**
2. **Future of IPCC**
3. **Second World Climate Conference**
4. **Comprehensive Approach - Status**

WORKING GROUP ON CLIMATE
July 13, 1990
Department of State

AGENDA

A. Houston Economic Summit (Environment Portion) (handout)

B. Preparations for IPCC Fourth Plenary, August 27-30, Sundsvall, Sweden

1. Logistics

2. Final RSWG Report (handout available)

3. Comments on Bolin executive summary and overview and conclusions document (handout available)

4. Revised executive summary (handout)

5. Revised overview and conclusions (not yet available)

6. Future of IPCC (handout)

7. U.S. Pledge for 1991

C. WMO and Anticipated UNEP Resolutions

1. Obasi/Tolba Letter of July 10 (handout)

2. WMO resolutions (handout)

3. UNEP Governing Council Special Session, August 1-3, Nairobi

D. Organizational Meeting to Prepare for Negotiations - September 24-26, Geneva

E. Second World Climate Conference Preparations

1. Draft ministerial declaration (handout - comments due July 20)

2. Prepcom - September 27-29, Geneva

NEXT MEETING: Tentatively -- Wednesday, August 1, 10:00 a.m. to 12:00 noon, Department of State

HOUSTON ECONOMIC DECLARATION

July 11, 1990

1. We, the Heads of State and Government of the seven major industrial democracies and the President of the Commission of the European Communities, meeting in Houston for our annual Economic Summit, celebrate the renaissance of democracy throughout much of the world. We welcome unreservedly the spread of multiparty democracy, the practice of free elections, the freedom of expression and assembly, the increased respect for human rights, the rule of law, and the increasing recognition of the principles of the open and competitive economy. These events proclaim loudly man's inalienable rights: When people are free to choose, they choose freedom.

2. The profound changes taking place in Europe, and progress toward democracy elsewhere, give us great hope for a world in which individuals have increasing opportunities to achieve their economic and political aspirations, free of tyranny and oppression.

3. We are mindful that freedom and economic prosperity are closely linked and mutually reinforcing. Sustainable economic prosperity depends upon the stimulus of competition and the encouragement of enterprise -- on incentives for individual initiative and innovation, on a skilled and motivated labor force whose fundamental rights are protected, on sound monetary systems, on an open system of international trade and payments, and on an environment safeguarded for future generations.

4. Around the world, we are determined to assist other peoples to achieve and sustain economic prosperity and political freedom. We will support their efforts with our experience, resources, and goodwill.

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THE INTERNATIONAL ECONOMIC SITUATION

5. In recent years, substantial progress has been achieved in promoting a stronger world economy through sound macroeconomic policies and greater economic efficiency. The economic expansion in our countries, now in its eighth year, has supported notable income growth and job creation in the context of rapid growth of international trade. However, unemployment remains high in a number of countries. Inflation, although considerably lower than in the early 1980s, is a matter of serious concern in some countries and requires continued vigilance. External imbalances have been reduced in the United States and Japan, whereas in other cases they have increased. Continuing adjustment remains a priority in order to counter protectionist pressures, alleviate uncertainties in financial and exchange markets, and contribute to avoiding pressures on interest rates. Sound domestic macroeconomic policies, which may differ according to conditions in each country, will make a major contribution to further external adjustment.

6. In the developing world, the experience of the late 1980s varied widely. Some economies, particularly in East Asia, continued to experience impressive domestic growth rates. The economies of a number of other developing countries have been stagnant or declined. Nonetheless, serious efforts -- in some cases by new leadership -- to implement economic adjustment and market-oriented policies have begun to yield positive results and should be continued.

INTERNATIONAL MONETARY DEVELOPMENTS AND POLICY COORDINATION

7. At a time of growing economic interdependence, the Summit countries have developed a cooperative process based on a common appreciation of the need for market-oriented policies and the importance of sound domestic budgetary and monetary policies. This process has contributed importantly to the strengthened performance of the world economy and to improved stability of exchange rates by concentrating attention on multilateral surveillance and close coordination of economic policies, including cooperation on exchange markets. It is important to continue and, where appropriate, to strengthen this cooperative and flexible approach to improve the functioning of the international monetary system and contribute to its stability.

8. To sustain the present economic expansion to the benefit of all countries, each nation must pursue sound policies. Balanced expansion of demand with increasing productive capacity is key, while external imbalances and structural rigidities require correction. Price pressures warrant continued vigilance.

9. Countries with sizable current account deficits should contribute to the adjustment process by the reduction of fiscal deficits, and undertake structural reforms to encourage private saving and increase competitiveness.

10. Countries with large external surpluses should contribute to the adjustment process by sustained non-inflationary growth of domestic demand with structural reform in order to improve the underlying conditions for growth and adjustment and to promote increased investment relative to saving.

11. The investment needs of the world as a whole are expected to grow in the coming years, particularly in Central and Eastern Europe and in developing countries undertaking market reforms, as well as in some industrial countries. To meet these needs, industrial and developing countries alike should foster saving and discourage dissaving.

12. The market-oriented restructuring of Central and Eastern European economies should stimulate their growth and increase their integration into the global economy. We support these changes and seek to assure that this difficult transformation will contribute to global growth and stability.

13. Within the European Community, the European Monetary System is leading to a high degree of economic convergence and stability. We note the European Community's decision to launch the Intergovernmental Conference on Economic and Monetary Union and the beginning of the first stage of that union. During this first stage, closer surveillance and coordination of economic and monetary policies will contribute toward non-inflationary growth and a more robust international economic system.

14. We welcome the prospect of a unified, democratic Germany which enjoys full sovereignty without discriminatory constraints. German economic, monetary, and social union will contribute to improved non-inflationary global growth and to a reduction of external imbalances. This process will promote positive economic developments in Central and Eastern Europe.

15. We call on the member countries of the International Monetary Fund (IMF) to implement the agreement by the IMF to increase quotas by 50 percent under the Ninth General Review of Quotas and to strengthen the IMF arrears strategy.

<u>Measures Aimed at Economic Efficiency</u>

16. Considerable progress has been made over the past few years in supplementing macroeconomic policies with reforms to increase economic efficiency. We welcome the progress in the realization of the internal market in the European Community and the continuing efforts to reduce structural rigidities in North America and Japan. Nonetheless, we emphasize the widespread need for further steps to

promote regulatory reform and liberalize areas such as retail trade, telecommunications, transport, labor markets, and financial markets, as well as to reduce industrial and agricultural subsidies, improve tax systems, and improve labor-force skills through education and training.

17. We welcome the major contributions of the Organization for Economic Cooperation and Development (OECD) in identifying structural policy challenges and options. We encourage the OECD to strengthen its surveillance and review procedures, and to find ways of making its work operationally more effective.

THE INTERNATIONAL TRADING SYSTEM

18. The open world trading system is vital to economic prosperity. A strengthened General Agreement on Tariffs and Trade (GATT) is essential to provide a stable framework for the expansion of trade and the fuller integration of Central and Eastern Europe and developing countries into the global economy. We reject protectionism in all its forms.

19. The successful outcome of the Uruguay Round has the highest priority on the international economic agenda. Consequently, we stress our determination to take the difficult political decisions necessary to achieve far-reaching, substantial results in all areas of the Uruguay Round by the end of this year. We instruct our negotiators to make progress and in particular to agree on the complete profile of the final package by the July meeting of the Trade Negotiations Committee.

20. We confirm our strong support for the essential broad objectives of the negotiations: reform of agricultural policies; a substantial and balanced package of measures to improve market access; strengthened multilateral rules and disciplines; the incorporation of new issues of services, trade-related investment measures, and intellectual property protection within the GATT framework; and integration of developing countries into the international trading system.

21. As regards agriculture, achieving the long-term objective of the reform of agricultural policies is critical to permit the greater liberalization of trade in agricultural products. Experience has shown the high cost of agricultural policies which tend to create surpluses. The outcome of the GATT negotiations on agriculture should lead to a better balance between supply and demand and ensure that agricultural policies do not impede the effective functioning of international markets. We therefore reaffirm our commitment to the long-term objective of the reform,

i.e., to allow market signals to influence agriculture production and to establish a fair and market-oriented agricultural trading system.

22. The achievement of this objective requires each of us to make substantial, progressive reductions in support and protection of agriculture -- covering internal regimes, market access, and export subsidies -- and develop rules governing sanitary and phytosanitary measures. Variations among countries in the mechanisms of agricultural support reflect differences in the social and economic conditions of farming. The negotiations on agriculture should therefore be conducted in a framework that includes a common instrument of measurement, provides for commitments to be made in an equitable way among all countries, and takes into account concerns about food security. The framework should contain specific assurances that, by appropriate use of the common measure as well as other ways, participants would reduce not only internal support but also export subsidies and import protection in a related way.

23. Agreement on such a framework by the time of the July meeting of the Trade Negotiations Committee is critical to the successful completion of the Uruguay Round as a whole. Accordingly, we commend to our negotiators the text submitted by the Chairman of the Agricultural Negotiating Group as a means to intensify the negotiations. We intend to maintain a high level of personal involvement and to exercise the political leadership necessary to ensure the successful outcome of these negotiations.

24. Negotiations on market access should achieve agreement on a substantial and balanced package of measures. As regards textiles, the objective is to liberalize the textile and clothing sector through progressive dismantling of trade barriers and its integration, under a precise timetable, into GATT on the basis of strengthened GATT rules and disciplines.

25. Negotiations on multilateral rules and disciplines should strengthen GATT rules in areas such as safeguards, balance of payments, rules of origin, and updated disciplines for dumping and antidumping measures. Concerning subsidies, rules are needed which will effectively discipline domestic subsidies so as to avoid trade distortions, competitive subsidization, and trade conflicts. Improved disciplines must also cover countervailing measures so that they do not become barriers to trade.

26. As regards the new areas, the aim is to develop new rules and procedures within the GATT framework, including: a framework of contractually enforceable rules to liberalize services trade, with no sector excluded a priori; an agreement to reduce trade distorting effects of trade-related investment measures; and an agreement to provide for standards and effective enforcement of all intellectual property rights.

27. A successful Uruguay Round is essential for industrialized and

developing countries alike. We seek the widest possible participation of developing countries in the Round and their further integration into the multilateral trading system. To achieve this objective, developed countries are prepared to accept greater multilateral disciplines in all areas and to offer improved market access in areas of interest to developing countries such as textiles and clothing, tropical products, and agriculture.

28. For their part, developing countries should substantially reduce their tariffs and increase the percentage of tariffs that are bound; subscribe to balanced and effective restraints on all forms of exceptions, including measures imposed for balance-of-payments difficulties; and participate meaningfully in agreements covering the new areas. The end result should be a single set of multilateral rules applicable to all GATT contracting parties, although some developing countries, especially the least developed, may need longer transition periods or other transitional arrangements on a case by case basis.

29. The wide range of substantive results which we seek in all these areas will call for a commitment to strengthen further the institutional framework of the multilateral trading system. In that context, the concept of an international trade organization should be addressed at the conclusion of the Uruguay Round. We also need to improve the dispute settlement process in order to implement the results of the negotiations effectively. This should lead to a commitment to operate only under the multilateral rules.

DIRECT INVESTMENT

30. Free flows of investment increase global prosperity by complementing the open international trade system. In particular, foreign direct investment can help restructure the economies of developing and Central and Eastern European countries, create new jobs, and raise living standards.

31. All countries should therefore seek to reduce their barriers to investment and resist protectionist pressures to discourage or discriminate against such investment. The OECD and the GATT should continue to promote investment liberalization. The multilateral development banks and the IMF should require investment liberalization in their programs in Central and Eastern Europe and developing countries.

EXPORT CREDITS

32. We welcome the important negotiations that are underway in the OECD on a balanced package of measures to strengthen multilateral

disciplines on trade- and aid-distorting export credit subsidies. This package, to be completed by spring of 1991, should reduce substantially, through improved discipline and transparency, distortions resulting from the use of officially supported commercial and aid credits. It is also important to avoid introducing trade distortions in financial flows to the nations of Central and Eastern Europe.

REFORM IN CENTRAL AND EASTERN EUROPE

33. We welcome the political and economic reforms taking place in Central and Eastern Europe. At the recent Conference on Security and Cooperation in Europe (CSCE) in Bonn and by the agreement to establish the European Bank for Reconstruction and Development (EBRD), the participating countries of the region accepted the key principles underpinning market economies. However, the degree of implementation of economic and political reform varies widely by country. Several countries have taken courageous and difficult measures to stabilize their economies and shorten the transition to a market economy.

34. We and other countries should assist Central and Eastern European nations that are firmly committed to economic and political reform. Those providing help should favor countries that implement such reforms.

35. Foreign private investment will be vital in the development of Central and Eastern Europe. Capital will flow to countries with open markets and hospitable investment climates. Improved access for their exports will also be important for those Central and Eastern European countries that are opening up their economies. Western Governments can support this process by various means, including trade and investment agreements. The recent decision by the Coordinating Committee for Multilateral Export Controls (COCOM) to liberalize export controls is a positive step.

36. We commend the work done by the Commission of the European Communities on the coordination by the Group of 24 (G-24) of assistance to Poland and Hungary inaugurated at the Summit of the Arch, which has made a significant contribution to helping these countries lay the foundation for self-sustaining growth based on market principles. We welcome the decision of the G-24 to enlarge the coordination of assistance to other emerging democracies in Central and Eastern Europe, including Yugoslavia.

37. We recognize that these countries face major problems in cleaning their environment. It will be important to assist the countries of Central and Eastern Europe to develop the necessary policies and infrastructure to confront those environmental problems.

38. We also welcome the recent initiatives in regional cooperation, e.g., in transport and the environment, that will make a positive contribution to economic progress and stability in the region.

39. We expect the new EBRD to play a key role in fostering investment in those countries and to contribute to orderly transitions toward market economies and a sound basis for democracy. We urge the rapid entry into force of the Bank.

40. The Center for Cooperation with European Economies in Transition at the OECD will encourage reforms and strengthen relations between these countries and the OECD, as will the OECD's follow up work from the CSCE Economic Conference in Bonn.

41. We invite the OECD to consider a closer relationship with those Central and East European countries that are committed to political and economic reform.

THE SOVIET UNION

42. We discussed the situation in the Soviet Union, and exchanged views regarding the message that Soviet President Gorbachev sent us several days ago on his economic plans. We welcome the efforts underway in the Soviet Union to liberalize and to create a more open, democratic, and pluralistic Soviet society, and to move toward a market-oriented economy. These measures deserve our support. The success of perestroika depends upon the determined pursuit and development of these reform efforts. In particular, we welcome President Gorbachev's suggestion for a sustained economic dialogue.

43. We have all begun, individually and collectively, to assist these reform efforts. We all believe that technical assistance should be provided now to help the Soviet Union move to a market-oriented economy and to mobilize its own resources. Some countries are already in a position to extend large scale financial credits.

44. We also agreed that further Soviet decisions to introduce more radical steps toward a market-oriented economy, to shift resources substantially away from the military sector and to cut support to nations promoting regional conflict will all improve the prospect for meaningful and sustained economic assistance.

45. We have taken note of the decision of the European Council in Dublin on June 26. We have agreed to ask the IMF, the World Bank, the OECD and the designated president of the EBRD to undertake, in close consultation with the Commission of the European Communities, a detailed study of the Soviet economy, to make recommendations for

its reform and to establish the criteria under which Western economic assistance could effectively support these reforms. This work should be completed by year's end and be convened by the IMF.

46. We took note of the importance to the Government of Japan of the peaceful resolution of its dispute with the Soviet Union over the Northern Territories.

47. The host Government will convey to the Soviet Union the results of the Houston Summit.

THE DEVELOPING NATIONS

48. We reiterate that our commitment to the developing world will not be weakened by the support for reforming countries in Central and Eastern Europe. The poorest of the developing nations must remain the focus of special attention. The International Development Association replenishment of SDR 11.6 billion, agreed to last December, will provide needed resources for these countries, and marks the incorporation of environmental concerns into development lending. It is our intention to take a constructive part in the Paris Conference on the least developed countries in September.

49. The advanced industrial economies can make a number of major contributions to the long-run development of the developing countries. By sustaining economic growth and price stability, we can offer stable, growing markets and sources of capital for the developing world. By providing financial and technical support to developing countries undertaking genuine political and economic reform, we can reinforce their ongoing liberalization. The industrialized nations should continue to make efforts to enhance their development aid and other forms of assistance to the developing countries, including reinforcing the effectiveness of the aid.

50. In the developing world, there is a growing acceptance of the view that growth can be encouraged by a stable macroeconomic framework, sectoral reform to provide more competition, and an opening of markets. Open, democratic, and accountable political systems are important ingredients in the effective and equitable operation of market-oriented economies.

51. Important contributions to a hospitable investment climate can be made by the protection of intellectual property, and by liberalization of investment regimes, including transparent and equitable investment rules, and equality of treatment for foreign and domestic investors.

52. The recent Enterprise for the Americas initiative announced by the U.S. President will support and encourage more market-oriented policies in Latin America and the Caribbean. We believe that such U.S. efforts hold great promise for the region and will help

improve prospects for sustained growth in the Americas through the encouragement of trade, open investment regimes, the reduction of U.S. bilateral concessional debt and the use of debt for equity and nature swaps.

53. In a number of countries, sustainable development requires that population growth remains in some reasonable balance with expanding resources. Supporting the efforts of developing countries to maintain this balance is a priority. Improved educational opportunities for women and their greater integration into the economy can make important contributions to population stabilization programs.

54. In the Mediterranean basin, the initiatives of economic integration, which are underway, deserve encouragement and support.

THIRD WORLD DEBT

55. Significant progress has been made during the past year under the strengthened debt strategy, which has renewed the resolve in a number of debtor countries to continue economic reforms essential to future growth. In particular, the recent commercial bank agreements with Chile, Costa Rica, Mexico, Morocco, the Philippines, and Venezuela involve significant debt and debt-service reduction. Important financial support for debt and debt-service reduction is being provided by the IMF and the World Bank, as well as by Japan. The Paris Club has agreed, in order to support medium term IMF-supported reform and financing programs, to provide adequate restructuring agreements, notably through multiyear reschedulings and through lengthening of the repayment period. The combination of debtor reform efforts and commercial bank debt reduction has had a notable impact on confidence in debtor economies, as clearly demonstrated through flows of both new investment and the return of flight capital to Mexico, in particular.

56. These measures represent major innovations in the case by case debt strategy and are potentially available to all debtor nations with serious debt-servicing problems which are implementing economic adjustment policies.

57. The adoption by debtor nations of strong economic reform programs with the IMF and World Bank remains at the heart of the debt strategy, and a prerequisite for debt and debt service reduction within commercial bank financing packages. It is vital that debtor countries adopt measures to mobilize savings and to encourage new investment flows and the repatriation of flight capital to help sustain their recovery. In this connection, the

recent U.S. Enterprise for the Americas initiative to support investment reform and the environment in Latin America needs to be given careful consideration by Finance Ministers.

58. For countries implementing courageous reforms, commercial banks should take realistic and constructive approaches in their negotiations to conclude promptly agreements on financial packages including debt reduction, debt-service reduction and new money.

59. Creditor nations will continue to play an important role in this process through ongoing contributions to the international financial institutions, rescheduling of official debt in the Paris Club, and new finance. We encourage the Paris Club to continue reviewing additional options to address debt burdens. In the case of the lower middle-income countries implementing strong reform programs, we encourage the Paris Club to lengthen the repayment period, taking account of the special situations of these countries. We welcome the decisions taken by France with respect to Sub-Saharan Africa and by Canada with respect to the Caribbean to alleviate the debt burden of the lower middle-income countries.

60. Creditor governments have also provided special support for the poorest countries through the implementation of Toronto terms in Paris Club reschedulings. All of us have cancelled official development assistance (ODA) debt for the poorest countries. We encourage the Paris Club to review the implementation of the existing options that apply to the poorest countries.

61. We note and will study with interest the Craxi Report on debt commissioned by the UN Secretary General.

THE ENVIRONMENT

62. One of our most important responsibilities is to pass on to future generations an environment whose health, beauty, and economic potential are not threatened. Environmental challenges such as climate change, ozone depletion, deforestation, marine pollution, and loss of biological diversity require closer and more effective international cooperation and concrete action. We as industrialized countries have an obligation to be leaders in meeting these challenges. We agree that, in the face of threats of irreversible environmental damage, lack of full scientific certainty is no excuse to postpone actions which are justified in their own right. We recognize that strong, growing, market-oriented economies provide the best means for successful environmental protection.

63. Climate change is of key importance. We are committed to undertake common efforts to limit emissions of greenhouse gases, such as carbon dioxide. We strongly support the work of the

Intergovernmental Panel on Climate Change (IPCC) and look forward to the release of its full report in August. The Second World Climate Conference provides the opportunity for all countries to consider the adoption of strategies and measures for limiting or stabilizing greenhouse gas emissions, and to discuss an effective international response. We reiterate our support for the negotiation of a framework convention on climate change, under the auspices of the United Nations Environment Program (UNEP) and the World Meteorological Organization (WMO). The convention should be completed by 1992. Work on appropriate implementing protocols should be undertaken as expeditiously as possible and should consider all sources and sinks.

64. We welcome the amendment of the Montreal Protocol to phase out the use of chlorofluorocarbons (CFCs) by the year 2000 and to extend coverage of the Protocol to other ozone depleting substances. The establishment of a financial mechanism to assist developing countries to tackle ozone depletion marks a new and positive step in cooperation between the developed and developing worlds. We applaud the announcement in London by some major developing countries, including India and China, that they intend to review their position on adherence to the Montreal Protocol and its amendments. We would welcome their adherence as a crucial reinforcement of the effectiveness of the Protocol, which would ultimately lead to a worldwide phase out of ozone depleting substances. We urge all parties to ratify the amended Protocol as quickly as possible.

65. We acknowledge that enhanced levels of cooperation will be necessary with regard to the science and impacts of climate change and economic implications of possible response strategies. We recognize the importance of working together to develop new technologies and methods over the coming decades to complement energy conservation and other measures to reduce carbon dioxide and other greenhouse emissions. We support accelerated scientific and economic research and analysis on the dynamics and potential impact of climate change, and on potential responses of developed and developing countries.

66. We are determined to take action to increase forests, while protecting existing ones and recognizing the sovereign rights of all countries to make use of their natural resources. The destruction of tropical forests has reached alarming proportions. We welcome the commitment of the new Government of Brazil to help arrest this destruction and to provide sustainable forest management. We actively support this process, and we are ready for a new dialogue with developing countries on ways and means to support their efforts. We are ready to cooperate with the

Government of Brazil on a comprehensive pilot program to counteract the threat to tropical rain forests in that country. We ask the World Bank to prepare such a proposal, in close cooperation with the Commission of the European Communities, which should be presented at the latest at the next Economic Summit. We appeal to the other concerned countries to join us in this effort. Experience gained in this pilot program should immediately be shared with other countries faced with tropical forest destruction. The Tropical Forestry Action Plan must be reformed and strengthened, placing more emphasis on forest conservation and protection of biological diversity. The International Tropical Timber Organization action plan must be enhanced to emphasize sustainable forest management and improve market operations.

67. We are ready to begin negotiations, in the appropriate fora, as expeditiously as possible on a global forest convention or agreement, which is needed to curb deforestation, protect biodiversity, stimulate positive forestry actions, and address threats to the world's forests. The convention or agreement should be completed as soon as possible, but no later than 1992. The work of the IPCC and others should be taken into account.

68. The destruction of ecologically sensitive areas around the world continues at an alarming pace. Loss of temperate and tropical forests, developmental pressures on estuaries, wetlands and coral reefs, and destruction of biological diversity are symptomatic. To reverse this trend, we will expand cooperation to combat desertification; expand projects to conserve biological diversity; protect the Antarctic; and assist developing countries in their environmental efforts. We will work within UNEP and other fora to achieve these objectives, and will participate actively in UNEP's work to protect biodiversity.

69. Efforts to protect the environment do not stop at the water's edge. Serious problems are caused by marine pollution, both in the oceans and in coastal areas. A comprehensive strategy should be developed to address land-based sources of pollution; we are committed to helping in this regard. We will continue our efforts to avoid oil spills, urge the early entry into force of the existing International Maritime Organization (IMO) Convention, and welcome the work of that organization in developing an international oil spills convention. We are concerned about the impact of environmental degradation and unregulated fishing practices on living marine resources. We support cooperation in the conservation of living marine resources and recognize the importance of regional fisheries organizations in this respect. We call on all concerned countries to respect the conservation regimes.

70. To cope with energy-related environmental damage, priority must be given to improvements in energy efficiency and to the development of alternative energy sources. For the countries that make such a choice, nuclear energy will continue to be an important

contributor to our energy supply and can play a significant role in reducing the growth of greenhouse gas emissions. Countries should continue efforts to ensure highest worldwide performance standards for nuclear and other energy in order to protect health and the environment, and ensure the highest safety.

71. Cooperation between developed and developing countries is essential to the resolution of global environmental problems. In this regard, the 1992 UN Conference on Environment and Development will be an important opportunity to develop widespread agreement on common action and coordinated plans. We note with interest the conclusions of the Siena Forum on International Law of the Environment and suggest that these should be considered by the 1992 UN Conference on Environment and Development.

72. We recognize that developing countries will benefit from increased financial and technological assistance to help them resolve environmental problems, which are aggravated by poverty and underdevelopment. Multilateral development bank programs should be strengthened to provide greater protection for the environment, including environmental impact assessments and action plans, and to promote energy efficiency. We recognize that debt-for-nature swaps can play a useful role in protecting the environment. We will examine how the World Bank can provide a coordinating role for measures to promote environmental protection.

73. In order to integrate successfully environmental and economic goals, decisionmakers in government and industry require the necessary tools. Expanded cooperative scientific and economic research and analysis on the environment is needed. We recognize the importance of coordinating and the sharing the collection of satellite data on earth and its atmosphere. We welcome and encourage the ongoing discussions for the establishment of an International Network. It is also important to involve the private sector, which has a key role in developing solutions to environmental problems. We encourage the OECD to accelerate its very useful work on environment and the economy. Of particular importance are the early development of environmental indicators and the design of market-oriented approaches that can be used to achieve environmental objectives. We also welcome Canada's offer to host in 1991 an international conference on environmental information in the 21st Century. We support voluntary environmental labelling as a useful market mechanism which satisfies consumer demand and producer requirements and promotes market innovation.

74. We note with satisfaction the successful launching of the Human Frontier Science Program and express our hope that it will make

positive contributions to the advancement of basic research in life science for the benefit of all mankind.

NARCOTICS

75. We urge all nations to accede to and complete ratification of the UN Convention Against Illicit Traffic in Narcotic Drugs and Psychotropic Substances (the Vienna Convention), and to apply provisionally terms of the Convention.

76. We welcome the conclusion of the UN Special Session on Drugs and urge the implementation of the measures contained in the Program of Action it has adopted.

77. We support the declaration adopted at the ministerial meeting on drugs convened by the United Kingdom that drug demand reduction should be accorded the same importance in policy and action as the reduction of illicit supply. Developed countries should adopt stronger prevention efforts and assist demand reduction initiatives in other countries.

78. We endorse the report of the Financial Action Task Force (FATF) and commit our countries to a full implementation of all its recommendations without delay. As agreed at the May meeting of Task Force Finance Ministers, the FATF should be reconvened for a second year, chaired by France, to assess and facilitate the implementation of these recommendations, and to complement them where appropriate. All OECD and financial center countries that subscribe to the recommendations of the Task Force should be invited to participate in this exercise. The report of the new FATF would be completed before we next meet. We also invite all other countries to participate in the fight against money laundering and to implement the recommendations of the FATF.

79. Effective procedures should be adopted to ensure that precursor and essential chemicals are not diverted to manufacture illicit drugs. A task force similar to the FATF should be created for this purpose, composed of Summit participants and other countries that trade in these chemicals, with the involvement of representatives of the chemical industry. The task force should address the problems which concern cocaine, heroin and synthetic drugs and report within a year.

80. We support a strategy for attacking the cocaine trade as outlined in particular in the Cartagena Declaration. We recognize the importance of supporting all countries strongly engaged in the fight against drug trafficking, especially Colombia, Peru, and Bolivia, with economic, law enforcement, and other assistance and advice, recognizing the need to make contributions within the framework of actions against drug trafficking carried out by the producer countries.

81. The heroin problem is still the most serious threat in many countries, both developed and developing. All countries should take vigorous measures to combat the scourge of heroin.

82. We should support an informal narcotics consultative arrangement with developed countries active in international narcotics control. Such a group could strengthen efforts to reduce supply and demand, and improve international cooperation.

83. We welcome the current review of UN drug abuse control agencies and urge that it result in a more efficient structure.

NEXT ECONOMIC SUMMIT

84. We have accepted the invitation of Prime Minister Thatcher to meet next July in London.

SECOND WORLD CLIMATE CONFERENCE
Geneva, 30 October-7 November 1990

13 July 1990

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. Our Meeting following the IPCC Report is a demonstration of our intention to take active and constructive step in the global response to the global climate change issue. It is also the expression of our will to fully contribute to the preparation for the 1992 UN Conference on Environment and Development.

3. Ever since the dawn of history, man's life on earth has been largely dependent on the environmental processes which we call weather and climate. The world climate system consists of a delicately balanced combination of many interactive components which include the atmosphere and the biosphere, as well as the land, sea and ice surfaces.

4. Climate has varied in the past. But the temperature increase which is predicted to occur in the decades to come due to the increasing accumulation of the greenhouse gases in the atmosphere has not been encountered in the last 100,000 years at least; nor has the past rapidity of change been as fast as that predicted. The greenhouse gases result from a host of human activities such as the burning of fossil fuel, deforestation, mining operations and waste management.

5. Recognising that climate change is a common concern of mankind United Nations General Assembly's Resolution 43/53 urged the intergovernmental and non-governmental organisations and scientific institutions, to treat climate change as a priority issue, and to co-operate in research and action-oriented programmes so as to increase the understanding of the causes and effects of climate change.

6. The World Climate Programme undertaken jointly by the World Meteorological Organisation, the International Council of Scientific Unions with the co-operation of its Scientific Committee on Oceanic Research, and UNESCO and its International Oceanographic Commission and UNEP have endeavoured during the last decade to promote a quantitative understanding of climate, and predictions of global and regional climate changes on all time scales and on their potential impacts. Through its three major projects the study of Tropical Ocean and Global Atmosphere, the Global Energy and Water Cycle Experiment, and the World Ocean Circulation Experiment, the World Climate Research Programme has succeeded in providing valuable information on the causes, processes and some of the effects of climate change.

7. The Intergovernmental Panel on Climate Change (IPCC) established by U.N.E.P. and W.M.O. has undertaken to study the problem of climate change including global warming. Through the work of its various working groups and their sub-groups the I.P.C.C. has produced a comprehensive report on the causes and effects of climate change. It has also proposed strategies to delay, limit or mitigate the impact of climate change, and at the request of United Nations General Assembly has proposed the elements for inclusion in a convention on climate.

DEFINITION OF PROBLEM AND RISKS

8. Global warming poses environmental threat of a magnitude the world has never known before. Human activities which have lead to the emissions of greenhouse gases into the atmosphere have so far committed the Global Commons to an irreversible warming so far. In order to stem an unprecedented global warming likely to lead to serious environmental consequences such as a rise in sea level of about 20 cm by the year 2030 and 65 cm by the end of the next century urgent action should be taken now. Carbon dioxide has been responsible for over half the enhanced greenhouse effect in the past and is likely to remain so in the future. It is therefore important that emissions of greenhouse gases especially CO2 and other long lived greenhouse gases be reduced as soon as possible. This is urgent because changes in emission rates of these gases lead to a slow rate of change in their concentration in the atmosphere. If action is delayed, it will take much longer and much greater reductions at greater economic sacrifice to stabilize concentrations at today's levels. The long lived gases (CO2 and N20) would require at least 60% reductions in emissions, and methane 15-20 % reduction in emissions in order to stabilise their concentrations in the atmosphere at today's levels. The other gases of concern, namely the CFC are addressed under the Montreal Protocol on Substances that Deplete the Ozone Layer.

GLOBAL STRATEGY

9. We consider therefore that a global response must be decided and implemented without further delay based on the best available knowledge such as those resulting from the IPCC assessment.
Recognizing that the principle of equity should be the basis of any global response to the climate change phenomena industrialized countries, which are responsible for most of the observed increase in the greenhouse gases' concentration in the atmosphere must take the lead, commit themselves to immediate action and provide resources and assistance to developing countries to help them in addressing climate change in a way compatible with their development needs. [To this end the industrialized countries will support developing countries with new, additional and specific contributions.] [To this end there is a need to negotiate the necessary support needed by developing countries] [To this end there is a need to provide the necessary support, including additional and specific financial assistance to the developing countries]

ACKNOWLEDGMENT OF THE CONCLUSIONS OF LONDON CONFERENCE ON THE MONTREAL PROTOCOL

10. [Short text to be included after the conclusions of the London Meeting]

ENDORSMENT OF THE CONCLUSION OF THE SCIENTIFIC PART OF SWCC

11. We are highly appreciative of the work done by IPCC.

We accept and are highly appreciative of the conclusions and recommendations of the scientific part of the Second World Climate Conference as presented in the annex 1 of this Declaration. Their implementation should be strongly supported by governments.

THEREFORE:

I. ROLE OF SCIENCE IN IMPROVING OUR UNDERSTANDING, CAPACITY OF PREDICTION AND OUR RESPONSE TO CLIMATE CHANGE

12. We reaffirm that, in order to reduce uncertainties, to increase our ability to predict (including early identification of as yet unknown climate-related problems) and to design scientifically sound response strategies, there is a need to strengthen both national and international activities in research, monitoring, and data and information exchange related to climate change.

13. Recognizing that climate changes are of a complex interdisciplinary character, we urge the full participation of scientists dealing with the atmosphere, the oceans and land, as well as with the physical, chemical and biological processes needed for a deeper understanding of climate issues. Given the intrinsically global nature of climate and climate research, we stress the need to strenghten international cooperation. The magnitude of the problem being addressed is such that no nation can undertake it alone. It is imperative therefore, that, to the extent feasible, national research programmes on climate be planned in such a way that they form integral parts of international research programmes. We urge that special resources to sustain such programmes are made available to less developed countries in order to insure their full participation in the international research effort and the response strategies based upon the results.

14. We stress that special efforts be directed to key areas of uncertainty, including:

the role of clouds, ocean and greenhouse gases; ecosystem responses to global change; effects of land-use changes in the hydrological cycle; climate changes on a regional scale and the socio-economic and cultural dimensions and impacts of climate change.

15. We consider that research programmes must be accompanied by long-term monitoring programmes so designed as to provide continuous and comprehensive coverage of climate-influencing variables as well as those useful in detecting climate change. We agree that long term governmental commitments are necessary to sustain these monitoring programmes. We ask further-more that obstacles to the free flow of relevant data and information be removed.

16. We reaffirm that there is no need to establish new international coordination mechanisms, but rather urge all countries and relevant organizations to contribute through their national efforts and to increase financial support and assistance in kind on a sustained basis to important existing programmes such as the World Climate Programme including the WMO/ICSU World Climate Research Programme, the ICSU International Geosphere-Biosphere Programme, and the climate-related components of programmes of WMO, UNEP, Unesco and its IOC and FAO. We further urge that these programmes be better supported in order to continue to strengthen their interdisciplinary approach, to include the participation of all nations, and to increase coordination in order to achieve still greater efficiency.

II. POLICY TARGET FOR URGENT POLICY ACTION

(Precautionary measures)

17. In order to achieve sustainable development, we must base ourselves on the precautionary principle. Environmental measures must anticipate, prevent and attack the causes of environmental degradation. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

18. We note that a mechanism is being set up by WMO and UNEP to undertake the necessary intergovernmental negotiations on global warming.

(Stabilization and reduction of greenhouse gases)

19. We recognise the fundamental need to conserve the global climate, and protect it from anthropogenic interference. Taking into account that the increase of greenhouse gas concentrations in the atmosphere threaten the natural variability of climate, we agree that the ultimate global objective should be to stabilize and reduce those concentrations.

20. We stress, as a first step, the need to stabilize, while ensuring stable development of the world economy, emissions of greenhouse gases not controlled by the Montreal Protocol. We note with appreciation the unilateral commitments of some industrialised countries to stabilize emissions at present level or reduce them by the year 2000.

21. We agree that stabilization of greenhouse gas emissions should be achieved by industrialized countries by the year [2000] and should be set at [present] emission levels.

22. We urge industrialized countries to establish greenhouse gases reduction programmes aiming at achieving at least 20% reduction of their current contribution to global warming potential, possibly by the year 2005 and in any case not later than the year 2010;

23. We recommend that the specifications of the obligation to stabilize and reduce greenhouse gases emissions be realized in the form of separate Protocols to the Climate Convention. Some of these protocols could be negotiated concurrently with the framework convention.

(Economic situation of certain countries)

24. We recognize that developing countries with, as yet, relatively low energy requirements, which can reasonably be expected to grow in step with their development, may have targets that accommodate that development. We also recognize that additional financial resources [will] [may] have to be made available to developing countries to enable them to limit their net emissions of greenhouse gases while ensuring a steady development of their economies;

(Fund (Climate Fund))

25. We recommend that existing institutions for development and financial assistance including the World Bank and other Multilateral Development Banks, Bilateral Assistance Programmes, the relevant United Nations organisations and specialized agencies, and scientific and technological organisations should give greater attention to climate change issues within their environmental and other relevant programmes by providing expanded funding including concessional funding. In addition, regional and subregional co-operation should be reinforced and funded so as to address and implement the required action at that level.

26. We commend that consideration should be given to the need for funding facilities including a clearinghouse mechanism and a possible new international fund and their relationship to existing funding mechanisms, both multilateral and bilateral. Such funding should be related to the implementation of the climate convention and associated protocols. In the meantime the donor community is urged to provide assistance to developing countries to support immediate actions addressing climate change without waiting for the Convention.

27. We recommend that additional resources should progressively, be mobilized to help developing countries take the necessary measures to address climate change consistent with their development needs.

28. We recommend further that the scope of resources needed be assessed. Such assessments should include *inter alia* country studies and the capabilities of existing institutions and mechanisms to meet the financing needs identified, similar to the approaches developed under the Montreal Protocol.

29. We recommend that, initially, international funding be directed towards

(i) conducting research and monitoring;

(ii) promoting public awareness, education and institutional and manpower development.

(iii) promoting efficient use of energy, including appropriate end use technologies, increasing the use of non-fossil fuels and switching to energy sources with lower greenhouse gas emissions, and the use of renewable energy sources;

(iv) increased financial support for forest protection and forest management improvement, for example through the Tropical Forestry Action Plan (TFAP), the Plan of Action to Combat Desertification, the International Tropical Timber ORganization (ITTO) and other relevant international organizations;

(v) arranging for technology transfer to and technology development in developing countries;

(vi) assisting developing countries in planning how to address problems posed by climate change;

(vii) supporting developing countries to enable their full participation in international meetings on the subject of climate change.

The use of financial resources could subsequently be extended inter alia to major energy sources with little or no environmentally damaging characteristics and for steps to reduce other global man-made emissions of greenhouse gases due to human activities.

(Economic instruments)

30. We recognise that an environmentally sound development must include policies which will achieve a sustainable energy system and take the environmental costs and benefits of energy fully into account. We are convinced that promoting energy efficiency is the most cost effective immediate measure for reducing energy-related emissions of atmospheric pollutants, in particular CO2.

31. We recommend that new policies at national level be established making extensive use of economic instruments in order to increase energy efficiency and reduce energy consumption.

Such instruments could include:

(i) taxes on environmentally damaging activities and energy inefficient product

(ii) emission trading (tradeable permits/allowances)

(iii) reduction or, wherever possible, elimination of subsidies to energy intensive and other activities that induce climate change

(iv) other measures such as emission changes and fees deposit refund systems and fiscal incentive

Such action should in particular affect energy prices with the aim to reflect environmental costs and benefits and provide incentives to reduce energy consumption. They should also modify production and consumption pattern and encourage production and use of energy efficient technologies.

(Technology development)

32. We agree that technological breakthrough in a wide range of fields covering energy, industry and other sectors related to the emission and absorption of CO2 and other greenhouse gases is the key element of any long-term strategy that deals with climate change in a way that meets the goal of sustainable development. To this end, we urge all countries, the industrialized countries in particular, to intensify their individual efforts and international cooperation in technology development concerning, inter alia, low-energy and low-GHG production processes and products (e.g. chlorofluorocarbon substitutes with little or no global warming potential), and CO2 fixation and reutilization.

(Transfer of technology)

[Alternative 1]

33. We urge that relevant technology be utilized by all sectors in all countries to the full extent possible. We recognize that there are great disparities in energy efficiency, even among the industrialized countries, and further urge all countries, industrialized and developing, to identify and take effective measures to remove barriers to the dissemination of the best available technology. This requires, in the case of developing countries, effective measures to aid their efforts in meeting the specific needs arising, to a great extent, from their lack of human and financial resources and other elements necessary for the continuous development and dissemination of the most appropriate technology. The East European countries, which are currently suffering the consequences of inefficient use of energy and other resources, also require special attention. To this end, we also urge all industrialized countries and relevant international institution to step up their contributions to the effective transfer and dissemination of relevant technology in ways that fully address the constraints that all these countries face.

[Alternative 2]

33. We consider important that this expansion of development employ appropriate and environmentally sound technology in order that the problem of global warming and climate change not be exacerbated. Consequently, the transfer and development of such technologies must assume a high priority. It will be important for the industrial nations to respond to this priority and assign sufficient resources to assure technological development and establishment of mechanisms for successful transfer.

(Forestry)

34. We recognize that the conservation of the world's forests is of crucial importance for global climatic stability, particularly having regard to the important contribution of forest destruction to global warming through the emission of carbon-dioxide, methane and other trace gases.

We stress the need to reduce the rate of deforestation and to enhance the potential of the world's forests as a sink for greenhouse gases, through vigorous programmes of reforestation and afforestation.

We endorse the target included in the Noordwijk Declaration of achieving net global forest growth of 12 million hectares per year, through conservation of existing forests and through agressive programmes of reforestation and afforestation.

We call on all countries to:

(i) Adopt clear objectives for the conservation, reforestation and sustainable management of forests in national development plans.

(ii) Amend national policies to minimize forest loss and their human disturbance associated with public and private development projects (e.g. roads, dams, resettlement projects, mining, logging).

(iii) Integrate forest management solutions with policies on environment, agriculture, transportation, energy, poverty and landlessness.

(iv) Strengthen, support and extend the Tropical Forestry Action Plan (TFAP) process to all countries with tropical forests, and expand support for immediate implementation of completed plans.

(v) Strengthen the role of the International Tropical Timber Organization (ITTO) in supporting the sustainable utilization of forest resources.

(vi) Strengthen the role of development banks, IMF, FAO, UNEP, and other multilateral and bilateral organizations in helping developing countries achieve conservation and sustainable development of forests by:

a) Requiring analyses of climate change implications, potential greenhouse gas emissions, and response programmes in their review of project proposals involving forests;

b) Expanding greatly aid and investment flows to the forest sector as well as for the production of energy from biomass.

c) Expanding debt relief via renegotiation of debt, and debt for conservation exchanges; and

d) Linking structural adjustment measures to alleviation of climatic impacts and reduction of gas emissions.

35. We call finally for the development of a World Forest Conservation Protocol or Convention, covering temperate, boreal and tropical forests, in the context of or in association with a Climate Convention which also addresses energy supply and use. The specific elements of such a protocol or convention are a matter for international negotiations which should begin at an early date. These elements may include: fundamental research, tropical forest planning, measures to use, protect and reforest, international trade, financial assistance and possible national and international targets for conservation, reforestation and afforestation.

(Desertification and drought)

36. We recommend that regional and/or sub-regional studies on these subjects be undertaken to cover the impacts of climate change in the following fields:

(i) Drought;

(ii) Desertification;

(iii) Water resources and their evolution;

(iv) Agriculture (positive and negative impacts);

(v) Energy;

(vi) Forests.

These studies should lead to the development of scenarios and short, medium- and long-term measures for mitigation of drought and stopping and reversing desertification for the attention of economic and political decision makers.

III. GLOBAL CONVENTION

37. We welcome the resolutions of the Executive Council of the WMO and Special Governing Council of UNEP authorising their Secretary General and Executive Director to begin negotiations for a Climate Convention, and associated Protocols. We call for such negotiations to begin without delay. We endorse the WMO and UNEP Governing Bodies Decisions in this respect. We urge all countries to join in these negotiations, with the aim of completing negotiations to ensure adoption of a Climate Convention by the time of the UN Conference on Environment and Development in 1992;

38. We recommend that such negotiations take account of the possible elements compiled by the IPCC, and that the Climate Convention be framed in such a way as to gain the support of the largest possible number of countries.

39. We welcome the offer of the Government of the United States to host the first negotiating meeting of a Working Group on the elaboration of a Climate Convention. We also welcome the possible invitation of Italy to host the first meeting of the Working Group for the elaboration of an Energy Protocol. We urge that these two meetings be convened at the beginning of 1991.

40. We recommend further that the Climate Convention and associated Protocols contain specific obligations and address in particular:

(i) the enhancement of research and systematic observation of climate.

(ii) the control of greenhouse gas emissions

(iii) the adaptation to the adverse effects of climate change in coastal areas

(iv) The needs of developing countries for financial assistance in their development efforts and transfer of technology

(v) appropriate institutional and decision-making procedures.

IV. INFORMATION AND PUBLIC AWARENESS

41. We believe that a well informed public is essential for addressing and coping with as complex an issue as climate change and urge countries to

(i) encourage wide participation of all sectors of the population in addressing climate change issues and developing appropriate responses

(ii) provide guidance for positive practices to limit/or adapt to climate change

(iii) incorporate in the curricula of their educational systems environmental education

(iv) establish national committees or clearing houses to collect, develop and disseminate accurate information on climate change issues.

V INSTITUTIONAL MATTERS

42. We congratulate the IPCC for the outstanding achievement of producing in a very short time its first report on the state of the science of climate change, the socio-economic impact and policy options. We recognize that the IPCC structure can provide an invaluable mechanism for periodic assessments, perhaps every five years, of the evolving knowledge from research and impact studies. We urge that the IPCC continue its analysis of risks of action and inaction, policy options and economic aspects of alternative measures for limiting greenhouse gas emissions, mitigating or adapting to climate change. We also urge that a further report on these issues should be produced during 1991 to support the then ongoing negotiations of a Climate Convention on Climate Change.

43. We further express our appreciation to WMO and UNEP for initiating the IPCC and providing an efficient Secretariat. We urge that this arrangement be continued and that countries continue to provide resources to support the Secretariat and participation of developing countries in the work of IPCC.

WORLD METEOROLOGICAL ORGANIZATION
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ORGANIZACION METEOROLOGICA MUNDIAL
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No. 29785/S

GENEVA, 10 July 1990

Annex: 1

Sir,

We have the honour to recall to your attention Resolution 44/207 of the forty-fourth session of the UN General Assembly on the protection of global climate for present and future generations of mankind, which, inter alia, supports the request made by the Governing Council of the United Nations Environment Programme, in its decision 15/36 that the Executive Director of the Programme, in co-operation with the Secretary-General of the World Meteorological Organization, begin preparations for negotiations on a framework convention on climate, taking into account the work of the Intergovernmental Panel on Climate Change, as well as the results achieved at international meetings on the subject.

May we further recall to your attention the decisions of a number of ministerial and other international meetings that negotiations on a framework convention on climate change begin as soon as possible, after the completion of the interim report of the Intergovernmental Panel on Climate Change, (IPCC). In this connection, you may recall the offer of President George Bush of the United States of America to host the first negotiation session.

We take this opportunity to inform you that the IPCC is expected to complete its interim report (First Assessment Report) in late August of this year. Its working groups on science, impacts and response options and its Special Committee on the Participation of Developing Countries have completed their respective parts of the Report.

Further, the Executive Council of WMO, in its forty-second (1990) session, has authorized its Secretary-General to convene jointly with the Executive Director of UNEP an open-ended ad hoc Working Group of government representatives to prepare for the Convention (vide copy of Resolution, attached). The Governing Council of UNEP, in its Special Session, is expected to adopt a parallel decision.

To: Ministers of Foreign Affairs of Members of the United Nations
Ministers of Foreign Affairs of Members of WMO

In keeping with the progress of events since the adoption of Resolution 44/207, we now wish to inform you that we are jointly convening - in Geneva from 24 to 26 September 1990 - a session of an open-ended ad hoc working group of government-nominated legal and technical experts with a mandate to prepare for the Convention. By this letter, we invite your Government to nominate your representative(s) to the session. We are doing so without awaiting the formal action by the UNEP Governing Council in order to give sufficient time for identifying your representative(s) and for the necessary preparations. You may wish to consider including on your delegation those who are familiar with the work of IPCC and the contents of the reports of its working groups and Special Committee.

The session of the open-ended ad hoc Working Group will take place in Salle II of the Centre International de Conférences de Genève (CICG), 15 rue de Varembé. The agenda and documentation will follow under separate cover.

Accept, Sir, the assurances of our highest consideration.

(G.O.P. Obasi)
Secretary-General
World Meteorological Organization

(M.K. Tolba)
Executive Director
United Nations Environment Programme

Resolution

Res. 4.1/1 (EC-XLII) - FRAMEWORK CONVENTION ON CLIMATE CHANGE

THE EXECUTIVE COUNCIL,

NOTING:

(1) Resolutions 43/53 and 44/207 of the UN General Assembly on the "Protection of global climate for present and future generations of mankind",

(2) Resolution 44/228 of the UN General Assembly "United Nations Conference on Environment and Development",

(3) The relevant parts of declarations and decisions adopted at various intergovernmental and non-governmental meetings during 1989 and 1990,

(4) Decisions of the WMO Executive Council on the Second World Climate Conference and recommendations of the Organizing Committee for the Conference,

(5) The work of the Intergovernmental Panel on Climate Change, which has included the compilation of the possible elements of a framework convention on climate change,

RECALLING:

(1) Decision 15/36 of the Governing Council of UNEP on global climate change,

(2) Resolution 4 (EC-XLI) of the Executive Council of WMO "Global Climate Change",

RECOGNIZING the actions taken by the Secretary-General, in co-operation with the Executive Director of UNEP, to respond to the request in Resolution 4 (EC-XLI) to begin preparations for negotiations on a framework convention on climate change;

CONSIDERING that the adoption by the UN General Assembly of Resolution 44/207 "Protection of global climate for present and future generations of mankind" demonstrated a universal recognition by governments of an urgent need for concerted international efforts to address the climate change issue, in particular by negotiating, after completion of the IPCC First Assessment Report, a framework convention on climate change and adopting the convention, if possible at the UN Conference on Environment and Development in 1992;

CONVINCED that further steps are needed to implement the decisions of the UN General Assembly and those of the governing bodies of WMO and UNEP on the negotiations of a framework convention on climate change;

AUTHORIZES the Secretary-General to convene jointly with the Executive Director UNEP, an open-ended ad hoc working group of government representatives, urging that where feasible, Members nominate experts in climate change who have been involved in the work of the IPCC;

REQUESTS that the ad hoc working group meet in Geneva in September 1990 to prepare for negotiations on a framework convention on climate change based, inter alia, on the findings of the IPCC First Assessment Report;

NOTES with pleasure the invitation of the Government of the United States of America to host a first negotiating session on the framework convention on climate change;

REQUESTS the Secretary-General:

(1) To convene jointly with the Executive Director of UNEP the first open-ended negotiating session on the framework convention on climate change not later than February 1991 taking into account the invitation by the Government of the United States of America;

(2) To report, jointly with the Executive Director of UNEP, to the 45th session of the UN General Assembly on the progress in the preparations for negotiations of framework convention on climate change;

(3) To report to the Eleventh Congress and to the Executive Council on the progress of the actions under this resolution.

Resolution

Res. 4.2/1 (EC-XLII) - SECOND WORLD CLIMATE CONFERENCE

THE EXECUTIVE COUNCIL,

RECALLING:

(1) Resolutions 43/53 and 44/207 of the UN General Assembly on the "Protection of global climate for present and future generations of mankind",

(2) Resolution of 44/228 of the UN General Assembly "United Nations Conference on Environment and Development",

(3) Resolution 4 (EC-XLI) of the Executive Council of WMO "Global Climate Change",

NOTING (Draft) Resolution 4.1/1 (EC-XLIII) Framework Convention on Climate Change,

AUTHORIZES the Secretary-General to convene jointly with the Executive Director of UNEP, and in close consultation with the Executive Heads of ICSU/UNESCO and its IOC, following the fourth session of the IPCC, a preparatory meeting open to all interested governments, such a meeting to include experts who have been involved in the IPCC process to prepare a draft of the ministerial declaration for the Second World Climate Conference, taking into account:

(1) Prior consultations with governments;

(2) The work of the IPCC including its first assessment report;

(3) The results of any prior preparatory meetings for the negotiation of a framework convention on climate change;

(4) The work of the Preparatory Committee for the 1992 Conference on Environment and Development;

(5) The need for continuation and enhancement of the necessary scientific research, monitoring and environmental and socio-economic studies of climate and climate change together with the maintenance and enhancement of the observational networks that supply the requisite data for these studies, as the foundation upon which response strategies and policy options will be based;

(6) The need to support the international exchange of information on climate and climate change;

(7) The need to support intergovernmental agencies working on climate and national climate institutions in particular those in developing countries;

FURTHER AUTHORIZES the Secretary-General jointly with the Executive Director of UNEP to request the Secretary-General of the United Nations to plan to take into account the outputs of the Second World Climate Conference in the discussion of the climate issue during the forty-fifth session of the United Nations General Assembly;

(ECDOCSE 1413)

REQUESTS the Secretary-General in consultation with the Executive Heads of UNEP, UNESCO and its IOC and ICSU to prepare a report to the Eleventh World Meteorological Congress including an account of the potential implications for WMO, and to ensure a wide distribution of the recommendations, Declaration and Proceedings of the Conference, timely implementation of the recommendations as appropriate through follow-up regional conferences and workshops and other forms of technology transfer, and that relevant SWCC outputs are brought to the attention of the planners of the 1992 UN Conference on Environment and Development.

Resolution

Res. 2.6/1 (EC-XLII) - INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

THE EXECUTIVE COUNCIL,

NOTING Resolutions 4 (EC-XL) and 4 (EC-XLI),

NOTING with satisfaction the progress made by the Intergovernmental Panel on Climate Change (IPCC),

FURTHER NOTING the expressions of need for the continuation of the work of IPCC by many governments at the third plenary of the Panel (Washington D.C., 5-7 February 1990),

RECOGNIZING also the forthcoming Second World Climate Conference during which the IPCC First Assessment Report will be considered;

REQUESTS the Secretary-General jointly with the Executive Director of the United Nations Environment Programme (UNEP) to arrange for the continuation of IPCC as a joint WMO and UNEP body to, inter alia:

(a) Undertake scientific and technical work in support of the negotiations of a framework convention on climate change;

(b) Periodically update the assessments of the available scientific information on climate change and the resulting environmental and socio-economic impacts;

(c) Undertake further environmental and socio-economic analyses of the various policy options posed as response strategies;

(d) Evaluate the special problems of the developing countries in their efforts to address the issue of climate change and assess possible options to deal with these problems;

(e) Take all appropriate steps to ensure the effective participation of developing countries and the broad dissemination of its work;

(f) Report regularly to the Council on the progress of its work, and through the Secretary-General of WMO and the Executive Director of UNEP to the United Nations General Assembly;

FURTHER REQUESTS the Secretary-General in consultation with the Executive Director of UNEP to review the report of the IPCC and the results of the Second World Climate Conference in the light of their possible implications for WMO and UNEP and to report on the review to Eleventh Congress.

Executive Summary

Science

* We are certain of the following:

- there is a natural greenhouse effect which already keeps the earth warmer than it would otherwise be,

- emissions resulting from human activities are substantially increasing the atmospheric concentrations of the greenhouse gases: carbon dioxide, methane, chlorofluorocarbons (CFCs) and nitrous oxide. These increases enhance the greenhouse effect, resulting on average in an additional warming of the Earth's surface. The main greenhouse gas, water vapour, will increase in response to global warming and further enhance it.

- the total increase of greenhouse gas concentrations attributable to human activities is at present equivalent to an increase of carbon dioxide since pre-industrial times (about 200 years ago) by about 50%

* We calculate with confidence that:

- atmospheric concentrations of the long-lived gases (carbon dioxide, nitrous oxide and the CFCs) adjust only slowly to changes of emissions

- the long-lived gases would require reductions in emissions from human activities of over 60% to stabilize their concentrations at today's levels; methane would require a 15-20% reduction.

* The human-caused emissions of carbon dioxide are small as compared to the natural carbon dioxide exchange between the atmosphere on one hand and the terrestrial system and the oceans on the other. The latter were, however, in close balance before anthropogenic emissions began and the steady human-induced emissions into the atmosphere represent a significant disturbance of the natural carbon cycle.

* Based on current model results, we predict:

- a rate of increase of global mean temperature during the next century of about 0.3 degrees C per decade (with an uncertainly range of 0.2-0.5 degrees C per decade) assuming the IPCC Scenario A (Business as Usual) emissions of greenhouse gases (i.e. few or no steps are taken to limit emissions of greenhouse gases) ; this is a more rapid increase than seen over the past 10 000 years. This will result in a likely increase in the global mean temperature of about 1 oC above the present value by 2025 (about 2 oC above that in the pre-industrial period), and 3 oC above todays value before the end of the next century (about 4 oC above pre-industrial). The rise will not be steady,

- that land surfaces warm more rapidly than the oceans, and higher northern latitudes warm more than the global mean.

- the oceans act as a heat sink and thus delay the full effect of greenhouse warming. The related (actual) temperature change is at any given time estimated to be between 50 and 80 % of the committed change, i.e. the change when the climate system has reached equilibrium.

* There are many uncertainties in our predictions particularly with regard to the timing, magnitude and regional patterns of climate change, especially changes of precipitation. This is due to our incomplete understanding of sources and sinks of greenhouse gases and the responses of clouds, oceans and polar ice sheets to a change of the radiative forcing caused by increasing greenhouse gas concentrations.

* Over many thousands of years there have been significant changes in the atmospheric greenhouse gas concentrations and global climate, such as those that occurred during the Ice Ages. The mechanisms causing these are not yet well understood.

* <u>Our judgement is that:</u>

- global mean surface temperature has increased by 0.3 to 0.6 oC over tha last 100 years, with the five global-average warmest years being in the 1980s. The increase has not been smooth in time, nor uniform over the globe.

- the size of the warming over the last century is broadly consistent with the predictions by climate models, but is also of the same magnitude as natural climate variability. Thus the observed increase could be largely due to this variability; alternatively this variability and other human factors could have upset a still larger human-induced greenhouse warming. The unequivocal detection of the enhanced greenhouse effect from observations is not likely for a decade or more.

Impacts

* Because of the lack of accurate estimates of the expected regional changes of climate, precise predictions of the regional impacts of climate change cannot yet be made. Some general conclusions can, however, be drawn.

* If no preventive measures to limit the further increase of man-induced emissions of greenhouse gases (Scenario A, Business as Usual), an average rate of global mean sea level rise of about 6 cm per decade is projected over the next century, with an uncertainty range of 3-10 cm per decade.

* Already a rise of sea level by 30-50 cm would affect the habitability of low-lying coastal regions significantly and a one meter rise (possible towards the end of next century as estimated in the Scenario A) would impact 360 000 km of coastline, render some island countries uninhabitable, displace tens of millions of people, threaten low-lying urban areas, flood productive land and contaminate fresh water supplies.

* Although studies have not yet conclusively determined whether on average global agricultural potential would increase or decrease, changes of climate would have important effects regionally. Decline in production might be expected in regions of high present-day vulnarability, where the ability to adjust is low.

* Some current forests will mature and decline in a climate, to which they are increasingly poorly adapted, while a potential for forests to grow might eventually develop elsewhere.

* Similarly other natural terrestrial ecosystems would be markedly influenced because the rates of climate change are likely to be faster than the ability of some species to adjust.

* Enhanced carbon dioxide concentrations in the atmosphere might enhance growth of certain plants.

* Comparatively small changes of climate can cause large water resource problems. The availability of water and biomass might be significantly affected, positively or negatively, and both are major energy sources in many developing countries.

Response strategies

* A major dilemma of the issue of climate change due to increasing emissions of greenhouse gases into the atmosphere is that actions may be required well before many of the specific issues that are and will be raised can be analyzed more thoruoghly by further research.

* The CFCs are already being eliminated to prevent their continued destruction of the stratospheric ozone layer. This is also an effective measure to slow down the rate of global warming. Every effort should be made to find replacements that have little or no greenhouse warming potential or ozone depletion potential rather than the HCFCs and HFCs that are now being considered.

* Assuming a projected increase of the world population to about 8 billion by 2030, the present global average emissions of carbon dioxide of about 1.45 ton of carbon per capita would have to be reduced to about

0.35 ton of carbon per capita in order to stabilize carbon dioxide concentrations in the atmosphere.

* If the present rate of deforestation were reduced to about half of the present rate, this could reduce the rate of increase of carbon dioxide in the atmosphere by 5-15% compared with the present rate. Reforestation of 12 million hectars per year during the next 40 years would similarly slow down the rate of increase of carbon dioxide in the atmosphere during this period by 5-15%.

Roles of Industrialized and Developing Countries

* Industrialized and developing countries have a common responsibility in dealing with the problem arising from climate change. The former should take the lead in two ways:
  - to limit climate change by adapting their own economies in line with future agreements to limit emissions,
  - to cooperate with developing countries in international action, without standing in the way of the latter's development.

* Sustainable development in industrialized as well as developing countries requires the proper concern for environmental protection as the necessary basis for continued economic growth. Environmental considerations must be systematically integrated into all plans for development. The right balance must be struck between economic growth and environmental objectives.

* The developing countrios are rapidly increasing their emissions of greenhouse gases in striving for improving their living standards. Recognizing the poverty that prevails among the polulations of developing countries, it is natural that achieving economic growth is given priority by them. Narrowing the gap between the industrialized and the developing world should provide a basis for full partnership of all nations in the world, which is essential for the development of a strategy to deal with the climate change issue.

Options

* The climate scenario studies of Working Group I and III outline control policies on emissions that would slow global warming from presently perhaps 0.3 oC per decade to 0.1 oC per decade.

* The potentially serious consequencies of climate change give sufficient reasons to begin adopting response strategies that can be justfied immediately even in the face of significant uncertainties. These include

- elimination of CFC emissions and careful assessment of the greenhouse gas potential of proposed substitutes,
- improved energy end use efficiency,
- improved forest management,
- use of cleaner, more efficient energy sources with lower emissions of greenhouse gases,
- review of agricultural practices.

* There is no single quick-fix technological option for limiting greenhouse gas emissions. A comprehensive strategy addressing all aspects of the problem and reflecting environmental, economic and social costs and benefits is necessary.

* Individual nations, or groups of nations, could initiate actions to stabilize and later reduce emissions and thus take the lead in the prevention of an accelerated increase of greenhouse gas concentrations in the atmosphere in order to prepare fo truly international agreements. An important aim would be to define targets for carbon dioxide and other greenhouse gases.

* In the long term perspective, work should begin on defining criteria which would reflect the impacts of climate change and its costs on one hand and social and economic cost and benefits and practicalities of reductions in emissions on the other. This evaluation should take into account what might be an acceptable level of climate change on the one hand and an acceptable rate of economical and technological adjustments on the other hand.

* Consideration of measures for reducing the impacts of global climate change should begin as soon as possible, particularly with regard to disaster prepareness policies, coastal zone management and control measures for desertification, many of these being jusltified in their own right. Measures to limit or adapt to climate change should be as cost-effective as possible, while taking into account important social implications. Limitation and adaptation should be considered as an integrated package.

* Environmental objectives can be achieved either through regulations or through market based economic instruments. The latter, through their encouragement of flexible selection of abatement measures, tend to encourage innovation and the development of improved technologies and practices for reducing emissions and therefore frequently offer the possibility of achieving environmental improvements at lower costs than through regulatory mechanisms. It is unlikely, however, that economic instruments will be applicable to all cirumstances.

Future Work and International Cooperation

* The measures that may be necessary require a high degree of international cooperation, with due respect for national sovereignty of states. To assist in that process, international negotiations on a convention on climate change should start as quickly as possible. -- Key issues for negotiations will include the criteria, timing, legal form and incidence of any obligations to control the net emissions of greenhouse gases, how to address equitably the concequences for all, any institutional mechanisms including research and monitoring that may be required, and in particular, the requests of the developing countries for additional financial resources and for the transfer of technology on a preferential basis.

* The IPCC recommends that research regarding the climate change issue in general, and the international economic implications in particular, be intensified.

* Because climate change would affect, either directly or indirectly, almost every sector of society broad global understanding of the issue will facilitate the adoption and the implementation of such response options as deemed necessary and appropriate. Further efforts to achieve such global understanding are urgently needed.

* The IPCC appeals to multilateral and bilateral funding organizations to assist developing nations in their efforts to take part in the international cooperation with regard to the climate change issue and to do so without awaiting the outcome of future negotiations on a climate convetion. It further appeals on an urgent basis to governments for increased contributions to the IPCC Trust Fund for future IPCC work.

Withdrawal/Redaction Sheet
(George Bush Library)

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01. List	Re: Global Change Task Force Group (2 pp.)	n.d.	(b)(6)	

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Record Group: Bush Presidential Records
Office: Economic Advisers, Council of
Series: Schmalensee, Richard, Files
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WHORM Cat.:
File Location: Group on Global Climate Change #2 (IPCC - Intergovernmental Panel on Climate Change) and RSWG (Response Strategy Working Group) [Letters, Memorandums, Reports, and Other Information][2]

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FOIA/SYS Case #:	2017-0310-F	**Appeal Case #:**	
Re-review Case #:		**Appeal Disposition:**	
P-2/P-5 Review Case #:		**Disposition Date:**	
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P-2 Relating to the appointment to Federal office [(a)(2) of the PRA]
P-5 Release would disclose confidential advice between the President and his advisors, or between such advisors [(a)(5) of the PRA]

LB

July 13, 1990

DOMESTIC POLICY COUNCIL
Working Group on Global Change
Task Force on Economic Costs

Bruce Bartlett
Deputy Assistant Secretary for
Economic Policy
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see: Pat Alex Cristofaro attending

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Jeff Holmstead & Gray with attach

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COUNCIL OF ECONOMIC ADVISERS
EXECUTIVE OFFICE OF THE PRESIDENT
WASHINGTON

MEMBER OF THE COUNCIL

July 12, 1990

MEMORANDUM FOR TASK FORCE ON ECONOMICS OF THE
WORKING GROUP ON GLOBAL CHANGE

FROM: RICHARD SCHMALENSEE

SUBJECT: Publishing our Report

This is to let you know that, per the attached memo from Allan Bromley, I will schedule a Task Force meeting in the near future to consider publishing our report after the "considerable scrubbing and updating" that is clearly necessary. The issues on the table seem to me to be the following:

- Do we agree with Dr. Bromley that "it would indeed be very useful to have [our] report published"? If no, our task is finished. If yes, two further questions require our attention.

- What is the best format for publication? There is no obvious report series in which our paper could appear as a routine matter, but it does not strike me as desirable to have its appearance be a significant, nonroutine event.

- How shall we organize "scrubbing and updating"? My impulse would be to have written comments sent to CEA by, say, mid-August. We could then prepare a revised draft, with bracketed language where necessary, for discussion in September.

Enclosed for your information is my attempt at an updated list of the members of our Task Force. Please let me know if it should be altered in any way.

THE WHITE HOUSE

WASHINGTON

July 5, 1990

MEMORANDUM FOR RICHARD L. SCHMALENSEE

FROM: D. ALLAN BROMLEY

SUBJECT: GLOBAL CHANGE ECONOMIC REPORT

I am sorry that it has taken so long to get back to you concerning your memo of June 15.

I believe that it would indeed be very useful to have your report published but I think that it would be important to give it some considerable scrubbing and updating before doing so. I suspect that there are regulations which would require that it be indicated as something other than a working group report to the DPC because these, I believe, are considered privileged documents which do not get published in the normal course of events.

Your paper, I think, breaks entirely new ground and would contribute in a very substantial way to more enlightened public discussions and for that reason I think it important that it be released.

Obviously it would be important to have the concurrence of all the members of your group and I would be more than happy to take a look at the final version before it goes out.

July 12, 1990

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Working Group on Global Change
Task Force on Economic Costs

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EXECUTIVE OFFICE OF THE PRESIDENT
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Date: July 12, 90

Please deliver to: Bruce Bartlett, Dep Asst Sec for Economic Policy
Main Treasury, Room 3445

FAX number of addressee: 786-8452

Telephone number of addressee: 566-2768

From: RICHARD SCHMALENSEE, MEMBER

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Telephone number of addressee: 357-9715

From: RICHARD SCHMALENSEE, MEMBER

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Policy, Plan & Evaluation, EPA
Room 1013, West Tower

FAX number of addressee: 252-0275 or 252-0780

Telephone number of addressee: 382-4332

From: RICHARD SCHMALENSEE, MEMBER

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USDA, Room 227E

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Telephone number of addressee: 447-4164

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White House, West Wing
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FAX number of addressee: 456-6279

Telephone number of addressee: 456-2632

From: RICHARD SCHMALENSEE, MEMBER

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From: RICHARD SCHMALENSEE, MEMBER

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Dept of Commerce, Room 4850

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July 12, 1990

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United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

file

→ Howard

Memorandum

To: Addressees

From: Indur Goklany, (DOI), Principal U.S. Delegate and Rapporteur, RUMS/IPCC-WG3 Goklany 5/2/90

Subject: Resource Use and Management Subgroup (RUMS-IPCC WG3-RSWG) Report

The April 23rd-25th meeting of RUMS was very successful from our point-of-view. We now have a report which will be circulated to all nations (see Attachment).

The meeting was attended by U.S., Canada, Australia , U.K., Japan, China, Brazil, Tanzania, Kenya, FAO and the Coal Industry Advisory Board. The U.S. was represented by USDA, Corps of Engineers, NOAA and DOI.

This report does not differ markedly from the initial drafts that you may have seen. The most important changes that were made to the April 3rd version are:

- Clarification that analysis of economic efficiency (and of costs and benefits) should also consider environmental factors.
- The language on subsidies is much softer in many places at the insistence of the Japanese. It now asks for "analysis and review" of subsidies where it initially had "analysis, review and, if necessary, eliminate".
- The conclusion section in the Food Security Section was eliminated, but its last paragraph is now the last paragraph in the Executive Summary.
- Reforestation and afforestation are now explicitly included as near-term options.
- There is now a little bit more on fisheries including a reminder of their role in recreation.

- The term "welfare" has now been substituted by "wellbeing", e.g., as in social and economic wellbeing.

There was a strong suggestion to have the RUMS report make recommendations, as opposed to merely provide a "menu of options". This had been anticipated, and the Co-chairman started the meeting by reviewing the process by which we had gotten to the meeting and the reasons for providing a menu rather than recommendations.

The paper clearly articulates the U.S. view that currently we should be pursuing policies that are **economically justifiable** now, and that criteria for determining justifiability include economic efficiency, cost-effectiveness and consideration of opportunity costs. (There was an unsuccessful effort to drop "economically" prior to "justifiable").

It also make several positive allusions to economic-based solutions, and notes the uncertainties in estimating not only changes in the climate, but also in estimating their impacts on resources and, further, on socioeconomic consequences.

The Executive Summary speaks for itself. Much of this is quite predictable, however, it does make some points which may not be clearly articulated in the other Subgroup reports, e.g.:

- Temperature change is one of several, and perhaps not the most important, climatic variable and that for many of these variables, we do not even know the direction of change.

- The effects of climate change could be trivial relative to changes due to other causes, e.g., population growth and other socioeconomic factors.

- That climate change could also have beneficial aspects in a number of circumstances.

- That human beings have a long and relatively successful history of coping with adverse climate change, and that we can learn from past lessons as well as lessons learnt from current resource use and management practices employed across the existing wide variation in climate over the face of the globe.

- That, while economic and technological growth may be seen to be part of the problem, they also make it easier to cope with any climate change.

- Recognition of the potentially positive aspects of CO_2, and that limitation strategies should explicitly consider these.

- That the ultimate objective is socio-economic wellbeing (which includes consideration of environmental factors).

- That increased productivity (for agriculture, forests, and water) and economic growth, consistent with the principles of sustainable growth and development, are environmentally beneficial.

- Decision-making on resource use and management should be decentralized--with some consideration of the broader society's concerns to deal with the "not-in-my-backyard" syndrome.

- Resources or resource sectors (e.g., agriculture and forestry) that are managed intensively are more able to adapt successfully than unmanaged ecosystems.

As noted, most of the other points are quite predictable, e.g., greater support for sustainable growth and development, increased reforestation and afforestation, inventorying, monitoring, assessments, research, technology transfer, and recognition of the special problems of developing nations, etc.

The RUMS meeting also discussed possible future tasks. These are specified in the attached letter from The Canadian Co-chairman (Pentland) to the RSWG chairman.

If you have any comments on this document, please provide them to me by COB May 16th (tel. 208-4951, fax 208-4867. Note the change).

Attachments. (Pass onto Howard G.)

COUNCIL OF ECONOMIC ADVISERS
EXECUTIVE OFFICE OF THE PRESIDENT
WASHINGTON

MEMBER OF THE COUNCIL

June 14, 1990

MEMORANDUM FOR TIMOTHY DEAL, ERIC MELBY

FROM: RICHARD SCHMALENSEE

SUBJECT: German Proposal on the Environment

This is obviously a very troubling document. I hope it bears so little relation to what has gone before (or that their attempt to sieze the pen is such a departure from past practice) that you can avoid having to work from it. If everything fails, however, here are some specific responses.

Introduction: There is no scientific basis for the statement that "Changes in the Earth's atmosphere will endanger life on earth unless present trends are checked." (Incidentally, these are the same words we heard from the German Environment Minister at the White House Conference in April.) Neither the WGI report of IPCC, which concludes that equilibrium temperature is likely to rise by 1°C by 2030 and 3°C by the end of next century in the "high emission" scenario, nor examination of agricultural impacts, sea-level rise, health impacts and other relevant factors by USEPA and WGII of IPCC provide any justification for the German statement. Do our German friends have different information?

There is no real support for the assertion that "it is of paramount importance for suitable preventive steps to protect the atmosphere to be taken without delay." I know of nothing that suggests that a few years' delay in G-7 action would make a quantitatively important difference to trace gas concentrations 60 years from now.

Paragraph #1: The Montreal Protocol focuses on curtailment of ozone depleting gases, many of which are (by happy coincidence) also powerful greenhouse gases. The language in paragraph #1 mentions "tightening targeted reductions for greenhouse gases" in the context of the Montreal Protocol. We should resist efforts to mis-characterize the purpose of the Montreal Protocol. Although we can and should applaud continued progress in reducing ozone-depleting gases and note that many of these gases are also powerful greenhouse gases, we should not allow it to be suggested that our support for the Montreal Protocol amounts to support for a greenhouse gas protocol.

Paragraph #2: The third sentence is deceptive: the OECD nations account for only about 40 percent of anthropogenic CO_2 emissions and that this share is projected to shrink.

The next sentence suggests commitment to adopt both a framework convention and a CO_2 emissions protocol in the same 1992 time frame. There is no rational basis for such a commitment given the current state of knowledge about the magnitude and impact of climate change. A lack of knowledge about the costs and benefits of particular response strategies is a major impediment to consideration of a CO_2 protocol at this time. If a protocol is ultimately deemed necessary, we believe that there are important advantages to looking at sources and sinks and at all greenhouse gases comprehensively.

The subsequent reference to "radical provisions" can only be intended as a bargaining chip; we cannot possibly agree to anything like this, and they must know it.

Paragraph #3: There is no scientific support for the assertion that "it is of pre-eminent importance for the protection of the climate" that forests be protected. There are lots of good reasons for protecting forests, but tropical deforestation accounts for only about 12 percent of anthropogenic CO_2 emissions, the climatic effects of which are (in our view) uncertain.

I hope we decide soon whether or not to agree in advance to a forestry protocol, but as far as I know that decision has not yet been made, and there is disagreement within the Administration. (This issue also arises in connection with paragraph #4, which assumes a protocol.)

Paragraph #7: Proposed declaration on debt forgiveness (first tick) is much too sweeping, although I gather we are willing to discuss debt-for-nature swaps.

Paragraph #8: We strongly applaud increased attention to environmental concerns in the Eastern European nations as they shift from centrally-planned to market-oriented economies. However, the suggestion for a mechanism to ensure the use of "best available technology" (whatever that might mean in practice) for all economic reconstruction projects is far too restrictive; no such requirement exists in our own nations. Eastern European countries should be asked to achieve desirable environmental improvement using market oriented rather than command-and-control technology requirements.