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GCC [Global Climate Change] January 1997 [1]

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Sandalow mtg 1/9/97

AGENDA

1. Deputies Meeting (Tuesday, January 14)
2. Domestic Policy Workgroups
3. Domestic Policy Outreach

Analytical Benchmark:

Stab. by 2010

Domestic policies

{ Emissions Trading
{ policies to transform mkts. (techn. diffusion)

Technology development policy

1. Biogas + Energy conversion technologies
2. Nuclear + Biomass
3. Transp.
4. Industrial process

Gardiner EPA 2 papers

Policy office EPA

Air Office EPA

to be discussed at mtg Thurs

Chapman DOE

10-12 Rm 4830

cc: JAF
55

THE WHITE HOUSE
WASHINGTON

January 8, 1997

MEMORANDUM FOR DISTRIBUTION

FROM: Kristen Panerali
National Economic Council

SUBJECT: Climate Change Deputies Meeting--CANCELLED

The joint NEC-CEQ Deputies meeting on climate change on Thursday, January 9 at 4 pm is cancelled. It is rescheduled for Tuesday, January 14 at 4:30 pm. in 231 OEOB.

Deputies plus one are invited to attend. Please call Kristen Panerali at 456-5353 with your clearance information by COB Monday, January 13.

Distribution:
Charles Curtis, DoE
Morton Downey, DOT
Ev Ehrlic, Commerce
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Cynthia Metzler, Labor
Richard Rominger, USDA
Alicia Munnell, CEA
Nancy Soderberg, NSC
Larry Summers, Treasury
Tim Wirth, State

U.S. Draft Protocol Framework
Key Issues

Deputies Meeting
1/14/97

Targets and Budgets

- Concept – Article 2
- Two periods – Article 2.3
- Comprehensive approach – Annex C
- Borrowing – see separate short paper

Developing Countries

- "No regrets" – Article 5.5
- Expanded list of obligations – Article 5.2, 5.3, 5.4, 5.5, 5.7
- Annex B – (and referenced in Article 2.2 and 2.4)
- Evolution – Article 16

Measurement/Reporting/Compliance

- Measurement and Reporting – Article 3
- Review and Compliance Process – Article 4

Trading/Joint Implementation

- International Emissions Trading – Article 6
- Joint Implementation – Article 7

MEMORANDUM

COUNCIL OF ECONOMIC ADVISERS

Date: 30 Jan 97

To: Alex Cristofaro
EPA
260-0780 (fax)

From: Jason Shogren

RE: Additional Language for Domestic Trading paper

Page 1--end of Paragr. 2
...to go beyond compliance. *In addition, tradable permits can provide incentive for reduced total energy use.*

Page 1--middle of Paragr. 3
...incentive provided by the tax. *In principle, if the entire structure (e.g., elasticities) is known, any quantity target that could be set by a tradable permit system could also be attained by an appropriately calculated tax. In so far as forecasting in practice is difficult, however,* the resulting level of emissions.....

Page 1--end of Paragr. 3
.....based on historical emissions *or some combination of the two.* This flexibility....

Page 2--end of Paragr. 2
....costs of the abatement program. *Initially, it was claimed that emissions allowances would sell in the range of $x to z per ton. Current spot prices are in the range of $80 to 90, in part due to the fact that the bill that was actually adopted was not as onerous as many in industry had feared, low price and wide spread availability of low sulfur coal, bonus allowances, postponement of capital investments, among other economic influences ...*

After some fact checking, the price of $170-$200 is the price reported in the ICF draft report Comparisons of the Economic Impacts of the Acid Rain Provisions of the Senate Bill (S.1630) and the House Bill (S.1630) prepared for the EPA in July 1990. The price range from this report is also cited in Hahn and May (1994) "The Behavior of the Allowance Market: Theory and Evidence. The Energy Journal. If you think these prices are biased due to the limitations of the model, please add a cite indicating where your prices can be found.

cc: Jeffrey Frankel
Alicia Munnell.

cc: State
SJ
MW

THE WHITE HOUSE
WASHINGTON
January 29, 1997

MEMORANDUM FOR DISTRIBUTION

FROM: Kristen Panerali
National Economic Council

SUBJECT: Climate Change Deputies Meeting

There are two Climate Change Deputies meetings scheduled for February. The first is on February 11, at 2:00 pm in 231 OEOB. The second is on Monday, February 24 at 2:00 pm in 231 OEOB. An agenda will be sent to you before the meetings.

Deputies plus one are invited to attend. Please call Kristen Panerali at 456-5353 with your clearance information (date of birth and social security number) by COB February 10.

Distribution:
Charles Curtis, DoE
Morton Downey, DOT
Ev Ehrlic, Commerce
Leon Fuerth, OVP
John Garamendi, DOI
Jack Gibbons, OSTP
Jamie Gorelick, DOJ
David Hales, AID
Fred Hanson, EPA
Jeff Lang, USTR
Jack Lew, OMB
Ira Magaziner, DPC
Cynthia Metzler, Labor
Richard Rominger, USDA
Alicia Munnell, CEA
Nancy Soderberg, NSC
Larry Summers, Treasury
Tim Wirth, State

cc: JHF
JS
MM

THE WHITE HOUSE

WASHINGTON

January 30, 1997

MEMORANDUM FOR DISTRIBUTION

FROM: ELGIE HOLSTEIN
DAVID SANDALOW

SUBJECT: Climate Change

In response to several requests, we are rescheduling the meeting previously set for next Tuesday, February 4.

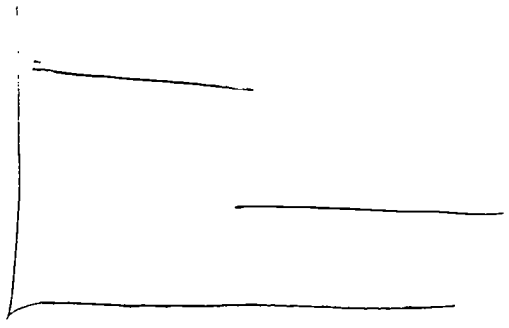
Our next meeting will be Monday, February 3 from 4:00-5:30 in OEOB Room 231. We will hear from Ev Ehrlich on the analysis and discuss the papers. **We have also reserved OEOB Room 231 on Wednesday, February 5 from 4:00-5:30, in case** there is a need for further discussion. Packages will be distributed to the deputies by COB Friday, February 7.

Please call Wendy Philleo (456-6224) for clearance.

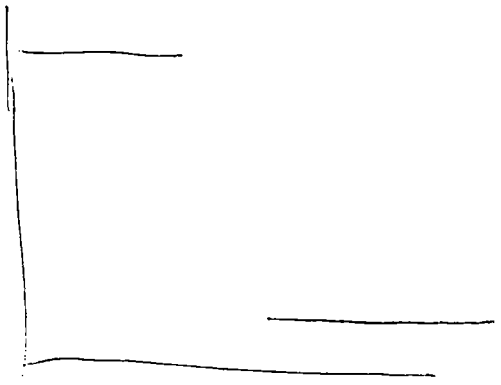
No increase
(Slow tech. progr.)

Rapid tech. progr.

Business

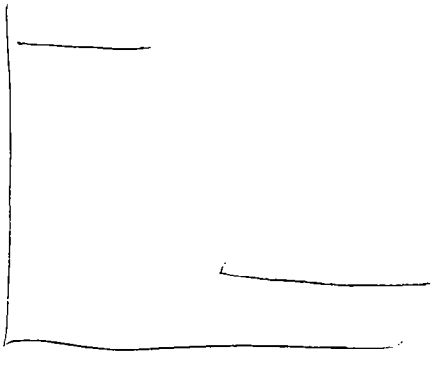


Base target path



high tendency

Business



Base target path

cc: AM
JA
RP
MM

THE WHITE HOUSE

WASHINGTON

January 6, 1997

MEMORANDUM FOR DISTRIBUTION

FROM: Kristen Panerali
National Economic Council

SUBJECT: Climate Change Deputies Meeting

There will be a joint NEC-CEQ Deputies meeting on climate change on Thursday, January 9 at 4 pm in 472 OEOB.

Deputies plus one are invited to attend. Please call Kristen Panerali at 456-5353 with your clearance information by COB Wednesday, January 8.

Distribution:
- Charles Curtis, DoE
- Morton Downey, DOT
- Ev Ehrlic, Commerce
- John Garamendi, DOI
- Jack Gibbons, OSTP
- Jamie Gorelick, DOJ
- David Hale, AID
- Fred Hanson, EPA
- Jeff Lang, USTR
- Jack Lew, OMB
- Cynthia Metzler, Labor
- Richard Rominger, USDA
- Alicia Munnell, CEA
- Nancy Soderberg, NSC
- Larry Summers, Treasury
- Tim Wirth, State

E X E C U T I V E O F F I C E O F T H E P R E S I D E N T

28-Dec-1996 08:42pm

TO: Alicia H. Munnell
TO: Raymond Prince

FROM: Jeffrey A. Frankel
Council of Economic Advisers

SUBJECT: Jan. 7 mtg. on Global CC

I have two major suggestions regarding Eileen Claussen's draft sent to us Dec. 20 under the title "Agenda..."

(1) p. 5, Article 6, item 2 "Trading...may be effectuated between private firms and between governments and firms," had better be amended by the addition of the phrase "when the firms have been allocated emission permits under national tradable-permit plans." For countries that do not choose to have such programs, the trading would not make much sense. (To be honest, I feel the same way about JI. But it's more serious with trading among Annex I countries, since they are the heart of the proposed agreement.)

(2) p. 1, Article 2, "Target". Regarding averaging, what do you think of the following provision (this also gets a bit at the banking and borrowing issues), instead of simple averaging over (say) 2020-2030:

"Each Party must meet at least 3 out of the following 4 requirements:

(1) for the period 2021-23, the average level of emissions...does not exceed 105% of the level of 1990,

(2) for the period 2024-26, the average level of emissions...does not exceed 100% of the level of 1990

(3) for the period 2027-2029, ...
95 % of the level of 1990.

(4) for the period 2020-2030, the average level of emissions...does not exceed 100 % the level of 1990.

I realize that the added complexity is highly undesirable in itself. But I think this is the best way of getting at the idea of averaging. Simple averaging over one period runs the great risk that the policy-makers early in the period will postpone the painful adjustment, because the deadline seems far off, and will be unable to do anything later in the period, because the magnitude of the task at that point is hopeless.

JF

THE LONGER-TERM VIEW: THE RELATIONSHIP OF EMISSIONS TO ATMOSPHERIC CONCENTRATIONS

While most discussions have focused on what steps might be taken in the medium term to reduce emissions of greenhouse gases, it is generally recognized that any such actions represent only an initial step and, by themselves, would fall far short of significantly reducing the risks of climate change. This paper presents information related to emissions paths that would be necessary to achieve various longer-term goals of stabilizing atmospheric concentrations of greenhouse gases. It also explores the implications that a longer term goal has for shaping near term policy decisions.

Several aspects of the climate change issue underscore its long term nature, but also suggest a need for beginning action now:

-- Once emitted, carbon dioxide will remain in the atmosphere for a 150-200 years.
-- Lags in the climate system result in temperatures increasing for several decades and sea level rising for centuries after greenhouse emissions have ceased to increase.
-- Uncertainties in scientific understanding of climate change and its relationship to long-term costs and benefits make selecting any specific ultimate concentrations goal somewhat speculative at this time.
-- The infrastructure for fossil-fuel based technologies developed over many decades. A transition to alternative sources of energy will also require many decades, but will only begin in earnest if research and development is begun now and if proper incentives are provided.

I. GLOBAL EMISSIONS AND ATMOSPHERIC CONCENTRATIONS

In the absence of any actions specifically to limit carbon dioxide emissions, the Intergovernmental Panel on Climate Change (IPCC), as shown in Figure 1, estimated that current emissions of 6 billion tons of carbon per year will grow to between 15-25 billion tons of carbon by 2050 and continue to increase through the end of the next century.

Global CO_2 Emissions & Concentrations

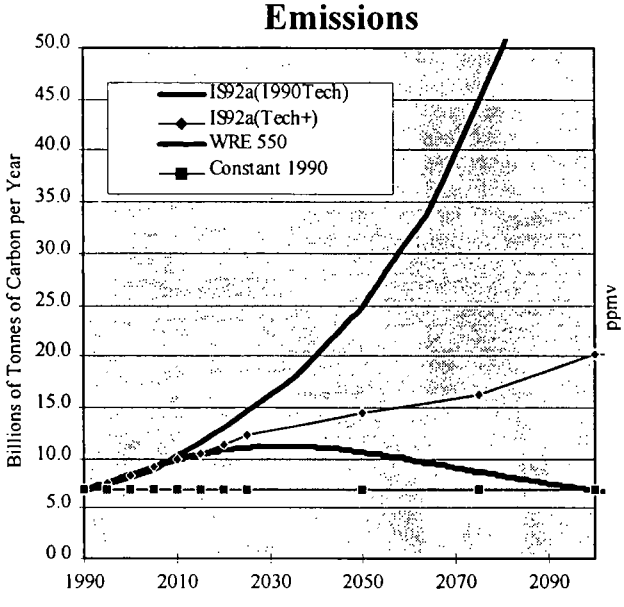


figure 1

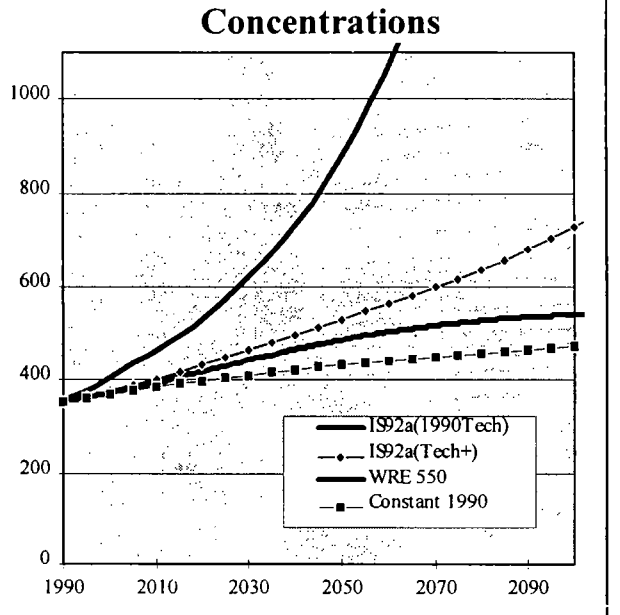


figure 2

(we will delete the WRE line)

Figure 2 shows the impact of these emissions scenarios on atmospheric concentrations. For context, preindustrial levels of carbon dioxide were about 280 ppm, and have increased to today's levels of about 360 ppm. Two scenarios with unrestrained projected growth are shown in figures 1 and 2. The "1990 tech" scenario assumes technology remains constant at 1990 levels in the future. The "tech+" scenario assumes technology improves substantially and results in lower costs for alternative fuels and enhanced energy efficiency. (The latter scenario represents the "central case" developed by the IPCC and is sometimes referred to as IS92a.) Under both of these scenarios, emissions grow substantially over time and concentrations far exceed a doubling of preindustrial levels prior to the end of the next century.

If it were possible to cap global emissions (both developed and developing countries) at 1990 levels, figure 2 shows that concentrations would nonetheless continue to rise throughout the next century and beyond, eventually exceeding a doubling of preindustrial levels.

Figure 3 shows the projected long-term atmospheric concentrations if emissions were stabilized at different levels. The figure shows that if emissions were stabilized at current levels, atmospheric concentrations would grow to almost 500 ppm by 2100, but continue increasing thereafter. It also shows that if emissions are stabilized at 10 PgC/yr, roughly 33 percent higher that today's level, then atmospheric concentrations would increase to more than a doubling from pre-industrial levels by 2100, while also continuing to increase thereafter.

ATMOSPHERIC STABILIZATION EMISSIONS PATHS

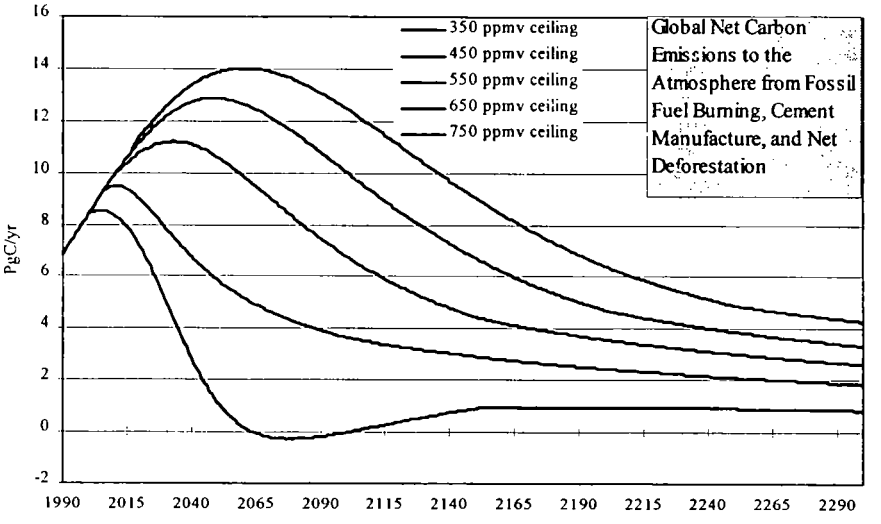


Figure 3

Key Dates & Rates

The Relationship Between CO_2 Concentration Ceilings, Maximum Emissions, and the Subsequent Rate of Emissions Decline: WRE Cases

Steady-State Concentration →	350 ppmv	450 ppmv	550 ppmv	650 ppmv
Deflection Date IS92a (Tech+) [a]	2001	2007	2013	2018
Deflection Date IS92a (1990Tech) [a]	2001	2006	2007	2007
Growth Rate to Maximum Date [b]	0.3%	0.3%	0.5%	0.5%
IS92a (Tech+) Growth Rate [c]	1.8%	1.4%	1.1%	0.9%
IS92a (1990Tech) Growth Rate [c]	1.6%	3.3%	2.8%	2.6%
Maximum Date	2005	2011	2033	2049
Maximum Emission [d]	6.0	8.0	9.7	11.4
Rate of Decline [e]	n.a.[e]	1.1%	0.8%	0.6%

[a] The deflection date is the year in which emissions in the emissions stabilization trajectory first fall below IS92a emissions by more PgC/yr.

[b] Average annual rate of growth (%/yr) of WRE fossil fuel carbon emissions between the "Deflection Date" and the "Maximum Dat

[c] The rate of growth (%/yr) of fossil fuel carbon emissions between the "Deflection Date" and the "Maximum Date."

[d] PgC/yr fossil fuel carbon emissions on the date of maximum totalanthropogenic carbon emissions.

[e] Rate of decline in fossil fuel carbon emissions, in percent per year, over the first 75 years following the date of maximum emissio 350 ppmv not defined as it requires a negative net emission.

Table 1

Table 1 also shows the relationship between various emission pathways and their impacts on various levels of atmospheric concentrations. For example, it illustrates that assuming the "Tech+" emission scenario, that global emissions must begin to deflect downward in the year 2013 to meet the 550 ppm concentration goal. It also shows the growth rates, rates of decline and maximum allowable emissions on a global basis for various emissions pathways and their corresponding concentration goals.

II. DEVELOPED AND DEVELOPING COUNTRY EMISSION TRENDS

Figure 4 presents current and projected emissions of carbon dioxide for developed and developing countries. Of the current emissions of roughly 6 billion tons, approximately two-thirds are from developed and one-third from developing countries. The U.S. is currently the largest emitter of carbon dioxide, with China the second largest source. However, on a per capita basis, the U.S. emits about 5 tons of carbon per capita, compared to an average of approximately 4 tons per capita in Japan and Western Europe, and 0.5 tons per capita for developing countries. While per capita differences remain large over time, by the middle of the next century, developing countries would become a source for more than half of total global emissions.

FIGURE 4

[INSERT FIG 4: shows developed and developing country emissions over time under a business as usual scenario.]

III. ILLUSTRATIVE EMISSION REDUCTION SCENARIOS

Limited mid-term actions to reduce emissions by developed countries alone have little impact on shifting the atmospheric concentrations curve. Figure 5 shows the small change in concentrations if Annex I (developed countries) freeze emissions at 1990 levels in the year 2010.

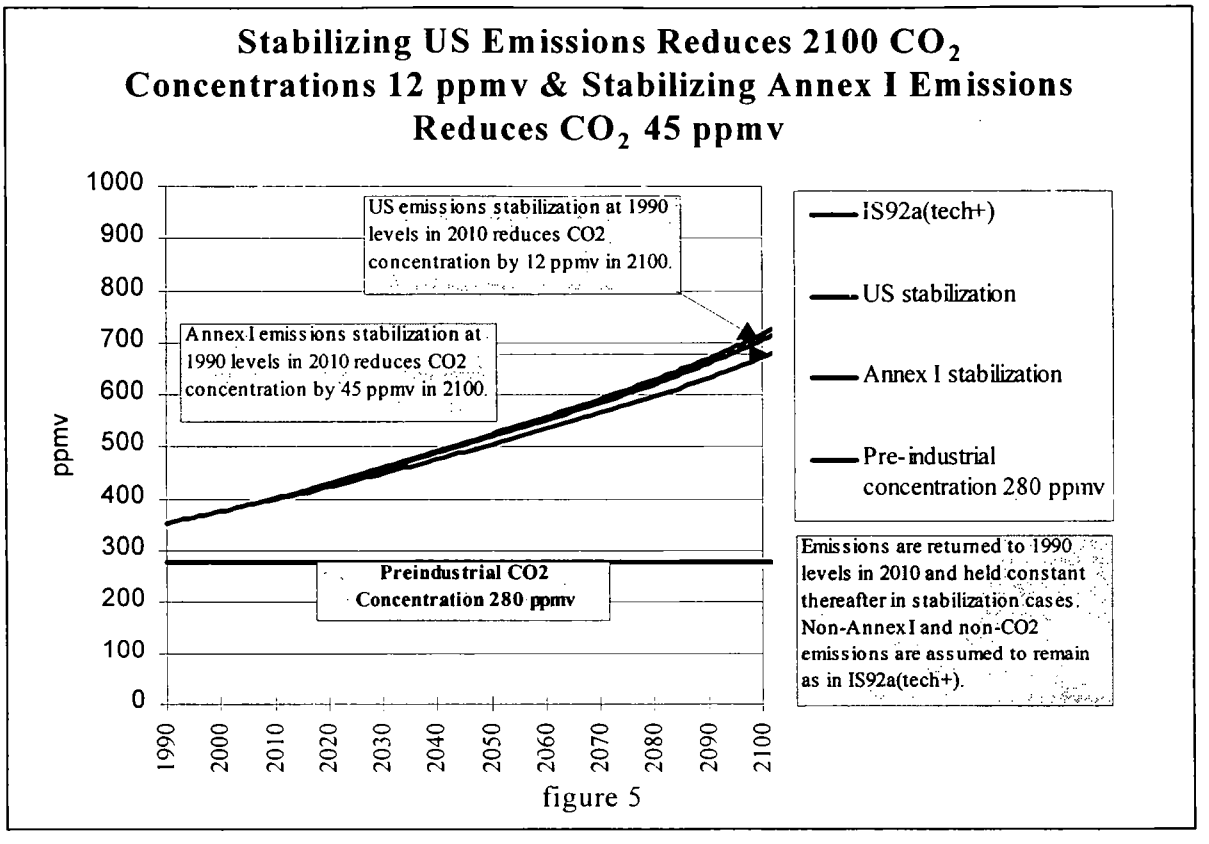


figure 5

Figure 6 illustrates two possible emissions profiles for developed countries. Both scenarios assume a freeze in emissions at 1990 levels in 2010. In one scenario emissions are then reduced by 2.5% per decade and in the second scenario they are reduced at 7.5% per decade. The figure compares these scenarios with the TECH+ scenario from the IPCC.

FIGURE 6

[see second to last page]

Figures 7 and 8 start with the developed country emission scenarios described in figure 6. These figures look at reductions that developing countries would have to take to limit global concentrations to 450 ppm, 550 ppm and 650 ppm. Figure 7 assumes that developed countries freeze emissions in 2010 at 1990 levels and then reduce emissions further at 2.5% per decade. It shows the level of allowable emissions for developing countries compared to their baseline (no action) case compared to the level of allowable emissions the goal were to stabilize atmospheric concentrations at 450, 550 and 650 ppm. This figure shows that to achieve stabilization at 550, developing countries would be able to emit on their currently projected path until about 2020 before significant reductions would be required. Figure 8 illustrates a similar case but assumes

that developed countries freeze at 2010 at 1990 emissions but then reduce at 7.5% per decade.

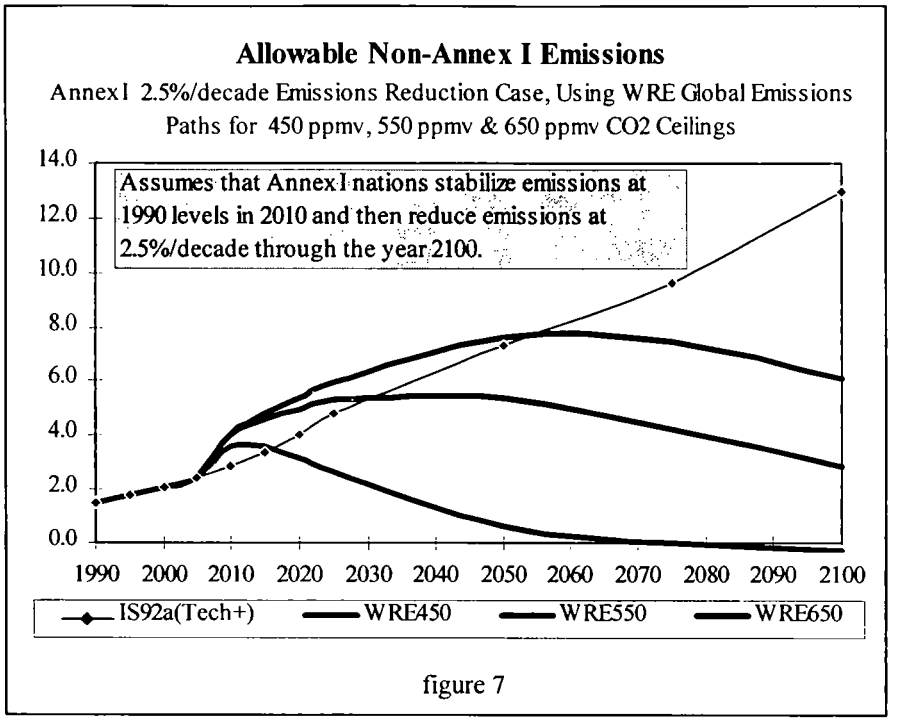


figure 7

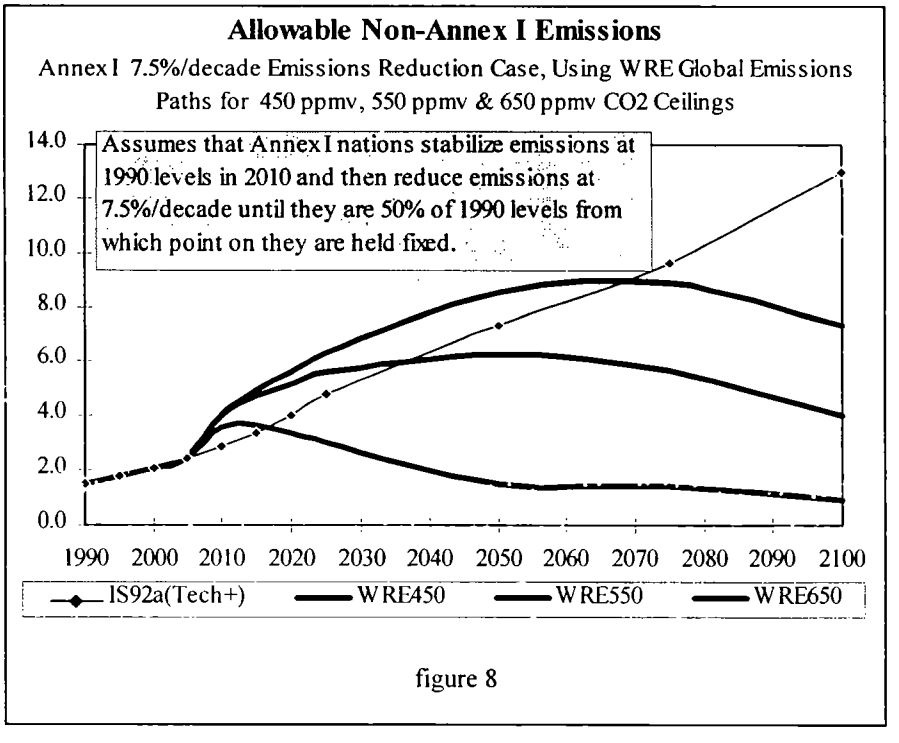


figure 8

Figure 9 shows the per capita emissions for both developed and developing countries that result from the scenarios described in the previous two figures. It shows that under these

scenarios, developed country emissions stay substantially greater than those in developing countries.

FIGURE 9

[see last page]

IV. THE ROLE OF TECHNOLOGY AND IMPACTS ON COSTS

As suggested in Figure 1, the rate of technological change can play a very important role in determining the level at which atmospheric concentrations can be stabilized. Figure 10 looks specifically at the costs associated with different technology cases. It looks at three specific cases:

-- 1990 tech: assumes no technological change from 1990

-- 1990 tech +: assumes significant improvements in reducing the costs of alternative fuels and in improving efficiency;

-- Advanced tech: assumes even further advances and cost savings.

A description of key assumptions for the latter two cases is included as Appendix 1.

Figure 10 shows for each of these technology cases, the total costs associated with achieving three different levels of atmospheric concentrations: 550, 650 and 750 ppm. The estimated costs under the assumption that no technological progress is possible were found to be about $12 trillion or 1.2% of total world GDP, compared to $1 trillion or 0.12% of GDP assuming substantial progress in reduction technologies. In the advanced technology case, which assumes very substantial non-fossil alternatives will be available by 2020, the cost virtually disappear. However, the assumed cost and performance of the alternative technologies would only become achievable with significant increases in research and development investments.

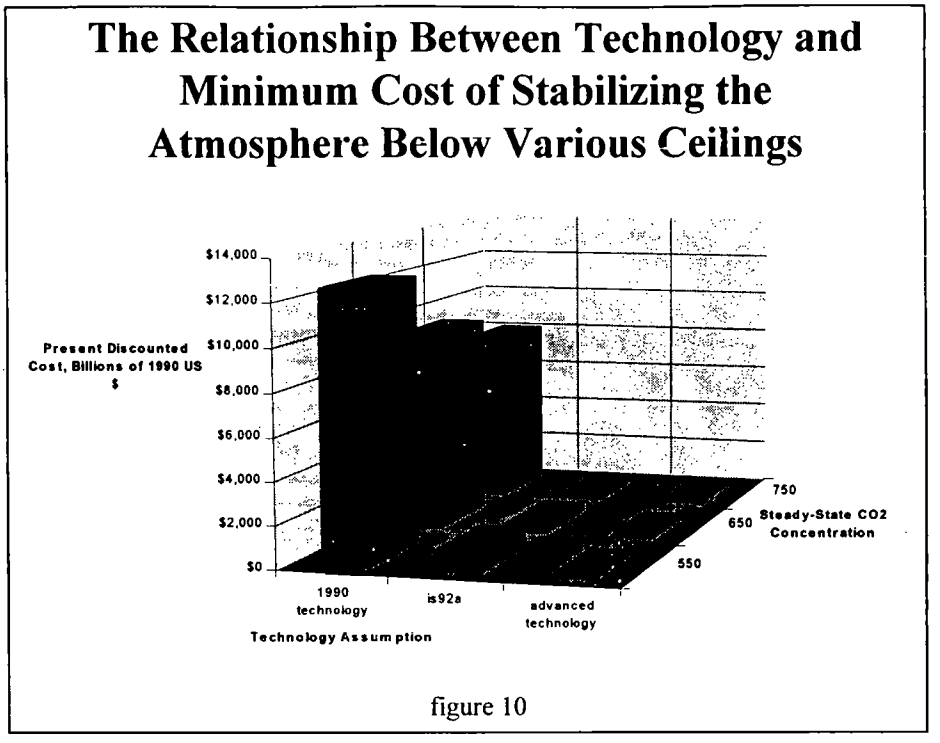


figure 10

Substantial technological progress aimed at reducing the costs of emission reductions is critical for several reasons. It would result in lower costs to the U.S. economy, both in terms of reductions made domestically and in the costs of a reductions obtained abroad through any emissions trading regime. Reducing the costs of alternatives is also critical to limiting future emissions from developing countries, particularly those with large fossil fuel reserves. Finally, expanding the technological frontier offers U.S. industry significant potential opportunities for expanding our industrial base both at home and abroad.

APPENDIX

KEY ASSUMPTIONS ABOUT TECHNOLOGY SCENARIOS:

IS92a (Tech+)

- **End-use (AEEI)** *Improves @ 1%/yr.*
- **Conventional Fossil Fuel Power Generation** *Improves @ 1%/yr.*
- **Non-Fossil Power Sources** *Improves @ 4.5%/yr, 1990 to 2025, 1.25%/yr thereafter.*
- **Biomass Energy** *Improves @ 1%/yr.*

ADVANCED ENERGY TECHNOLOGY

- **ADVANCED SOLAR/WIND/FUSION**
  - Ÿ The cost of Solar/wind power reaches a busbar cost of $0.04/kWh by 2020 and
  - Ÿ the cost decreases at 0.5 percent/year thereafter.
- **LOW COST BIOMASS**
  - Ÿ By the year 2020, 20% of the biomass resource is available at $1.40/GJ, and
  - Ÿ 80% is available at $2.40
- **ADVANCED LIQUEFIED HYDROGEN FUEL CELLS FOR TRANSPORT**

figure 6

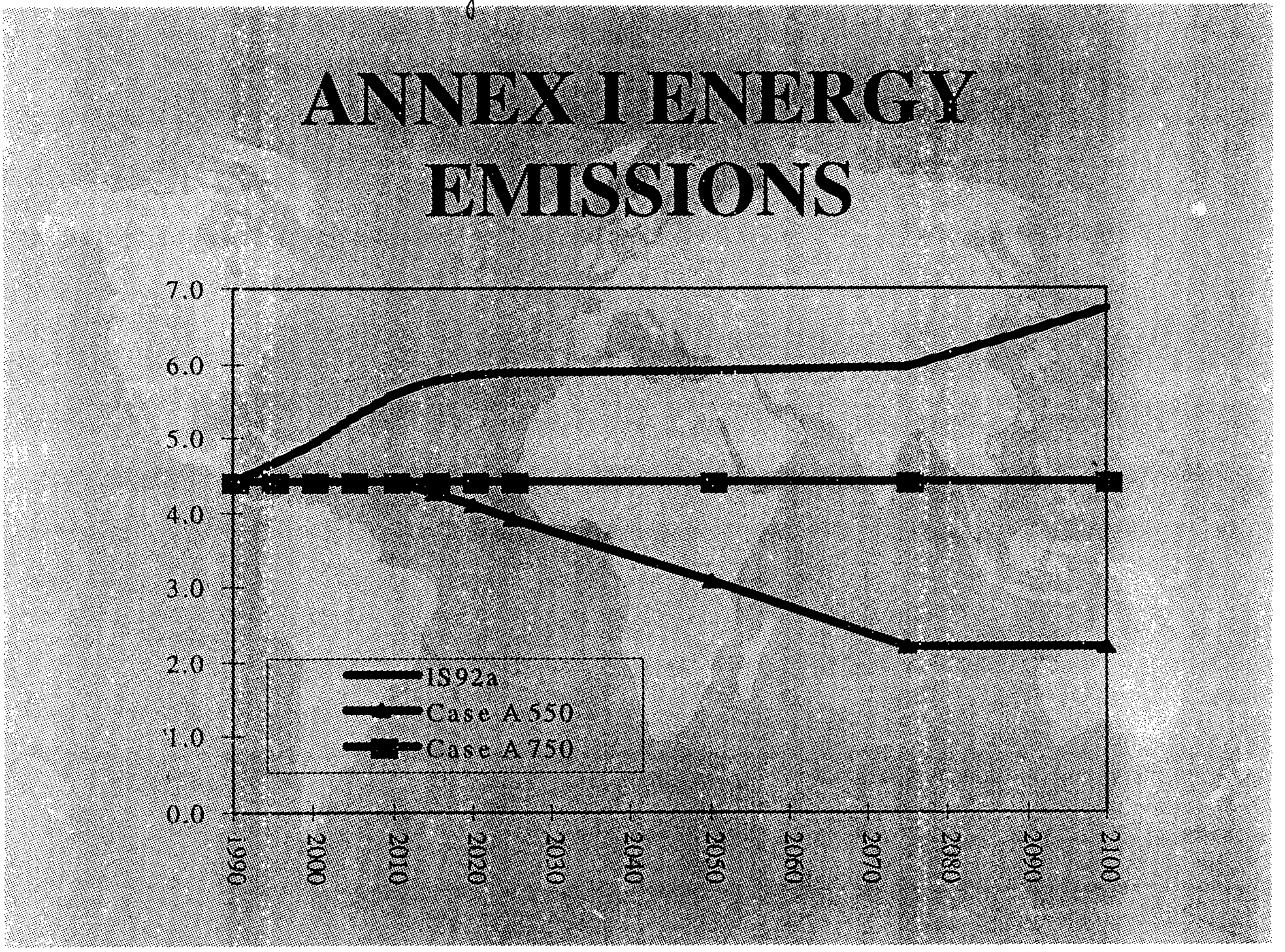
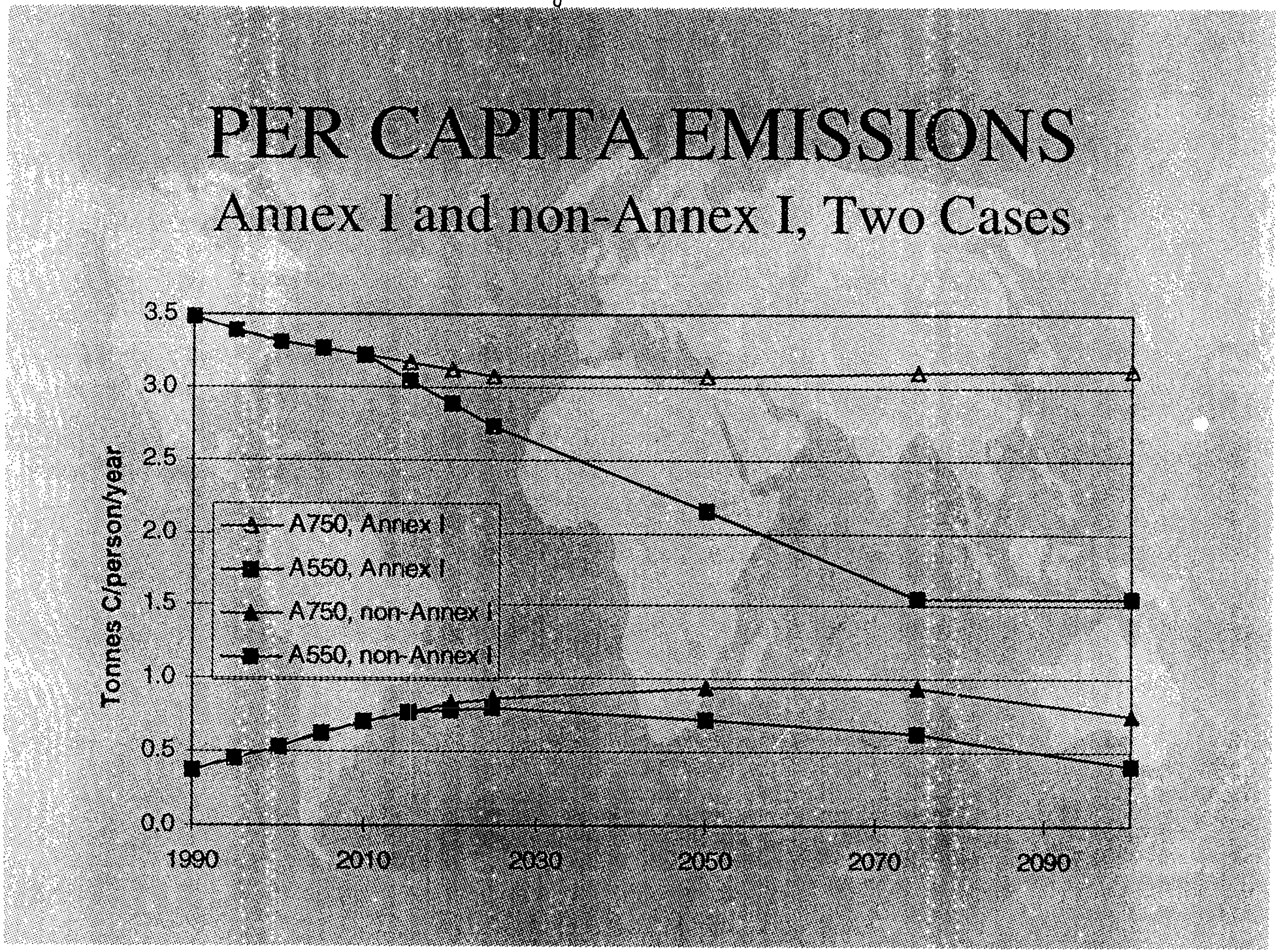

ANNEX I ENERGY EMISSIONS
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
IS92a
Case A 550
Case A 750
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100

figure 9


PER CAPITA EMISSIONS
Annex I and non-Annex I, Two Cases
Tonnes C/person/year
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1990
2010
2030
2050
2070
2090
A750, Annex I
A550, Annex I
A750, non-Annex I
A550, non-Annex I

Mon, 2/3/97, 4pm

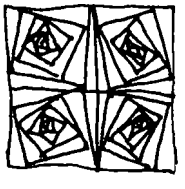
cc: JHF
JS
MM

FAX TRANSMISSION

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF POLICY, PLANNING AND EVALUATION
401 M STREET SW
WASHINGTON, DC 20460
202-260-4332
FAX: 202-260-0275

To:	Assistant Secretaries' Climate Change Group (see attached list)	**Date:**	January 30, 1997
Fax #:	See attached list	**Pages:**	19, including this cover sheet.
From:	William N. White Special Assistant to David Gardiner		
Subject:	Climate Change Mitigation Overview Paper		

COMMENTS:
Please find attached the revised version of the overview paper discussed at the last Assistant Secretaries meeting, for your review prior to the Assistant Secretaries' meeting on Monday. If you do not receive the complete fax please call me at 260-1345.

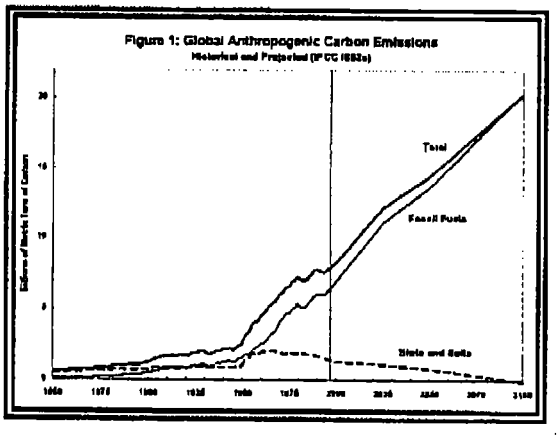


Overview of Greenhouse Gas Mitigation Options

Introduction

Over the next century, important shifts in the global economy would be required to address climate change. While many mitigation options exist, some of these policies entail costs, increases in energy prices, or have important budgetary implications. This paper presents a context for the consideration of the climate issue, lays out the broad policy options available for limiting emissions, but does not analyze the costs and benefits of particular options.

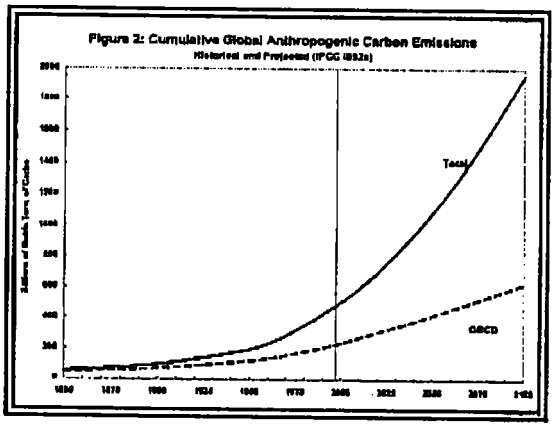
Growing emissions of greenhouse gases (GHGs) from industrial activity and land-use changes are rapidly raising the concentrations of these gases in the atmosphere, making some degree of climate change virtually certain. Although there are many sources of greenhouse gases, carbon dioxide (CO_2) from fossil fuel use is the source of greatest concern because of its rapid historical and projected growth.[1] Atmospheric carbon concentrations are already over 30% higher than their preindustrial levels and rising at about 4% per decade. The further potential for human activities to disrupt the natural balance is enormous because there are hundreds of years' worth of carbon (at current rates of use) currently available in proved fossil fuel reserves that could be exploited under current economic and technological conditions – and even larger "ultimately recoverable" reserves. In the absence of controls, emissions are projected to grow quickly as the developing countries experience rapid population growth and industrial development. These trends are expected to lead to ongoing atmospheric accumulation and climate change into the indefinite future, with a doubling of atmospheric carbon concentrations sometime during the second half of the next century and a resulting long-run increase in average global temperatures by an estimated 1.5° to



[1] In total, human activities have already resulted in roughly 250 billion tons of carbon (gigatons of carbon or GtC) emissions from fossil fuel combustion and perhaps 200 GtC from net deforestation since 1700. In terms of carbon equivalent, cumulative anthropogenic greenhouse gas emissions since the beginning of the Industrial Revolution have been roughly 570 billion metric tons of carbon equivalent (GtCe), of which about 450 GtC have been carbon. (Deforestation and other changes in land use have reduced the amount of carbon stored in biota and soils by perhaps 275 GtC, or around 10%, since the beginning of agriculture.) More than 75% of all fossil emissions in history have occurred since 1945, and 50% have occurred since 1970. About 40% of total carbon emissions have accumulated in the atmosphere, raising the stock of atmospheric carbon by nearly 30% from 280 ppm (parts per million) to over 360 ppm. Somewhat less than half of current emissions are accumulating in the atmosphere, while the rest is absorbed in natural sinks (the oceans and biosphere) through processes that are as yet only poorly understood. Although most of the increased carbon will ultimately be absorbed by the oceans, the increased atmospheric concentrations of carbon dioxide and other greenhouse gases will affect the climate for centuries to come.

4.5°C. Even stabilizing global emissions at 1990 levels *permanently* will lead to a near doubling of atmospheric carbon concentrations by the end of the next century.

Climate change is truly a global problem in the sense that emissions from anywhere will affect everyone everywhere. As a consequence, concerted international action will be needed to induce all countries to cooperate in reducing emissions. Nevertheless, cooperation will be hampered by the uneven distribution of past and future emissions. Simply put, the developed industrial nations have relatively high levels of per capita emissions and are largely responsible for past emissions, while the developing nations, whose per capita emissions are currently very low, will be responsible for the bulk of emissions in the future.[2] Since the developed countries have high levels of emissions now and have already used up a substantial portion of the overall "GHG budget," the developing countries will be reluctant to undertake any emissions reductions at all in the absence of significant emission controls on the part of the developed countries. (The issue becomes more complex when all GHG emissions and sequestration from land-use changes are taken into account, but the basic point holds.) Sharing the burden of control among countries will thus be a very serious and difficult issue.



At the same time, it is clear that actions taken by the developed countries alone are likely to have little effect on cumulative global emissions or on atmospheric concentrations. Based on the projections shown in Figures 1 and 2, stabilization of Annex I country[3] emissions at 1990 levels from 2000 through 2100 would reduce cumulative carbon emissions by around 8%, and would reduce atmospheric CO_2 concentrations in 2100 by less than 5%. In other words, Annex I emissions stabilization will still lead to well more than a doubling of atmospheric CO_2 concentrations by 2100. Even stabilizing total global emissions – which, given anticipated population growth, would require dramatic reductions in global per capita

[2] Historically, fossil carbon emissions have come mainly from the U.S. (27% of the postwar total), the rest of the OECD (22%), and the former Soviet Bloc (24%). The rest of the world, with nearly 80% of the population, is responsible for a mere 27% of cumulative emissions. On a per capita basis, U.S. emissions are over 5 tons per person per year; the industrial nations of Western Europe and Japan emit about 2 to 2.5 tons per person; and the nations of the former Soviet Bloc, whose per capita emissions used to be very high due to the inefficiencies of central planning, have fallen to about 2.5 tons per person. At the other end of the spectrum, the developing countries of the Americas, Africa and Asia have emissions on the order of 0.6 to 0.2 tons per person.

Despite their relatively low emission levels, developing countries' emissions are growing very rapidly. (Developing county emissions grew by a whopping 21% between 1990 and 1995, and global fossil fuel emissions have been roughly stable during this period only because of the 30% reduction in former Soviet Bloc emissions associated with the collapse of the centrally planned economies.) Given current projections of population growth and economic activity, developing countries' share of annual global fossil emissions should surpass that of the developed countries during the second quarter of the next century. However, their share of *cumulative* fossil emissions will remain below that of the developed countries for many years to come, as will their per capita emissions.

[3] The OECD nations plus the former Soviet Bloc.

emissions – will not lead to stabilized concentrations. *Stabilization of concentrations requires global emissions to fall well below current levels, and ultimately to decline to zero.*

Researchers have examined in some detail the emissions paths – and various distributions of emissions between developed and developing countries – required to meet atmospheric carbon concentration targets of 450 to 750 ppm, representing increases of 63% to 173%% over preindustrial concentrations.[4] All of these targets require significant reductions in global carbon emissions from the roughly 1500 MMTC projected over the period 1991 to 2100 in the absence of controls, as shown in Table 1. Furthermore, these budgets must be distributed both across countries and across time. And while there is room for increases in emissions in the near term, higher growth in emissions in the near term must be offset by increasingly dramatic reductions later on.

Table 1: Alternative Carbon Targets and Budgets

Target	Carbon Budget 1991-2100 (GtC)	Reduction from 1500 GtC
450 ppm	630 - 650	-57% to -58%
550 ppm	870 - 990	-34% to -42%
650 ppm	1030 - 1190	-21% to -31%
750 ppm	1200 - 1300	-13% to -20%

The United States is currently engaged in international negotiations concerning limits on greenhouse gas emissions with the goal of signing an agreement in Kyoto, Japan, in December, 1997. This legal instrument will prescribe the obligations of the United States and other countries with respect to greenhouse gas emissions. Among the items under negotiation are:

- the emissions budget for single or multiple years
- the additional temporal flexibility accorded to emission reduction obligations such as the banking and borrowing of reduction obligations
- the gases and sources to be included in an emissions budget and the rules for trading among them
- the extent of and rules for international trading of emission reduction obligations
- measurement, verification and compliance mechanisms to ensure countries meet their budgets
- other policies and measures

A domestic mitigation program would have to implement this agreement and be consistent with its provisions. Since many issues are currently unresolved, it is not possible at this time to precisely delineate the options for implementing a domestic greenhouse gas mitigation program. Nonetheless, it is possible to outline several general approaches for mitigating greenhouse gas emissions.

[4] The lower target would limit the projected average global temperature increase to roughly between 0.6° to 1.75°C; the higher target would limit the increase to between 1.4° to 3.5°C.

Mitigation Options

There are a number of policies and options which may be used to mitigate emissions of greenhouse gas emissions. Some options are more focused on the short term and aim to increase the rate at which existing energy efficient technologies are deployed in the marketplace. These options seek to overcome information and other market barriers to the use of these technologies. Other options seek to create new government infrastructure to internalize greenhouse gas emissions in the marketplace. Finally, no mitigation program can be fully successful without the development of new technologies that dramatically reduce greenhouse gas emissions in the long term.

Technology Diffusion

~~Market Transformation Programs~~

There is evidence that a wide range of energy saving technological options already exists, but is not being implemented. Studies by the National Academy of Sciences, the Office of Technology Assessment, and the American Council for an Energy-Efficient Economy have demonstrated that the technological potential already exists to cut energy consumption by 20% or more at a net economic benefit. Market transformation programs seek to deploy this potential.

Some of these barriers to the deployment of existing technologies are the result market failures. Markets, by themselves, will not provide information at optimal levels. This is because those providing information cannot capture all the returns to their investment. However, for energy efficient technologies to be employed, potential buyers of products need to know of the technology, as well as its performance and economic benefits. Service providers must have the expertise to appropriately design for, install, and operate the technology. In many cases, these conditions are not met.

A second market failure relates to environmental externalities. Using energy efficient equipment results in less generation of pollution. However, these pollutant reductions are not valued in the marketplace even though they result in widespread social benefits. This, in turn, results in underinvestment in energy saving technologies.

A number of successful, market transformation programs are currently underway. The Climate Change Action Plan (CCAP) programs, as well as other DOE programs, are overcoming many of the existing market failures in all sectors of the economy. Despite budget cuts, these programs are making a substantial contribution to controlling growth in greenhouse gas emissions. Examples include the ENERGY STAR consumer labeling program which allows manufacturers to label qualifying, efficient products and provides reliable information on energy consumption to consumers. The Green Lights Program is targeting the provision of energy efficient lighting in the commercial sector, while DOE's motor challenge program seeks to improve the efficiency of electric motors in industry.

The CCAP programs were designed to maximize reductions by the year 2000, a relatively short period of time to achieve fundamental market transformation. With continued support beyond the year 2000, these programs should significantly restrain growth in U.S. greenhouse gases through 2010 and beyond. Previous interagency analysis indicates that around 1/3 of total emissions growth through 2010 will be avoided by the CCAP.

There are additional barriers that the Climate Change Action Plan programs and other efforts are not yet fully addressing. Many arise from split incentive problems, which occur when the manufacturer or purchaser of a technology does not receive the energy bill savings. Others are related to the ubiquitous problems of imperfect information. Following are some example areas where further efficiency improvements can be gained through government interventions to overcome market failures:

- Should a domestic emissions trading system be created, a reserve of allowances or a portion of auction revenues could be set aside to reward new R&D investment and production of efficient equipment.

- A financial institution (along the lines of Sallie Mae) could be established to invigorate a profitable secondary market for energy efficiency financing.

- An energy performance rating system for commercial buildings could be established to provide better information to prospective buyers and energy efficiency education and/or certification for designers and contractors.

- Sector-wide compacts could be established in which entire industries could pledge improvements in energy intensity and benefit from shared information on technologies.

Standards and Regulations

Limitations on greenhouse gas emissions could also take the form of standards and regulations. Such standards could include:

- *Minimum energy efficiency standards for energy consuming equipment:* Historically, these have targeted appliances and other residential and commercial equipment, as well as personal transportation (i.e., the Corporate Average Fuel Economy (CAFE) program).
- *Other measures:* These can take many forms and could include minimum purchase requirements for renewable sources of electricity, demand side management programs (which mandate electric utilities to undertake information and energy efficiency subsidy programs), federal spending rules for transportation infrastructure, and federal procurement policies.

Standards could also be imposed directly on sources of greenhouse gas emissions. For example, a powerplant could face a limit on the amount of carbon dioxide emitted per kilowatt of electricity generated. Another example is methane from some landfills, which is already controlled due to limits on emissions of volatile organic compounds. However, such a program would probably be inferior to an emissions allowance trading program (described below).

1. Energy efficiency Standards

Appliance Standards

Standards for energy consuming equipment can expand markets for such technologies, help to reduce information barriers and can lower consumer's decision costs. Standards can also provide incentives to private research and development by reducing uncertainty in the market. U.S. homeowners spend $110 billion each year to power home appliances. These uses account for about 70% of all the primary energy consumed in homes.

During its typical 10-15 year lifetime, an appliance's operating costs may exceed its initial purchase price several times over. Nevertheless, many consumers do not consider energy efficiency when making purchases. Manufacturers are often reluctant to invest in more efficient technology that may not be accepted in the highly competitive marketplace.

Recognizing the great potential for energy savings, many states began prescribing minimum energy efficiencies for appliances. Anticipating the burden of complying with differing state standards, manufacturers supported the development of federal standards that would preempt state standards. Federal standards provide a high degree of certainty for energy savings and achieve higher penetration rates for efficiency gains than voluntary, educational or incentive programs.

In 1975, the U.S. Congress established a program of test procedures, energy conservation standards, and labeling for certain major household appliances including refrigerators, freezers, air conditioners, water heaters, furnaces, dishwashers, clothes washers, clothes dryers and kitchen ranges and ovens. A 1987 amendment, the National Appliance Energy Conservation Act, set the first national efficiency standards for these appliances and established a schedule for regular updates by DOE to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified.

The Energy Policy Act (EPACT) of 1992 expanded coverage to certain commercial and industrial equipment, including commercial heating and air-conditioning equipment, water heaters, certain incandescent and fluorescent lamps, distribution

transformers, and electric motors. EPACT also established maximum water flow-rate requirements for certain plumbing products and provided for voluntary testing and consumer information programs for office equipment, luminaires, and windows.

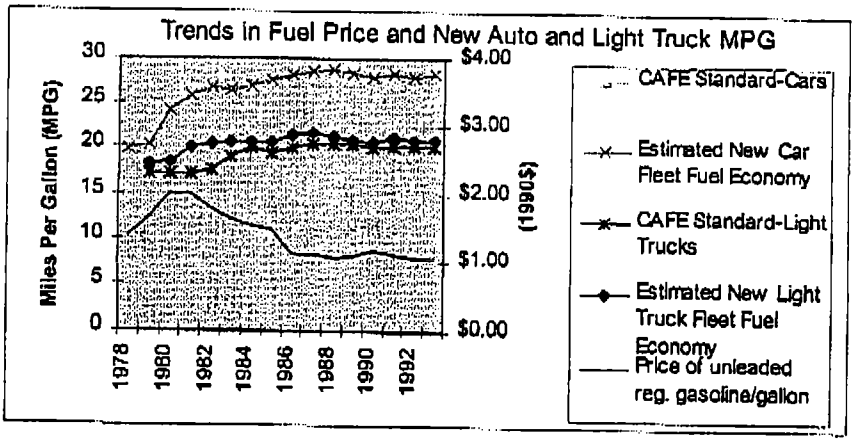
Under DOE's first rulemaking in November 1989, updated standards were set for refrigerators and freezers that went into effect January 1993. The Final Rule for energy conservation standards for clothes washers, clothes dryers, and dishwashers issued in May 1991 became effective May 14, 1994.

The initial standards included in EPCA, and those already amended by DOE, are expected to save about 23 quadrillion Btus (24.3 exajoules) of source energy from 1993 to 2015. Current appliance standards have already saved consumers $1.9 billion and will ultimately save $58 billion in energy costs over the lifetimes of units installed between 1990 and 2015.

In addition, more efficient products are more competitive internationally and have environmental benefits from reduced atmospheric emissions. The total emission reductions of federal appliance standards implemented to date are estimated to be 14.2 MMTCE in the year 2000. Further development of standards could result in additional reductions.

Personal Transportation

The Energy Policy and Conservation Act of 1975 established mandatory average fuel economy standards for new cars and light trucks starting with the 1978 model year.



The standard is calculated by each manufacturer's fleet (domestic or import) and model year. Each manufacturer's fleet average is equal to the sales-weighted fuel economy of all its new cars or light trucks of that vintage that are sold in the United States. Manufacturers that exceed the standard can carry forward credits for up to three years; manufacturers that fall short can carry backward projected future credits for up to three years. Failure to comply with CAFE requirements can result in a civil penalty. No major U.S manufacturer has ever paid a fine; only European manufacturers of luxury cars have opted to pay a fine rather than comply with the standards in a given year or take advantage of the credit system.

Opinions differ concerning the impact of CAFE on the fuel economy of the fleet of light duty vehicles on the road and its implications for future requirements. One view is that CAFE has constrained consumer choice, and has caused manufacturers to subsidize fuel efficient vehicles in order to stay in compliance. This view is supported by observations that CAFE standards have tracked new vehicle fuel economy fairly closely. During the period when CAFE standards were rising, from 1978-1985, fuel economy also rose, and during the period since 1985 both CAFE standards and on-road fuel economy have remained steady. As measured by EPA, CAFE and new vehicle fuel economy have not differed by more than a few MPG in any year since CAFE was introduced.

Others argue that rises in fuel economy in the late 70's and early 80's can be explained not by CAFE, but first and foremost by rising fuel prices and expectations about future fuel prices as a result of fuel crises in 1973-74 and 1979-80. Statistical analyses are employed to show that a combination of other factors also explain changes in fuel economy during the entire period in which CAFE has applied, including fuel prices, changes in consumer preferences for vehicle attributes other than fuel economy, and a proper accounting of the time required for manufacturers to change products in response

2. Other Measures

Standards could also be used to limit greenhouse gas emissions in other sectors of the economy. Most prominent among these are:

Electricity Restructuring: There is currently a trend among states to adopt retail competition for the electricity industry. This trend could be accelerated with federal legislation. Retail competition is expected to lower the price of electricity by as much as 20-25% in certain regions and change the fuel mix of generation. Preliminary EPA and DOE analysis indicates that utility greenhouse gas emissions could rise by as much as 2-6% as a result. To mitigate the environmental impacts of competition and maintain the environmental benefits of current state level renewable and demand side management programs, a number of options have been adopted at the state level (for states that have already adopted competition) or are under consideration for the rest of the nation. These include:

- A "portfolio standard" for renewable energy or greenhouse gas emissions: This involves requiring that all generators meet a specified level of renewable generation or greenhouse gas emission reduction either by undertaking such projects themselves or purchasing "credits" from others who have.

- A social benefit fund: Revenue is collected by placing a charge on transmission service. The funds are then used to subsidize energy efficiency projects or low income consumers. California has already adopted this approach.

- Information disclosure requirements: Generators could be required to disclose the emission profiles of their generation, facilitating the marketing of "green" electricity.

- Additional air pollutant requirements: Many states are hesitant to adopt retail competition because they perceive that differing regional environmental requirements both put their electric industry at a competitive disadvantage and will result in more pollution being transported into their states. Thus, additional environmental requirements to "level the playing field" – which could include greenhouse gas emission reductions – are currently being debated.

The Intermodal Surface Transportation Efficiency Act (ISTEA): This Act establishes the rules for federal transportation funding to the states. In 1991, ISTEA authorized $140 billion in transportation projects over a six year period. The Act expires in 1997 and Congress is now considering options for its reauthorization. These could include provisions that would indirectly reduce greenhouse gas emissions. Examples include the following:

- *Congestion Mitigation and Air Quality Improvement Program:* Additional funds could be targeted to transportation projects that reduce air emissions and energy consumption on a long-term sustainable basis.

- *Brownfields Restoration:* Successful redevelopment of browfields can help revive inner city areas and reduce sprawl, thereby reducing vehicle miles traveled. By focusing job growth in inner city areas it encourages greater reliance on more energy efficient and environmentally sound transporation modes, including transit, walking, and bicycling. More funds could be made available for these projects.

- *Incentive Funds:* Climate actions through ISTEA can produce economic efficiency and reduce emissions, while increasing mobility choice and community livability. One option would be to create a $500 million Fuel Efficiency Incentive Fund that rewards the ten states that are able to reduce fuel consumption, on a per capita basis, the greatest over the next five years.

Emissions Trading

Emissions trading is a tool for meeting a total quantity limit on emissions. It involves allocating or auctioning emissions allowances to sources, and allowing the trading of allowances in a market with sufficient mechanisms to ensure compliance with targeted levels. Emission trading systems can offer both static and dynamic efficiency advantages over more traditional forms of regulation. The potential for static efficiency gains exists because emitters face different abatement costs. Emissions trading allows those with high abatement costs to purchase allowances from those whose costs are lower. Total costs would therefore be lower than through traditional regulations which

require all polluters to comply with a specific standard. However, it should be noted that such a program involves people and firms adjusting to higher energy prices.

Dynamic efficiency gains can arise because emissions trading provides an incentive to conduct research and development in pollution abatement technologies. Under traditional regulation, firms have little incentive to investigate ways of abating pollution by more than the minimum required to comply with regulatory requirements -- even though going beyond the standards would result in additional environmental benefits. This, coupled with the inability of firms to capture all the economic benefits from R&D spending, results in under-investment in abatement technology R&D. Under emissions trading, emitters continue to face an incentive to look for further cost-effective ways of achieving emissions reductions even when they are in compliance with allowance limits. This is because any "surplus" allowances created can be sold to others in the emissions allowance market or banked to meet future reduction obligations. Emissions trading can therefore lead to a more rapid rate of development of pollution control technologies than those traditional regulatory policies that do not offer incentives to go beyond compliance. In addition, tradable permits can provide incentives for reduced total energy use. Experience in the United States has shown that final compliance costs for the programs that have incorporated emissions trading have, in general, been dramatically lower than ex ante expectations.

An emissions trading program, like any program designed to limit greenhouse gases, must contain certain elements. First and foremost, an agreed upon emissions budget must be established. A central authority must be given the responsibility for verifying compliance and must be provided sufficient information to do so. Finally, there must be real consequences for noncompliance with allowance limitations or reporting requirements, such as penalties or subtraction of allowances.

A program would have to establish permit lifetimes, monitoring and enforcement provisions, as well as rules for permit banking, borrowing, and trading. Consideration should also be given to transaction costs, which should be kept as low as possible. However, particularly difficult issues involve who is required to hold a permit and how permits should be allocated.

The decision for determining who should be required to hold a permit should consider the following:

- *Coverage:* While it may not be necessary to ensure that every ton of greenhouse gas is accounted for within an emission trading regime, the scope of coverage of the trading program should be sufficient to ensure compliance with targets set in accordance with an international agreement.
- *Administrative and Compliance feasibility:* The number of sources involved in the trading program should be small enough to be administratively feasible and large enough to ensure market competition. In addition, monitoring and verification of permit compliance must be possible for those included in the program.

- *Potential to Diffuse Low Greenhouse Gas Technologies:* Alternative points of intervention should be evaluated for their ability to provide incentives for research, development, adoption and diffusion of low greenhouse gas technologies.
- *Market Impacts:* Any program that limits emissions will affect the bottom line of firms. The permit program will have economic impacts that vary depending on program design. For example, exempting certain sizes or categories of sources from permit requirements because of administrative or equity concerns (e.g., small boilers or home heating oil) has competitive implications within the energy market.
- *Wealth transfers:* Allocating permits redistributes wealth within the economy. The amount of redistribution can be large depending on the permit price (which is determined by the emissions target and the cost of fossil fuel substitutes). While one option would be to auction permits with revenues accruing to the government, another would be to award permits to sources based on historical rates of emissions. In the latter case, wealth would be transferred to whomever is allocated permits.

In the case of carbon dioxide, direct emitters number in the hundreds of millions since they include sources such as automobiles and residential gas water heaters. However, since virtually all of the carbon contained in fossil fuel extracted from the ground (with the possible exception of certain feedstocks) is eventually released to the atmosphere, a trading program need not focus uniquely on direct emitters, but can target other points in the energy market. These include fuel extraction, processing, refining, distribution, and secondary conversion (e.g., coal to electricity). In addition, these points could vary by fuel type. For example, an emission trading program could focus on the point of final combustion for coal, but on refining for oil, or distribution for natural gas.

In an emission trading system, some mechanism must be provided for allocating permits to sources. There are a number of options available for so doing. These include allocating permits on the basis of baseline/historical emissions (where permits are given to those currently emitting) or through an auction (where revenues accrue to the government). These two mechanisms could also be combined: some portion of permits could be allocated on the basis of historical emissions while the rest are auctioned. Given that an auction could produce substantial revenues, some decision would have to be made with respect to what to do with the proceeds.

Research and Development (R&D)

Given the long term nature of the climate change problem and the long lifetimes of energy related capital stock, R&D can be an important element of a greenhouse gas mitigation program. The aim of such a program would be to lower the costs of renewable and other lower carbon energy supply technologies and increase the efficiency of energy-consuming products and equipment. Since energy supply equipment can have lifetimes of 60 years or more, having economically viable, less carbon intensive technologies in the

market place as capital stock turns over can produce long term emission reductions. This underscores the immediacy of the need for R&D.

Without government support, markets will underinvest in R&D. This is because, despite rules ensuring intellectual property rights, investors in R&D cannot capture all of the economic returns of their investments. Others benefit from learning about winning technologies without having to compensate original investors. This problem is particularly acute in the energy sector, where research has a long-term time horizon and involves a high degree of experimentation, with some options facing a real potential for failure. In addition, R&D spending on energy efficiency technologies results in widespread environmental benefits that are not captured by markets. Most industrial pollution in the United States comes from the country's seven most energy-intensive industries: steel, aluminum, petroleum refining, chemicals, pulp and paper products, glass, and metal casting. These industries account for about 80 percent of the energy consumed in U.S. manufacturing and for more than 90 percent of hazardous waste and 60 percent of air emissions produced. Existing environmental regulations provide little incentive for these industries to reduce pollution below required levels even though doing so would result in additional environmental benefits. Energy R&D thus offers the potential of preventing pollution that is not valued in the marketplace, but is valued by society.

R&D is particularly important for addressing the issue of climate change. The Framework Convention on Climate Change sets as its objective the stabilization of the concentration of greenhouse gases in the atmosphere at safe levels. No matter what concentration level turns out to be "safe", this obligation requires that anthropogenic CO2 emissions must, over the very long term, decline dramatically, perhaps to zero. Otherwise, atmospheric concentrations would continue to increase as carbon that is now stored in the ground accumulates in the atmosphere.

While replacing the present energy technology is a daunting task, it will eventually happen in any event. The supply of conventional oil and gas resources is limited, and during the first quarter of the twenty-first century most energy models suggest that the ability of the energy system to expand supply at the same pace as global demand will become increasingly difficult. This is likely to lead to higher fossil fuel prices and inaugurate another energy system transition.

Were it not for climate change, coal would play the dominant role in this transition. Coal could be used as a feedstock for synthetic liquids and gases and become an increasingly important fuel for electric power generation around the world. Roughly 1200 GtC of coal – 200 year's worth at current rates of use – are currently available from proved reserves. Given estimates of "ultimately" recoverable fossil fuel resources ranging from 5,000 to 12,000 GTC, it is apparent that uncontrolled fossil fuel use could lead to potentially disastrous levels of atmospheric CO2 and climate change. These levels compare to only about 180 GtC from manmade sources that has accumulated in the atmosphere to date.

The importance of energy technology in shaping the cost of achieving any climate goal is indisputable. Edmunds has calculated that the world-wide discounted costs of stabilizing the atmosphere at 550 ppmv by the year 2100 using 1990 energy technologies would exceed $12 trillion or more than 1.5 percent of GDP – even with maximum temporal and geographical flexibility. In contrast, an advanced technology scenario lowers costs to approximately one trillion dollars or only 0.12% of GDP.[5] Thus R&D spending has the potential to dramatically reduce control costs.

In the United States, measured in almost any way, energy R&D investment levels have declined substantially over the last decade. For example, total (public and private) United States expenditures for energy R&D declined from $5.2 billion in 1985 to $3.4 billion in 1994, a real decline of 42% (expressed in constant 1987 US dollars; Dooley 1996). Furthermore as a percent of GDP, United States investments in energy R&D have declined from 0.074% of GPD in 1985 to 0.035% of GDP in 1994 (Dooley 1996). Public spending declined 10% from 1992 to 1995.

The pattern of energy R&D expenditures could be reoriented given the concern over climate change. The International Energy Agency (IEA) has reported that over the period 1977-1990, its governments spent approximately $120 billion on energy-related R&D. Of this, almost 50% was channeled into nuclear fission research, almost 12% into nuclear fusion research, close to 15% into fossil fuel related research and 9% into general research on electricity generation. Only 5.8% was spent on research on energy conservation and 9% on renewable energy. The latter two options have a considerable potential to mitigate the risk of global warming.

In the shorter term, promising technologies to reduce greenhouse gases include:

- Biofuels: If R&D were funded at current levels for five to ten years, ethanol from fast-growing dedicated crops, crop waste, and wastepaper could be produced for as little as sixty to seventy cents a gallon by 2005. The potential for biofuels is large in the United States because of the presence of excess cropland. Bioenergy could also be derived from municipal and agricultural wastes.

- Hybrid vehicles: These operate with both an internal-combustion engine and some kind of energy-storage device, such as a battery or a flywheel. Supporting technologies include lightweight, superstrong materials and advanced engines, among other things. Current research is being undertaken by the Partnership for a New

[5] For example the efficiency of the average fossil fuel powerplant is assumed to increase at more than 1.0%/yr between 1990 and 2050, from 0.33 to 0.66. End use energy intensity declines at between 0.5%/yr (OECD nations) and 2.5%/yr (Eastern Europe and the Former Soviet Union). The cost of non-fossil fuel electric power generating technologies, other than nuclear and hydroelectric, declines at an average annual rate of 4.5%/yr between 1990 and 2025, and at 1.25%/yr from 2025 to the year 2100. And the cost of biomass energy production declines at an annual rate of one percent per year between 1990 and 2100 from 1990 values ranging from $2.50/GJ to $4.40/GJ, depending on the location and scale of production

Generation of Vehicles, a collaboration among several federal agencies, national laboratories, and the auto industry and has as its goal the development of prototype vehicles.

- Advanced batteries for use in electric cars: These include nickel metal-hydride battery—which promise to double the range achievable with existing lead-acid batteries. In conjunction with advances in clean power generation, these batteries hold the prospect of replacing imported oil with domestically produced electricity.

- Fuel cells. These are compact modular devices that generate electricity and heat with high efficiency and virtually no pollution. They run on hydrogen converted from natural gas and other fuels. The Japanese government has been increasing its fuel-cell budget by an average of 20 percent a year for the past five years, and Japanese companies are less than five years behind U.S. companies in this technology.

- Electricity from biomass and wind: R&D has the potential to bring these technologies into the current range of wholesale costs for coal and other traditional sources of electricity: three to five cents per kilowatt-hour. Gasifying biomass and using advanced turbines could bring biomass power to 4.5 cents per kilowatt-hour within a decade. according to the DOE's National Renewable Energy Laboratory. Royal Dutch Shell projects that by 2010 commercial energy from biomass could provide five percent of the world's power; using Shell's projections, the value of that power generation could exceed $20 billion.

- Photovoltaics: Photovoltaic (PV) cells, which convert sunlight into electricity, now cost one tenth what they did in 1975. In developing nations distributed sources can obviate the need for huge power lines and other costly elements of an enormous electric-power grid (much as personal computers replace large mainframe computers). PV modules sold worldwide totaled less than four megawatts in 1980 and now exceed 80 megawatts a year.

In the longer term, potential future low greenhouse gas emitting technologies include:

- Advanced liquefied hydrogen fuel cells
- Hydrogen transformation from natural gas, biomass, or electrolysis
- Non-fossil fuel electric power generating technologies including solar photovoltaic, nuclear fusion, wind, and commercial biomass energy production.
- Sink enhancement technologies such as CO2 scrubbers and deep injection.

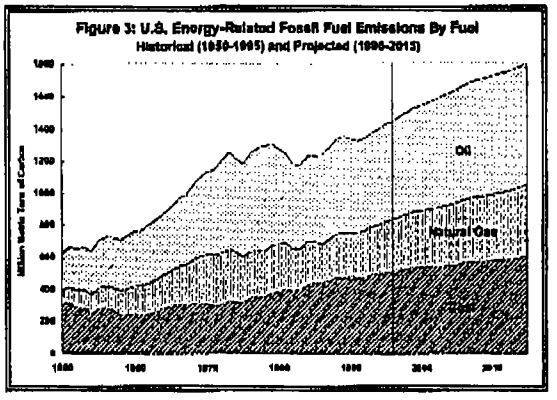
Some reorientation of, and stimulation for, *private* R&D could be expected if some of the other mitigation options described below were adopted. That is, if carbon emission or energy efficiency constraints are adopted, the market for technologies that mitigate carbon would be expanded, raising the pay-off to successful R&D in this area. This would not eliminate the need for government sponsored research, however, as the market failures described above would continue to exist.

Conclusion

A number of mitigation options exist for controlling greenhouse gas emissions. In considering which are most appropriate, it is useful to consider the time scale in which they operate. In the near term, priority could be placed on diffusing currently underutilized energy efficiency technologies. This could be best accomplished through programs to address current information and other market barriers. Both the programs of the current Climate Change Action Plan, current energy labeling programs, as well as DOE's appliance standards are targeted at this problem. In the medium term, new government infrastructure, either in the form of emissions trading or expanded regulatory programs could be put into place to limit greenhouse gas emissions. However, in the long run, it is only through the adoption of new, non-fossil technologies, that stabilization of atmospheric concentrations of greenhouse gases can be accomplished. Thus, it is important for any program to consider the incentives it provides for both private and government research and development.

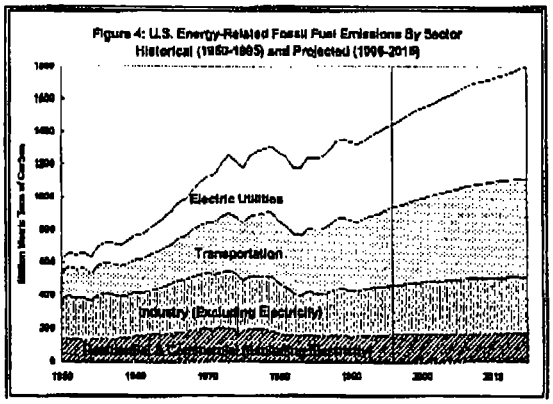
Attachment: U.S. Emission Trends

Total U.S. greenhouse gas emissions in 1995 were about 1,557 MMTCe (million metric tons of carbon equivalent), with gross emissions of 1,674 MMTCe offset by 117 MMTC of carbon sequestered by the nation's forests. *This total represents an increase of 100 MMTCe, or nearly 7%, in just five years.* Of the total, methane accounted for 176 MMTCe, mainly from landfills and agricultural activities, nitrous oxides about 40 MMTCe, and the various halocarbons 37 MMTCe. The remaining bulk of U.S. emissions were carbon emissions from fossil fuel combustion and non-fossil industrial activities.



Annual U.S. fossil-related carbon emissions have grown from around 620 MMTC (million metric tons of carbon) in 1950 to about 1430 MMTC in 1996, and are projected to rise to around 1800 MMTC over the next twenty years. Coal's share of the total has fallen from 50% in 1950 to 35% in 1996; while oil's share has risen from 36% to 42% and natural gas' share has risen from 14% to 23%. These shares are expected to remain fairly steady over the next quarter century.

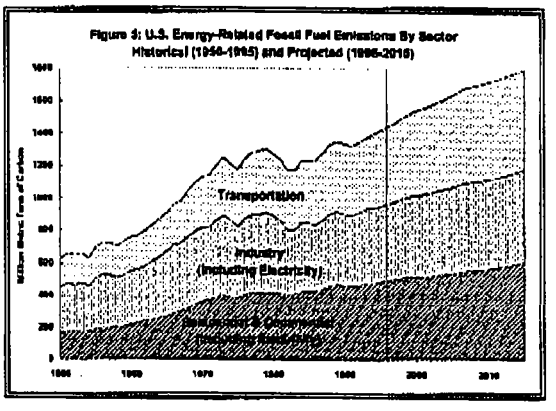
The electric utility sector's share has grown from 12% in 1950 to 35% in 1996 (500 MMTC), as the American economy has steadily increased its use of electricity. Over 85% of electric utility sector carbon emissions come from burning coal. Similarly, the transportation sector's share of fossil-related carbon emissions has grown from 28% in 1950 to 33% in 1996 (470 MMTC), with oil accounting for practically all of the fuel use in the transportation sector. Thus, the transportation and utility sectors together currently account for 68% of U.S. fossil-related carbon emissions.



In contrast, carbon emissions from the residential and commercial sectors' direct energy use have fallen from 22% of the total in 1950 to 12% in 1996; while emissions from industrial direct energy use have fallen from 38% to 20%. However, if electricity-related carbon emissions are attributed to the sectors that consume the electricity (rather than to the utility sector which produces it), the residential and commercial sectors' share has risen from 28% in 1950 to 35% in 1996. In contrast, the industrial sector's share has fallen from 44% in 1950 to

32% in 1996, as industry's share of economic activity has declined and services' share has risen.

Attributing electricity-related emissions to end-use sectors, then, 35% of carbon emissions are related to households and commercial businesses; 33% are related to transportation, and 32% are related to industry. These shares are projected to remain fairly constant over the next twenty to twenty-five years, although transportation's share of carbon emissions will increase slightly, while electricity generation will account for a slightly increasing share of primary energy consumption.



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THE ROLE OF R&D IN LIMITING GREENHOUSE GAS EMISSIONS

One of the key issues in developing a domestic climate change policy will be the emphasis placed on potentially expanding the Federal R&D effort into technologies that promise to reduce future greenhouse gas emissions and/or lower the cost of achieving a given greenhouse gas reduction target. While advances in technology clearly will play a pivotal role in long-term emission reductions, the key decisions will involve:

- the emphasis placed on medium term vs. long term emission reductions;
- the near-term budget implications of enhanced investments in technology development;
- the extent and character of private-sector participation in an expanded R&D effort;
- the relationship between R&D and near-term technology deployment efforts; and
- the role, if any, of international coordination on R&D efforts.

Achieving greenhouse gas emission reductions that would stabilize atmospheric concentrations at "safe" levels will require major advances in technology in every sector of the economy. Fortunately, many of the necessary advances are within plausible pathways of current research and development efforts. Federal R&D is already pursuing most of the important CO_2-mitigating technologies because they provide other benefits that have long been the basis of national policy, such as reducing criteria air pollutants and other environmental harms; decreasing dependence on foreign oil; increasing the competitiveness of domestic industries; and providing leadership in industries likely to achieve an international market of several hundred billion dollars per year in the next century.

Achieving these goals will nonetheless be difficult at a time of constrained federal spending and sharp reductions in long-term private sector R&D. Since 1978, federal investment in energy R&D has declined 75%. Energy R&D investment by industry fell 33% from 1983 to 1993; the electric utility and the gas industry have cut their R&D investments sharply. Industry as a whole has reduced its basic and applied research from 27% of its total R&D in 1988 to 17% in 1994. A viable R&D component of a climate strategy would entail both expanding federal resources and stimulating additional private sector R&D activity.

The need for major technology advances can be seen from the following equation:
Emissions = *Population* x *Affluence* (GDP/capita) x *Technology* (Emissions/GDP)

From 1990 to 2060, we may well see global population double and affluence increase by a factor of four. At the same time, the world may ultimately need to *lower* emissions from 1990 levels, requiring the average emissions-related technology to improve by more than a factor of ten during the next few decades and then be rapidly deployed throughout the world.

Any R&D effort is intrinsically valuable but inherently risky. We can confidently expect significant benefits (based on empirically high returns on federal, private or blended investment) as well as some unexpected benefits (e.g. much of the gas turbine technology that is today generating cleaner, low-cost electricity had its roots in government-funded work on military jet engines). However, we cannot predict ahead of time the technology "winners" from R&D. The operational risks are making premature commitments to development programs that prove to be technical or economic dead ends, such as the breeder reactor or synfuels debacles of the 1970s. At the other extreme, underfunding the most promising areas by spreading an R&D effort too thinly across a spectrum of technologies, as we did during the 1980's in energy efficiency and renewable energy R&D, misuses scarce resources while foregoing substantial progress. Lessons learned form the past two decades have shaped our current R&D strategy, which chart a sensible middle course between the two extremes.

This paper will examine the most promising R&D for mitigating CO_2, focusing on four strategic thrusts: (1) clean power generation, (2) energy efficiency, (3) carbon sequestration accompanying a transition to a hydrogen-based economy, and (4) very advanced research, such as superconductivity, nanotechnology, and photosynthetic mechanisms. Responding to the climate problem may require breakthroughs in all of these areas, and in any case the high-risk nature of R&D requires the pursuit of multiple pathways. From a technology development standpoint, successful (i.e. low-cost) climate stabilization will require:

- Accelerated diffusion of existing low-CO_2 technologies by 2010 (see "Market Transformation" paper);

- Significant penetration of new very-low-CO_2 technologies from 2010 to 2020 (the period of greatest economic concern in the current negotiations); and

- Substantial or nearly universal deployment of near-zero-CO_2 technologies in the succeeding decades (where the opportunity exists for fundamental alterations in the energy system).

Increasing the probability of achieving these desirable outcomes will require expanding the government's current R&D spending in these areas, which is roughly $1.3 billion per year. Also, partnerships with industry, "market pull" deployment initiatives, improved regulations, and other policies will be required to ensure technological success and accelerated market penetration. The benefits could be enormous, including the avoidance of the costs associated with the other approaches to CO_2 mitigation such as higher taxes and regulation. A 1997 study by Pacific Northwest Laboratory found that developing and deploying advanced technologies over the next 15 to 30 years could lower the present value cost to the global economy of stabilizing the atmosphere at 550 ppm CO_2 from one trillion dollars down to nearly zero.

CLEAN POWER GENERATION

Natural gas technologies now set the benchmark for low cost, cleaner power generation. Moreover, advances in natural gas turbines will yield overall energy conversion efficiencies of 60% or more in the next decade, doubling the efficiency of traditional coal-fired plants. Fuel cells, which generate electricity directly from hydrogen derived from fuels such as natural gas, are promising because of their high efficiency and low emissions. High temperature fuel-cells, such as molten carbonate and solid oxide, may have significant application in power generation with further R&D. Molten carbonate fuel cells are expected to reach 50-60% efficiency by 2000, and perhaps 70% by 2005.

High efficiency coal-fueled power plants, such as integrated gasification combined cycle (IGCC) are now being demonstrated at efficiencies (40 to 43%) that are competitive with more traditional coal-fired power plants but with much lower emissions, including 35-45% lower CO_2 emissions. The efficiency of the next generation IGCC plant could exceed 55%, and, in combination with a fuel cell, achieve 60% by

Given the uncertain nature of R&D, the level of funding necessary to achieve such a world cannot be known, but is likely to be considerably higher than today's investment levels, especially if the Nation seeks to maintain world leadership in these technologies. In PVs, deep R&D cuts in the 1980's have left us with only 40% of the world market. The Japanese outspend our $60 million R&D effort in PVs by more than two to one. The relatively high price for electricity in other developed nations, and the far greater financial incentives they offer industry, means alternative energy will be cost-effective in foreign countries before it is here. Our primary competitive advantage can come only from technological leadership.

ENERGY EFFICIENCY

Another key response to climate change is R&D to improve the efficiency of energy use. A major R&D effort aimed at improving energy efficiency could have a significant impact on greenhouse gas emissions. Shell's "DEMATERIALISATION" scenario imagines such a world with improvements in energy intensity reaching a sustained 2% per annum, which has been seen for only limited periods in the past, from a "New Generation Vehicle" and other relentless advances in efficient technology (see Figure 4).

The market for clean technologies could be a few hundred billion dollars per year. Figure 5 shows global CO_2 emissions through 2100 in this scenario. Again, emissions of the criteria air pollutants would show an even sharper decline. National and world dependence on Persian Gulf oil would be severely reduced. Carbon dioxide content in the atmosphere would stabilize at about 550 to 600 ppm. Three sectors are particularly important for energy efficiency gains: transportation, industry, and buildings.

TRANSPORTATION

Transportation R&D is essential because the sector uses very little electricity, so advances in clean power generation offer little hope of lowering its CO_2 emissions in the near term. Also, two other major national problems– urban air pollution and dependence on foreign oil –stem largely from the transportation sector. The current federal strategy is to develop cars and trucks that are highly fuel-efficient as well as ones that run on fuels other than petroleum, including natural gas, electricity, and biofuels (ethanol).

The partnership for a New Generation of Vehicles (PNGV) is a collaboration among federal agencies, national laboratories, and the auto industry to design and build a prototype clean car by 2004 with three times the fuel efficiency of existing cars and very low emissions, but comparable or improved performance, safety, and cost. Multiple technology paths are being pursued to build a hybrid vehicle that has both an advanced engine (such as a clean diesel, Stirling or gas turbine) and an energy storage device (such as a battery, fly-wheel or ultra capacitor). Supporting R&D includes lightweight, super-strong materials such as composites; high-temperature ceramics; regenerative breaking; and advanced power electronics.

Biofuels are one of the most attractive options for lowering transportation's CO_2 emissions. Federal R&D has brought the cost of ethanol from $3.60 per gallon in 1980 to $1.20 per gallon. With continued R&D in bio-engineered organisms and fast-growing crops, the biofuels program is expected to produce ethanol from waste paper, crop waste, and dedicated crops for under 70 cents a gallon by 2005, competitive with oil at $25 a barrel, its current price. Significant penetration of biofuels is possible in the next two decades.

Proton-exchange membrane (PEM) fuel cells have perhaps the greatest long-term potential for reducing transportation CO_2. Recently PNGV developed an on-board reformer for converting gasoline into hydrogen to run a PEM fuel cell, which would have a 50% increase in fuel efficiency over an internal combustion engine, half the CO_2, and a 99% reduction in conventional pollutants below ultra-low emission vehicle standards. A PEM fuel cell running on ethanol would have virtually no net CO_2

emission. A decade of R&D may be needed to bring costs down and integrate the fuel cell into a commercial vehicle. Maximum efficiency and emissions reductions would come from running the car on hydrogen directly, which will require even more research.

The ultimate low-CO_2 vehicles and the fuels they would use cannot be known today. To ensure that the R&D leads to commercially viable vehicles, a number of programs are needed to ensure that the infrastructure is available to support vehicles that run on non-traditional fuels.

INDUSTRY

The industrial sector consumes about one-third of the nation's energy. The seven most energy-intensive industries—steel, aluminum, petroleum refining, chemicals, pulp and paper products, glass, and metal casting—account for about 80% of the energy consumed in U.S. manufacturing and more than 90% of the hazardous waste. They represent the largest opportunity for reducing industrial CO_2 emissions.

The Department of Energy has formed partnerships with each of these industries to develop visions of energy-efficient, low-polluting, highly competitive "Industries of the Future" and then technology roadmaps to identify the best R&D opportunities. These include advanced materials development, such as ceramic composites; separation technology, such as advanced membranes; catalysis; bioprocessing, biocatalysis, and renewable feedstocks; sensors and controls; and industrial cogeneration of electricity and heat, which can achieve overall efficiencies of more than 80% and could ultimately utilize biomass.

These industries (except chemicals) significantly under invest in R&D compared to the industry averages. What R&D they have devoted to the environment has traditionally been focused on compliance- end-of-pipe treatment and control, as opposed to prevention—since that is how our regulatory system is designed. While increased R&D is needed, if Federal pollution prevention technology development is to achieve maximum industry cost-share, market penetration, and significant greenhouse gas reduction, the Administration must complete its regulatory reinvention revolution, exploring innovative approaches through Project XL, the Common Sense Initiative, and the Environmental Leadership Program.

Traditional point-source controls that address a single waste at a time and only after the waste has been

generated must be replaced by prevention-based, innovation friendly strategies. These include basing standards on desired performance, not "best available technology"; focusing on facilities, communities, and ecosystems, not the waste, the media nor the pipe; emphasizing multi-media solutions that address all wastes; emphasizing continuous improvement, not bright-line fixed compliance; expanding the use of information, measurement, and feedback, such as the Toxic Release Inventory; and wherever possibly, using fiscal tools and market mechanisms such as trading schemes and bankable emissions credits. Prevention R&D, as opposed to end-of-pipe R&D, is the key to CO_2 mitigation, and prevention-oriented regulations can help shift private-sector R&D dollars in the industrial sector to the development of low-CO_2 industrial technologies.

BUILDINGS

The buildings sector consumes one-third of the nation's energy and two-thirds of its electricity. Federal R&D into buildings technologies has been remarkably successful. Consider just five technologies developed or advanced by the national laboratories in the past two decades at a cost of roughly $40 million— building design software and advanced lighting, windows, oil burners, and refrigerator compressors. These have provided cumulative net savings of more than $15 *billion* to consumers and businesses, exceeding the $14 billion spent on *all* energy efficiency R&D since 1978. They are today providing more than 10 million metric tons of annual CO_2 savings.

Continued R&D in the buildings sector is likely to prove just as cost-effective. Key near-term technologies include improvements in lighting, superwindows, advanced design software, high-efficiency clothes washing, heat-pump water heaters, gas heat pumps, improved insulation and duct systems, more efficient cooling including gas cooling, solar heating and cooling, and day lighting. Urban heat island mitigation R&D could enable deep and highly cost-effective energy savings in air conditioning, while dramatically reducing smog formation. Relevant R&D includes developing highly reflective roofing and road materials, and modeling the impact of those materials and shade trees on buildings and cities.

Longer term R&D needs include electrochromic glazes for windows, building-integrated PV systems, and PEM fuel cells. In 2010, a building using efficient technologies with electricity and hot water provided by an 80% efficient fuel cell could have no first-cost penalty with well under half the energy of a typical

1990 building and one-tenth the CO_2 emissions.

CAPTURE AND SEQUESTRATION

In addition to the portfolio of R&D options related to less CO2 intensive technologies for energy supply and use, capture and disposal of CO2 offers an additional alternative for reducing atmospheric concentrations of CO2. If major reductions in CO2 emissions are necessary, and global reliance on fossil fuels continues beyond the middle of the next century, then some form of CO2 sequestration will almost certainly be needed as part of the CO2 solution mix. The Climate Technology Initiative, launched under the auspices of the Framework Convention on Climate Change and supported by the US, stresses the need to "assess the feasibility of developing longer term technologies to capture, remove or dispose of greenhouse gases...."

Moreover, a successful program to develop save, low cost greenhouse gas sequestration options should garner bipartisan support for progress on climate change issues by allowing for continued use of fossil fuels while minimizing the direct costs of mitigation programs. If these disposal techniques are sufficiently low in cost, they could also be a means to induce developing country participation in a climate change mitigation program, thereby overcoming another institutional barrier to implementing an effective mitigation program.

A long-term R&D strategy would include demonstration of a number of sequestration options and research into their possible environmental impacts; converting CO_2 into an industrial chemical feedstocks; other novel sequestration options, such as CO_2 fixation by micro-algae; selectively permeable membranes for CO_2 capture; processes for converting fossil fuels and biomass into CO_2 and hydrogen; development of hydrogen infrastructure technology, including transportation and storage; and PEM fuel cells.

As noted earlier, R&D into clean power generation and energy efficiency support many long-standing national goals and have been pursued for years. Carbon dioxide capture and sequestration, however, makes sense on a massive scale only in a greenhouse-gas constrained world. So, at least in this country, this area has been relatively under funded; since 1990 Japan has spent more than 30 times what we have on CO_2 capture and sequestration.

- within a zero-sum constraint toward Federal R&D resources that would necessitate reducing investments in other R&D areas, or

- expand the overall Federal R&D effort

2) Expand current partnerships with industry to focus on key CO_2 objectives through sectoral R&D initiatives in electric utilities, natural gas industry, industrial processes (e.g. Industries of the Future), transportation (e.g. PNGV), and buildings.

3) Lay the R&D foundation for longer-term radical energy system shifts, e.g. a hydrogen-based energy economy or building CO_2 sequestration technologies into the energy system.

4) Fiscal policy adjustments (not contemplated in this paper), e.g., accelerated depreciation for low-carbon technologies, tax credits for low-carbon technology development and deployment.

5) Design legislation to support CO_2 reduction goals, including reinventing environmental regulation to encourage energy efficiency investments as a key compliance strategy. Ensure that expected legislation, such as utility restructing, supports CO_2 goals.

6) Engage in internationally-coordinated R&D efforts, either under the aegis of a negotiated protocol to the Framework Convention on Climate Change or through other mechanisms.

FIGURE 4

DEMATERIALISATION

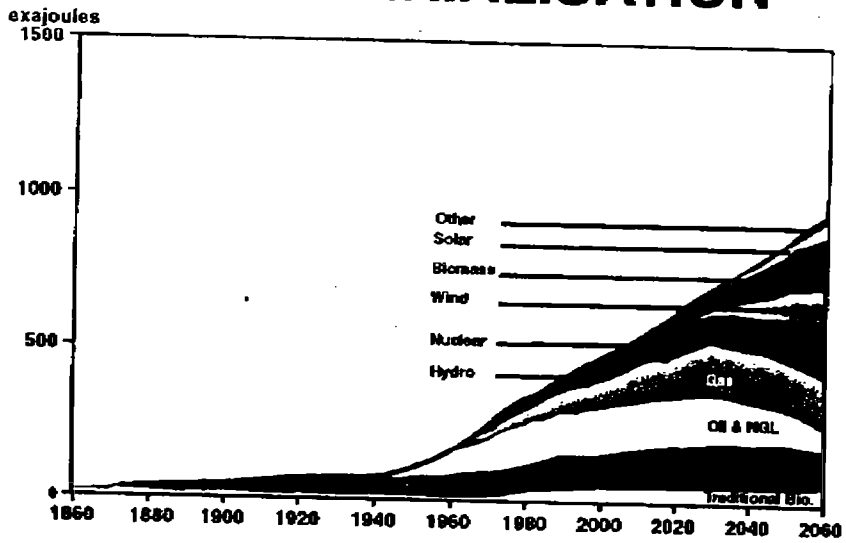
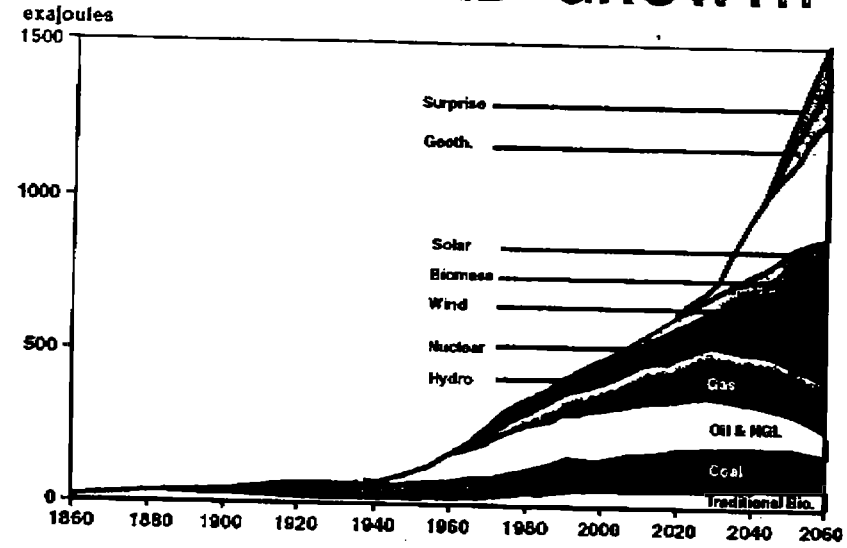


FIGURE 2

SUSTAINED GROWTH



FIGURES 3 and 5

CO2 EMISSION - FOSSIL FUELS

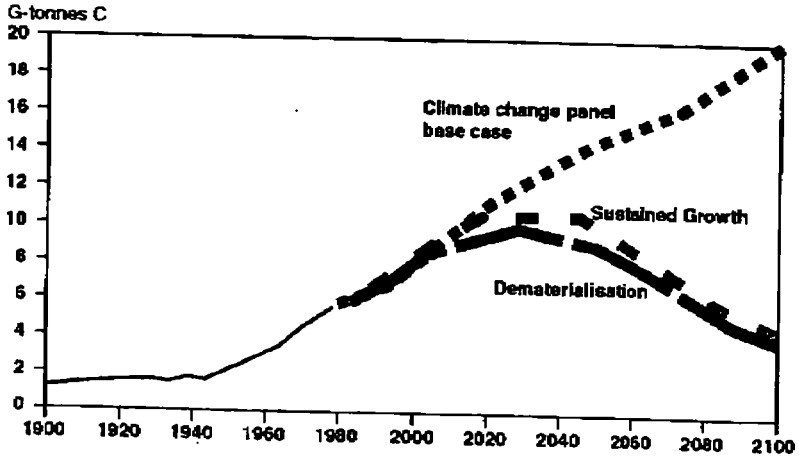
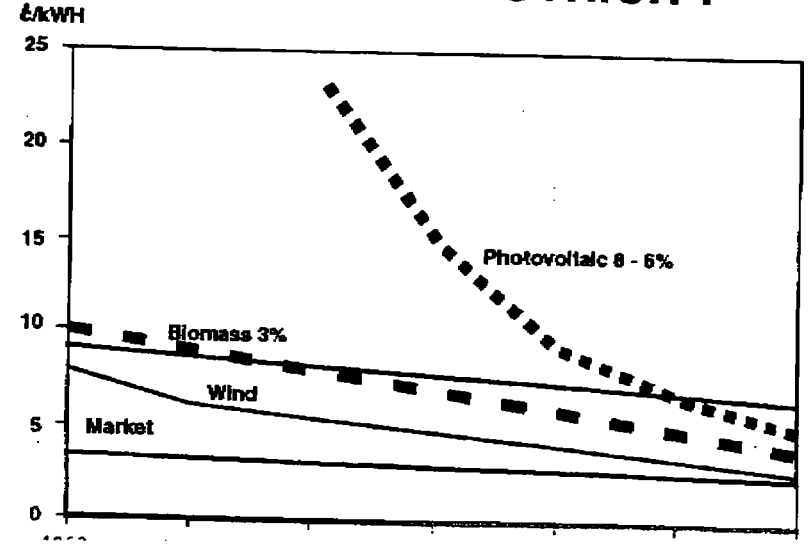


FIGURE 1

COST OF ELECTRICITY



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To: Assistant Secretaries' Climate Change group (See attached list)

Date: January 31, 1997

Fax #: See attached list

Pages: 13, including this cover sheet.

From: William N. White
Special Assistant to David Gardiner

Subject: Regulation and standards paper

COMMENTS:

Please find attached the draft paper on Regulation and Standards for discussion at the Assistant Secretaries meetings next week. Please contact me directly at 260-1345 if you do not receive the complete transmission.

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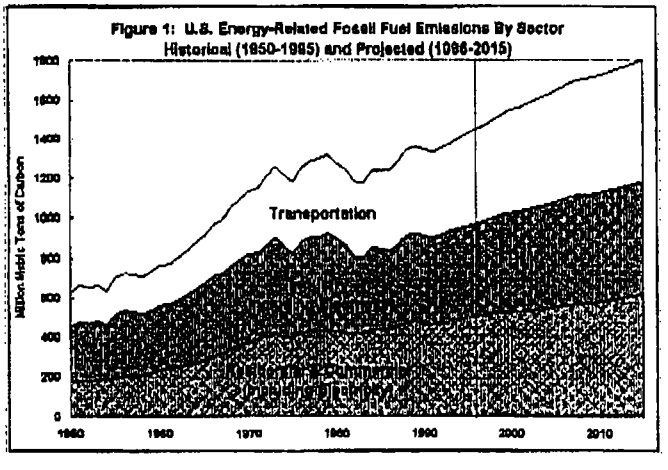
Using Standards and Regulations to Reduce Greenhouse Gas Emissions

Introduction

Limitations on greenhouse gas emissions could take the form of standards and regulations. This paper lays out the broad policy options available for limiting emissions using standards and other measures, but does not analyze the costs and benefits of particular options. Standards to limit greenhouse gas emissions could take the form of:

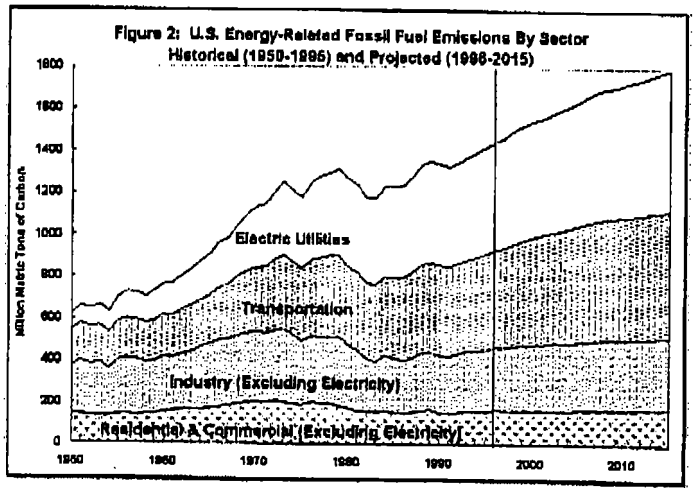
- *Minimum energy efficiency standards for energy consuming equipment:* Historically, these have targeted appliances and other residential and commercial equipment, as well as personal transportation (i.e., the Corporate Average Fuel Economy (CAFE) program).
- *Other measures:* These can take many forms and could include minimum purchase requirements for renewable sources of electricity, demand side management programs (which mandate electric utilities to undertake information and energy efficiency subsidy programs), federal spending rules for transportation infrastructure, and federal procurement policies.
- *Direct limits on greenhouse gases:* Standards could specify allowable greenhouse gas emission levels per unit of output (or some other factor). For example, a powerplant could face a limit on the amount of carbon dioxide emitted per kilowatt of electricity generated. Another example is methane from some landfills, which is already controlled due to limits on emissions of volatile organic compounds.

Within any program of standards, flexibility could be introduced by allowing those who perform better than the levels prescribed by the standards to trade their resulting "credits" with others, thereby reducing costs. Such a program could share many of the characteristics of an emissions trading program.



Figures 1 and 2 summarize sectoral CO_2 emissions (with and without emissions associated with electricity). As indicated, with respect to direct emissions, electric utilities account for about one-third of total CO_2 emissions, transportation for about one third, roughly one fifth for industry, seven percent for the residential sector, and about 4% for the

commercial sector. If electric utility emissions are attributed to final energy consumers, then industry's share rises to about one third and the residential and commercial sectors each account for 15-20% of the total.



Energy Efficiency Standards

1. Appliance Standards

Standards for energy consuming equipment can expand markets for such technologies, help to reduce information barriers and can lower consumer's decision costs. Standards can also provide incentives to private research and development by reducing uncertainty in the market. U.S. homeowners spend $110 billion each year to power home appliances. These uses account for about 70% of all the primary energy consumed in homes.

During its typical 10-15 year lifetime, an appliance's operating costs may exceed its initial purchase price several times over. Nevertheless, many consumers do not consider energy efficiency when making purchases. Manufacturers are often reluctant to invest in more efficient technology that may not be accepted in the highly competitive marketplace.

Recognizing the great potential for energy savings, many states began prescribing minimum energy efficiencies for appliances. Anticipating the burden of complying with differing state standards, manufacturers supported the development of federal standards that would preempt state standards. Federal standards provide a high degree of certainty for energy savings and achieve higher penetration rates for efficiency gains than voluntary, educational or incentive programs.

In 1975, the U.S. Congress established a program of test procedures, energy conservation standards, and labeling for certain major household appliances including refrigerators, freezers, air conditioners, water heaters, furnaces, dishwashers, clothes washers, clothes dryers and kitchen ranges and ovens. A 1987 amendment, the National Appliance Energy Conservation Act, set the first national efficiency standards for these appliances and established a schedule for regular updates by DOE to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified.

The Energy Policy Act (EPACT) of 1992 expanded coverage to certain commercial and industrial equipment, including commercial heating and air-conditioning equipment, water heaters, certain incandescent and fluorescent lamps, distribution transformers, and electric motors. EPACT also established maximum water flow-rate requirements for certain plumbing products and provided for voluntary testing and consumer information programs for office equipment, luminaires, and windows.

Under DOE's first rulemaking in November 1989, updated standards were set for refrigerators and freezers that went into effect January 1993. The Final Rule for energy conservation standards for clothes washers, clothes dryers, and dishwashers issued in May 1991 became effective May 14, 1994.

The initial standards included in EPCA, and those already amended by DOE, are expected to save about 23 quadrillion Btus (24.3 exajoules) of source energy from 1993 to 2015. Current appliance standards have already saved consumers $1.9 billion and will ultimately save $58 billion in energy costs over the lifetimes of units installed between 1990 and 2015.

In addition, more efficient products are more competitive internationally and have environmental benefits from reduced atmospheric emissions. The total emission reductions of federal appliance standards implemented to date are estimated to be 14.2 MMTCE in the year 2000. Further development of standards could result in additional reductions.

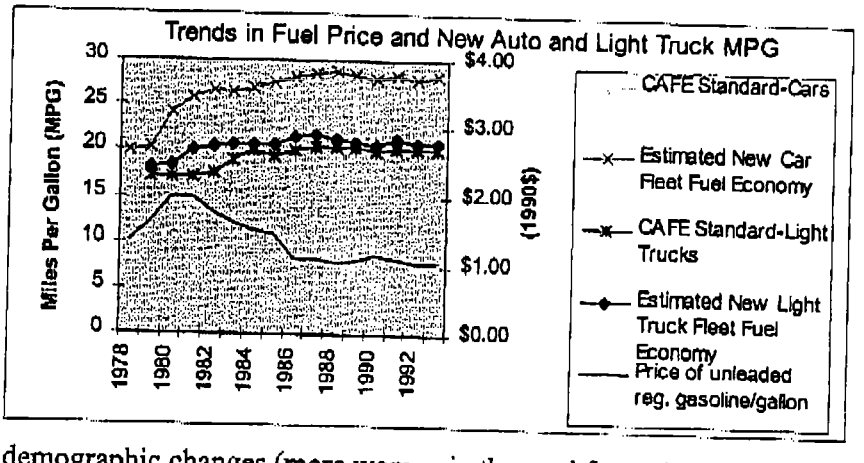
2. Personal Transportation

Consumers make choices about which type of vehicle to purchase and how much they drive their vehicles. There are many attributes that consumers may consider when purchasing a vehicle, such as: price, fuel economy, quality, safety, styling, performance, reliability, handling, comfort, options, size, etc. Fuel economy can conflict with a number of these attributes, and recent surveys confirm that fuel economy is very low on the list of attributes that consumers seek today. If the cost to society of greenhouse emissions is not reflected in the cost of owning and operating a vehicle, consumers will make inefficient choices, a classic case of market failure. One way to incorporate the external costs into the prices that consumers face is through regulation.

Such regulations already exist in the United States. The Energy Policy and Conservation Act of 1975 established mandatory average fuel economy standards for new cars and light trucks starting with the 1978 model year. The standard (currently, 27.5 mpg for cars and 20.7 mpg for light trucks) is calculated by each manufacturer's fleet (domestic or import) and model year. Each manufacturer's fleet average is equal to the sales-weighted fuel economy of all its new cars or light trucks of that vintage that are sold in the United States. Manufacturers that exceed the standard can carry forward credits for up to three years; manufacturers that fall short can carry backward projected future credits for up to three years. Failure to comply with CAFE requirements can result in a civil penalty. No major U.S manufacturer has ever paid a fine; only European manufacturers of luxury cars have opted to pay a fine rather than comply with the standards in a given year or take advantage of the credit system.

Emissions of greenhouse gases from the transportation sector account for about one-third of total U.S. GHG emissions. Transportation greenhouse gas emissions are expected to grow from about 430 million metric tons of carbon "equivalent" (MMTCe) in 1990 to 550 or more MMTCe in 2010. Passenger cars and light duty trucks (light vehicles) contribute the majority of transportation emissions. Emissions from light vehicles alone accounted for 20% of total U.S. greenhouse gas emissions in 1990, and in the absence of new policy measures are expected to rise from about 250 million metric tons of carbon equivalent (MMTCe) in 1990 to 350-400 MMTCe in 2010. All of this growth will likely be from light trucks, which are projected to account for a greater share of emissions than cars by the year 2000.

The major factors underlying the rapid growth in emissions from light vehicles are: growth in vehicle miles traveled; stagnant new fleet fuel economy levels; and growth in the relative proportion of light trucks sold, which have lower CAFE standards than cars.



Actual growth in vehicle miles traveled (VMT) since 1990 has averaged 2.4% per year. Growth in VMT is a function of a number of factors, including demographic changes (more women in the workforce; immigration), land use patterns (where people live in relation to where they work, shop, etc); the cost of driving each mile (now at an all-time low on an inflation-adjusted basis); and others.

Corporate average fuel economy of new car fleets increased steadily along with increasing CAFE standards throughout the late 1970s until the mid 1980s. Since then, new car and light truck fuel economy has been stagnant as new more efficient technologies have been applied to performance (which has increased by 60% for all light vehicles in the last 15 years) and utility rather than to fuel economy. Absent a driving force such as policy changes or fuel price increases, no significant increase in new fleet fuel economy is expected to occur. Further, because new vehicle fuel economy has been stagnant for several years, the in-use fleet of cars and light-trucks has also nearly reached a fuel economy equilibrium.

In fact, the overall in-use fuel economy of the combined new light vehicle fleet (i.e., cars and light trucks such as minivans, sport utility vehicles, and pickup trucks) has already begun to *decline*. Each year, about 15 million light vehicles are sold in the United States. In the past 15 years, sales of light trucks have skyrocketed. They have gone from under 25% of the market in 1982 to almost 45% today. A key reason that this shift is important in terms of GHG emissions is that light trucks face lower CAFE standards than cars (almost 7 mpg lower). Moreover, since light trucks tend to last longer than cars, they are likely to be driven more miles over their lifetime than cars.

In 1994, President Clinton convened a Federal Advisory Committee Policy Dialogue to assist in the development of measures to significantly reduce greenhouse gas emissions from personal motor vehicles ("CarTalk"). Although CarTalk ended without consensus among all members of the Committee, the process did result in a number of analyses and proposed policy options. These are summarized in the attachment.

Other Mandates

Standards could also be used to limit greenhouse gas emissions in other sectors of the economy. Most prominent among these are:

Electricity Restructuring: There is currently a trend among states to adopt retail competition for the electricity industry. This trend could be accelerated with federal legislation. Retail competition is expected to lower the price of electricity by as much as 20-25% in certain regions and change the fuel mix of generation. Preliminary EPA and DOE analysis indicates that utility greenhouse gas emissions could rise by as much as 2-6% as a result. To mitigate the environmental impacts of competition and maintain the environmental benefits of current state level renewable and demand side management programs, a number of options have been adopted at the state level (for states that have already adopted competition) or are under consideration for the rest of the nation. These include:

- A "portfolio standard" for renewable energy or greenhouse gas emissions: This involves requiring that all generators meet a specified level of renewable generation

or greenhouse gas emission reduction either by undertaking such projects themselves or purchasing "credits" from others who have.

- A social benefit fund: Revenue is collected by placing a charge on transmission service. The funds are then used to subsidize energy efficiency projects or low income consumers. California has already adopted this approach.

- Information disclosure requirements: Generators could be required to disclose the emission profiles of their generation, facilitating the marketing of "green" electricity.

- Additional air pollutant requirements: Many states are hesitant to adopt retail competition because they perceive that differing regional environmental requirements both put their electric industry at a competitive disadvantage and will result in more pollution being transported into their states. Thus, additional environmental requirements to "level the playing field" – which could include greenhouse gas emission reductions – are currently being debated.

The Intermodal Surface Transportation Efficiency Act (ISTEA): This Act establishes the rules for federal transportation funding to the states. In 1991, ISTEA authorized $140 billion in transportation projects over a six year period. The Act expires in 1997 and Congress is now considering options for its reauthorization. These could include provisions that would indirectly reduce greenhouse gas emissions. Examples include the following:

- *Congestion Mitigation and Air Quality Improvement Program:* Additional funds could be targeted to transportation projects that reduce air emissions and energy consumption on a long-term sustainable basis.

- *Brownfields Restoration:* Successful redevelopment of browfields can help revive inner city areas and reduce sprawl, thereby reducing vehicle miles traveled. By focusing job growth in inner city areas it encourages greater reliance on more energy efficient and environmentally sound transporation modes, including transit, walking, and bicycling. More funds could be made available for these projects.

- *Incentive Funds:* Climate actions through ISTEA can produce economic efficiency and reduce emissions, while increasing mobility choice and community livability. One option would be to create a $500 million Fuel Efficiency Incentive Fund that rewards the ten states that are able to reduce fuel consumption, on a per capita basis, the greatest over the next five years.

A Program of Standards on Direct Emissions

This system would establish a set of greenhouse gas performance standards for sources of emissions. Flexibility could be introduced by allowing the trading of emission

reduction "credits" when sources perform superior to specified levels. A source could thus comply with the performance standard either through its own control efforts, or by purchasing credits from other sources.

For such a system to work, a performance standard would be established for each sector covered under the program. For example, for coal fired electric boilers, a limit could be placed on the amount of carbon per Btu of energy combusted. Sources surpassing that limit would earn "credits" that would be tradable. The amount of tradable credit would be based on the source's past production rate.

The performance standards themselves would be "rate based." That is, they would establish allowable emissions per unit of production, but not set total output limits. The total amount of tradable credit available to a source would be the product of the amount by which the source is surpassing the rate-based standard and its historical production levels.

Likely candidates to include in such a program include:

- Manufacturers of energy-using equipment for which an efficiency standard can be set. For example, residential, commercial, and industrial equipment (refrigerators, furnaces, ranges, HVAC equipment, motors, and lighting) could be included.
- Transportation equipment manufacturers, including passenger vehicles, light and heavy duty trucks, commercial transport equipment (planes, trains), and off-road equipment (e.g., tractors, farm equipment) and small engines (e.g., mowers).
- The many sources of non-CO_2 emissions (such as coal mine methane, agricultural sources of emissions, and halogenated substances). A credit program is also well suited to "opt-in" smaller sources which are not included under the regulator requirements due to administrative and monitoring considerations, but have the potential to reduce emissions at low costs.
- Electric utilities and heavy industry
- Petroleum refiners

Under a program of this type, the set of performance standards for all sectors must be consistent with the national target. Since total CO_2 emissions are not directly limited, such compliance would have to be projected based on an analysis of the performance standards.

Trading Credits and Determining Compliance

Credits could be traded bilaterally between the source who creates the credit and the source whose performance (i.e., emissions) exceed the regulatory standard. Alternatively, brokers and central exchanges could also be a mechanism for trades.

The authenticity of the credit generating reductions must be approved by the regulating authority at some point. For some sectors, credits could be certified for one year only. For example, a utility emitting under its limit in a year would generate credits equal to the reductions in that year only. These may be sold in that year or banked for the utilities or use or future sale.

For other sectors, annual certification would not be feasible. For equipment manufacturers, credits would be granted for each piece of equipment sold with performance better than the standard. Credits would equal the emissions associated with this improvement for the life of the equipment. It would not be feasible to track each piece of equipment that is produced to ensure its continued operation and performance. Therefore, lifetimes, usage, and degradation assumptions would need to be stipulated.

Conclusion

There is a long history of government using standards and regulations to address market failures relating to environmental externalities, the provision of information, and energy security. In addition, the role of government in the provision of transportation infrastructure and the regulation of natural monopolies is large. Consequently, the number of actions could be taken to mitigate emissions of greenhouse gases is large. These range from direct limits on emissions, to changes in government policies that indirectly affect the demand for energy. Given this wide array, choices must be made that consider both the costs that such interventions may impose and the resulting reductions in greenhouse gas emissions.

Attachment: Summary of the "Car Talk" Process

In 1994, President Clinton convened a Federal Advisory Committee Policy Dialogue to assist in the development of measures to significantly reduce greenhouse gas emissions from personal motor vehicles ("CarTalk"). Although CarTalk ended without consensus among all members of the Committee, the process did result in a number of analyses and proposed policy options. In 1995, several members of the CarTalk Committee published a "Majority Report" that contains a package of recommendations to return greenhouse gas emissions from light vehicles to their 1990 levels in each of three target years: 2005, 2015, and 2025. Their recommendations include a mix of regulatory and other options in three key areas (fuel economy, alternative fuels, and VMT) that are designed to work together to achieve the objective. Separately, other members of the Committee issued a "Report Acceptable to Auto Industry Members" that includes a different set of options to achieve the same objective.

There are essentially three ways to reduce carbon emissions from light vehicles: improve fuel economy; use fuels with lower life-cycle carbon emissions; or reduce miles driven. The regulatory options considered by the Committee and recommended in the *Majority Report* or the *Report Acceptable to Auto Industry Members* are described below. As both reports point out, it is important to keep in mind that there is no "silver bullet" for reducing greenhouse gas emissions from light vehicles. Instead, a package of options designed to complement each other is likely to be the most effective in reducing emissions.

Fuel Economy Measures

The regulatory approach recommended in the CarTalk *Majority Report* calls for increased CAFE standards, combined with feebates. Taken together, these measures were estimated to reduce emissions by 39 MMTCe in 2005, 121 MMTCe in 2015, and 179 MMTCe in 2025.

Increase CAFE: The Committee estimated that a 1.5 mpg per year increase in the CAFE standards (average for combined car and light truck fleet), beginning in 1998, would reduce emissions by 36 MMTCe in 2005. This corresponds to 45 mpg for new cars and 34 mpg for new light trucks in 2007; a 1.0 mpg per year increase would reduce emissions by 117 MMTCe in 2015.

Introduce feebates for fuel economy: A feebate structure for fuel economy would require rebates proportional to the extent to which a vehicle's fuel consumption is lower than average and would assess fees to the extent to which fuel consumption is higher than average. Since carbon emissions are inversely proportional to fuel economy, feebates could also be based on relative carbon emissions per mile. The *Majority Report* also discusses introduction of feebates for after-market low rolling resistance tires. Tire

feebates would provide a rebate for purchase of tires that have rolling resistance below a set point, and fees for rolling resistance levels above the set point.

Alternative Fuels Measures

Provide subsidies and tax incentives for low GHG alternative fuels: The Committee recommended subsidies and tax incentives for natural gas vehicles and infrastructure, electric vehicles, and other potentially low GHG emitting fuels. The lowest GHG fuels are those which are produced from biomass feedstocks, with very few fossil fuel inputs. One example is production incentives to producers of alternative fuels in proportion to life-cycle greenhouse gas emissions. The CarTalk *Majority Report* estimates that subsidies and tax incentives, plus a research and development investment to encourage commercialization of electric vehicles, natural gas vehicles, and other alternatively-fueled vehicles could reduce emissions by 6.6 MMTCe in 2005, 48 MMTCe in 2015, and 117.6 MMTCe in 2025.

VMT Measures

The *Majority Report* recommends a package of measures to reduce the number of vehicle miles driven each year. Taken together, these measures are estimated to reduce emissions by 41 MMTCe in 2005, 56 MMTCe in 2015, and 75 MMTCe in 2025.

Encouraging equitable shift of state and local road subsidies to cost-of-driving (VMT fees): Money spent by federal, state, and local governments to build and maintain roads far outweighs money collected through gas taxes and tolls. The *Majority Report* states that a VMT fee could shift the costs of road building and maintenance which road users do not now directly cover. Such a fee could be designed to be revenue neutral.

Encouraging land use changes away from auto dependency: The *Majority Report* recommended a package of options for increasing density in urban areas, thereby reducing VMT. Examples include financing programs and policies to require government facilities to be located in areas accessible to public transit. Also recommended is funding through ISTEA for programs to guide development planning and for development of bicycle and pedestrian infrastructure.

Reforming workplace parking subsidy programs: Currently, employees do not have to pay taxes on parking benefits of up to $160 per month. Employer-provided transit benefits are tax-exempt only up to $60 per month, and no tax-exempt benefit is available for those who walk or bike to work, or rideshare. The *Majority Report* called for substantial reform of the workplace parking subsidy by equalizing the federal tax benefit for any commuting mode and making the benefit contingent on an employers' offering a taxable cash allowance instead of the benefit.

The *Report Acceptable to Auto Industry Members* called for many of the same measures outlined above, with very important exceptions. This report does not include increased CAFE or feebates, but does recommend either a gasoline tax or VMT fee, and additional research and development funding.

Gasoline Tax: The *Report Acceptable to Auto Industry Members* states that increasing the variable cost of driving will provide an appropriate and effective incentive for Americans to drive less, use less fuel, and produce less CO2, and for improvements in fuel economy. The revenues could be returned to the public or costs could be shifted so that total driving costs do not increase but rather the proportion of driving costs that motorists perceive to vary with number of miles driven. The *Report Acceptable to Auto Industry Members* estimates reductions from a gasoline tax increase of 4 cents per mile per year (above inflation) at 54 MMTCe in 2005, 119 MMTCe in 2015, and 202 MMTCe in 2025.

MCM, 2/3/97, 4pm

cc: JAF
SS
MM

Fax Cover Sheet

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Please Deliver to:

Alicia Munnell/Jeff Frankel

Fax #: 395-6958
Company: CEA

From:

JEREMY SYMONS

Phone:

Pages: 9

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Message:

Attached is the revised version of the Market Transformation Paper, for your review prior to the Assistant Secretaries' meeting on Monday.

Jeremy Symons
EPA, Office of Atmospheric Programs
202-233-9301

Role of Technology and Market Transformation in a National Policy to Limit Greenhouse Gas Emissions

Energy-efficient technologies provide a sizable opportunity to limit emissions of greenhouse gases while simultaneously enhancing economic productivity. However, to capitalize on this opportunity, the U.S. needs to overcome market barriers that have directed the country along a less-than-optimal energy efficiency path to date. This paper discusses the need to support current market transformation programs in order to capture the economic benefits of increased energy efficiency. This paper also discusses the potential for additional initiatives to provide further efficiency and economic improvement.

Market transformation policies would be a cornerstone of a national policy to limit greenhouse gas emissions, and would be complementary to other policies designed to implement whatever targets and timetables (emissions budgets) the U.S. adopts under the climate change negotiations. Some energy efficiency improvement would result from a clear policy signal on climate change and energy.[1] However, even highly efficient forms of regulation, such as cap and trade, do not address underlying market barriers that would restrain the energy-efficiency response to these policies. Failure to fix these barriers would result in a higher cost of the national policy than is necessary.

Policies that can unleash more of the potential of energy-efficient technologies are important because they allow a smoother and less costly transition to meeting a carbon constraint. In addition, greater energy efficiency will enhance the economy by generating productivity investments. Paying energy bills is a relatively less productive use of consumer and business resources than the many other investments and spending choices that consumers and businesses have available to them.[2] Shifting capital from wasted energy expenditures to new investments will therefore help drive economic growth, employment and consumer income. Further improvements in productivity and competitiveness can occur due to the substantial ancillary benefits of advanced technologies and processes in the industrial sector.[3] Several major studies support the economic value of improved energy efficiency:

- Most recently, the Energy Information Administration released an energy efficiency report based on the *Annual Energy Outlook 1996.* The study suggests that a reduction in U.S. energy consumption of 12 percent (by the year 2015) would increase GDP by 0.5 percent.

- Additional studies by the National Academy of Sciences, the Office of Technology Assessment, and the American Council for an Energy-Efficient Economy (jointly with the Union of Concerned Scientists and others) have all demonstrated that the technological potential exists to cut energy consumption by 20% or more at a net economic benefit.[4]

However, there is clear evidence that this potential is not being realized in the current market system because of a number of institutional, organizational, and other barriers that work against the diffusion of existing, energy-efficient technologies and the development of advanced technologies. Many cost-effective, energy-efficient technologies have relatively small market shares and low rates of technology diffusion. There is a sizable remaining potential, or "efficiency gap."

Market Barriers Constrain the Markets for Energy-Efficient Technologies

The existence or availability of a financially attractive technology does not by itself mean the technology will be purchased and used in sizable quantities. For high rates of market penetration, a number of other key factors have to be in place:

- Potential buyers of products need to know of the technology;
- Potential buyers of products need clear, reliable information on the performance and economic benefits of the technology;
- Potential buyers must be the ones to see the benefits of lower energy bills; and
- Service providers and users of the technologies must have expertise to appropriately design for, install, and operate the technology.

In many cases, these factors are not in place due to a wide variety of market barriers. For example, the attached table provides a list of market barriers in the buildings sector.

These barriers result in consumers and businesses ignoring otherwise cost-effective investments in energy-efficient technologies. Consequently, many cost-effective, energy-efficient technologies have relatively small market shares and low rates of technology diffusion. There is a sizable remaining potential, or "efficiency gap." For example, fluorescent lighting ballasts were found in almost every commercial building in 1989. Energy-efficient ballasts had been on the market for many years, were based on well-known, proven technology, delivered equivalent performance to its inefficient counterpart, and had a longer lifetime. Although purchases of efficient magnetic ballasts in 1989 represented investments with IRRs of 60% or greater, only about 12 percent of the market had found the technology and about 24 percent of the market was purchasing the technology due to state standards. The remaining 64 percent of the market was purchasing less efficient technologies and committing themselves to much higher operating expenses over the life of the ballast. This remaining 64% represented a large efficiency gap for building lighting.

The benefits of removing the barriers to the penetration of products such as efficient ballasts extend beyond their direct energy and cost savings. There is a substantial ripple effect that further increases the potential for energy-efficient technologies. First, overcoming barriers to diffusion of today's technologies improves the manufacturers' incentives to invest in R&D needed for the next generation of technologies. This leads to new technologies that expand the potential for future energy savings. Second, as sales and production experience increases for efficient technologies, both the fixed and variable costs of production generally fall, reducing the cost of the technology to the end-user. This "learning by doing" increases the cost-effectiveness of energy-efficient technologies and expands the potential for greenhouse gas reductions.

Current Programs Are Overcoming Many Barriers to Energy Efficiency

A number of market transformation programs are currently underway. The Administration's Climate Change Action Plan (CCAP) launched over 40 initiatives in 1993. Building on other DOE and EPA programs, the CCAP's goal was to return U.S. greenhouse gas emissions to 1990 levels by the year 2000. Despite large funding cuts, the CCAP programs are successfully overcoming market barriers and are currently expected to deliver approximately 3/4 of the emissions reductions originally projected in the CCAP. With continued support beyond the year 2000, these programs will significantly restrain growth in U.S. greenhouse gases through 2010 and beyond. Current Administration projections indicate that around 1/3 of total emissions growth through 2010 will be avoided by the CCAP programs.

For example, DOE's Rebuild America program and EPA's Green Lights and ENERGY STAR® Buildings programs are demonstrating that many of the barriers in the commercial buildings sector can be overcome. These programs have formed over 2500 partnerships to improve energy efficiency in buildings by up to 40% through technology investments with annual rates of return of 20-50%. Program partners saved over $250 million on their energy bills in 1996. Because the rates of return are so high, they offer increased yields to businesses over typical investment opportunities, spurring new investment, economic growth, increased federal tax revenues, and new jobs.

Additional programs are working successfully in other energy markets. For example, through EPA and DOE's ENERGY STAR® Consumer Labeling program, barriers that consumers have faced are being removed. These efforts ask manufacturers to label their more efficient products as consumers are provided with information on these products' environmental and economic benefits. Through 1996, this program has seen thousands of products labeled and billions of dollars invested in ENERGY STAR® products. Consumers saved approximately $500 million on their energy bills in 1996.

From a federal government budget perspective, market transformation programs are a cost-effective means of achieving change through government intervention. For every dollar spent on the programs by the government, approximately $40 of private investment in better technologies is leveraged, leading to energy cost savings of approximately $100.[5] Total expenditures on CCAP programs in 1997 is $183 million.

Areas of Opportunity to Boost Economic Growth While Reducing Greenhouse Gas Emissions

A successful strategy to reduce greenhouse gas emissions while improving the economy would include:

(1) Restored full funding of CCAP programs, with a sustained commitment to these programs beyond the year 2000.

(2) New initiatives to overcome additional market barriers throughout the economy.

Because the CCAP's focus on the year 2000 limited the options that were implemented, a longer term goal would provide significant new opportunities to overcome remaining market barriers. Some of these areas of opportunity are discussed below. An interagency effort is underway to assess potential initiatives to address these opportunities and to develop a national market transformation plan that effectively narrows the efficiency gap by 2010 and beyond. Example approaches mentioned below are illustrative of the types of initiatives that may be included in a final plan.

Opportunities in the Commercial and Residential Sectors

The commercial and residential sectors are the focus of several successful CCAP programs, such as the ENERGY STAR consumer labeling programs, the Rebuild America program, and the Green Lights and ENERGY STAR Buildings programs. These programs overcome important informational and other barriers. There remain opportunities to overcome additional market barriers and achieve greater efficiency. For example:

Builder/Buyer Split Incentives -- Key decisions on building specifications and equipment replacement are often left to builders and architects who do not pay the energy bills and have little or no incentive to choose and apply proven, state-of-the-art technologies and designs. Builders and architects as well as building owners have expressed a desire for a means of providing reliable and impartial energy performance information for commercial buildings. This would allow building purchasers to make informed decisions and demand good energy performance. CCAP programs in this sector have built the reputations and developed the technical expertise that would be needed to address this barrier.

Landlord/Tenant Split Incentives -- In landlord-tenant arrangements, the building owner often makes long-range investment decisions but does not pay the energy bills for the property. In these situations, the owner will not invest in energy efficiency opportunities in spite of excellent, low-risk financial returns. An initiative that could improve leasing practices could help to eliminate this important barrier. For example, an initiative that provided reliable information on energy performance to potential tenants would correctly align the market incentives.

Energy Information -- Empowering consumers and businesses to save money and preserve the environment requires that they be properly informed about energy choices. One available vehicle for better information is their monthly energy bills. Better information could include benchmarking comparisons showing how their bill measures up to model, cost-effective efficiency and to other customers. It could also include information on the overall efficiency and renewable components of the customer's power provider.

Opportunities in the Industrial Sector

Current government efforts in the industrial sector include a strategic set of programs focusing on both short-term and long-term efficiency and productivity improvements. For example, the Climate Wise program encourages greater efficiency, and DOE's Industries for the Future is working with key industrial sectors to bring new technologies to market through 2020. The announcement of a new climate policy would create a large opportunity to work more aggressively with industries on early reductions in greenhouse gas emissions through available technologies.

In addition, there is an important new opportunity to facilitate the use of efficient *distributed generation* technologies. Small-scale cogeneration of heat and power, as well as renewable technologies, are attractive options for many industrial sites (as well as large commercial sites) around the country, and ongoing efforts by DOE continue to improve their competitiveness. These technologies can provide electricity on-site with relatively low carbon emissions (compared to fossil fuel utility plants). But distributed generation has not been embraced largely due to a range of economic disincentives arising from the structure of the regulated utility industry. The deregulation of the electric utilities is therefore opening important new opportunities for these technologies. However, the dampening effect of the historic difficulties in implementing distributed generation projects as well as the confusion of the new market place (due, for instance, to the unproven reputations of a host of new players) will likely continue to restrain growth in efficient distributed

generation. Programs that could provide reliable information and technical guidance could bridge the transition from a regulated to a more effective market. The structure of a new climate change policy could present additional opportunities to further encourage efficient distributed generation technologies.

Cross-cutting Opportunities

A number of additional opportunities exist across all sectors of the economy. For example:

Financing for Energy Efficiency Investments -- Large companies often rely on their own capital for new investments and yet are reluctant, due to organizational barriers, to use that same capital for investments in efficiency (even though they offer impressive rates of return). Small to mid-size businesses and consumers have little access to capital to begin with, and they have a difficult time obtaining reasonable financing. Consequently, in all sectors of the economy, there are significant opportunities for efficiency improvements that could be made if financing designed specifically for energy efficiency investments were widely available. Previous opportunities to achieve a public good through organizing financial markets have been addressed by creating a secondary financing market through "Government sponsored enterprises" (GSEs), like Fannie Mae, Freddie Mac or Sallie Mae. These GSEs purchase particular types of loans (e.g. home mortgages, student loans) from primary lenders, such as commercial banks and mortgage companies, and bundle these loans for sale in the secondary security market to investors.

Incentives Through a Domestic Greenhouse Gas Policy -- A new U.S. climate change policy would provide unique opportunities to provide further incentives to improve the penetration and innovation of energy efficiency and renewable technologies. In addition to constraining the diffusion of existing technologies, the market barriers discussed in this paper also lead to under investment in private R&D for the next generation of technologies. Because consumers and businesses undervalue the energy cost savings of new technologies, manufacturers see little reward from efficiency innovation and do not invest sufficiently in R&D. As barriers to the diffusion of existing technologies are removed, private R&D will increase, but not sufficiently to maintain a sustainable emissions pathway. For this reason, federal R&D efforts are important to long-range environmental and economic success (see the paper on "Research and Development"). A new climate change policy provides additional opportunities to stimulate increased private R&D by providing more direct incentives. This could work in a number of ways. For example, under a domestic trading system with a cap on greenhouse gas emissions, a reserve of allowances or a portion of auction revenues could be set aside to reward new R&D investment and production of efficient and renewable technologies.

Business Accounting Practices -- Currently, companies ignore future energy liability and undervalue the benefits of investments in energy efficiency. When a firm invests in energy efficiency, the accounting shows only a liability, and there is no recognition of the reduction in future energy expenditures. With the longer term focus beyond 2000 and a clear policy signal on energy, it may be possible to work with businesses to develop new practices that more accurately reflect energy liabilities. Strategic improvements to tracking demand and use of energy resources would allow firms to identify and capitalize on profitable improvements that are currently hidden in the noise of corporate financial data.

Government Procurement -- In addition to providing a strong energy signal to businesses, a new climate policy will create additional opportunities for coordinated government action in promoting efficient technologies. Programs like ENERGY STAR Computers have benefited

significantly from federal procurement policy in the past, but innovative initiatives are often difficult because of decentralized and sometimes restrictive procurement policies. The federal, state, and local governments together purchase a sizable portion of energy-consuming technologies. Harnessing the combined purchasing power of all levels of government could be an important opportunity to provide large markets for efficient and renewable technologies. This would provide a strong incentive for increased R&D; reduce the cost of production of these technologies (due to the effects of "learning by doing"); demonstrate the successful performance of new technologies; and make all participating governments more energy efficient.

END NOTES

1. Under the 1987 Montreal Protocol to limit stratospheric ozone depletion, the U.S. required the phase out of the production of CFCs by 1996. Early analyses suggested that the cost to reduce CFC use by 50% would be $3.50 per kilogram. By 1990, it became clear that CFC use could be entirely eliminated by 1996 at a cost of $2.45 per kilogram. The technological innovations that have reduced the cost were made possible by a tradeable permit regime, but were spurred by the clear policy signal of the Montreal Protocol and by government efforts working with manufacturers.

2. In 1992, the American Council for an Energy-Efficient Economy (ACEEE) applied input-output economic modeling to measure the impact of the Market Case in their study, *America's Energy Choices*. They found that the projected 20% decrease in energy use (from baseline growth) would lead to the creation of one million new jobs (net, an increase of 0.7%), a 0.5% increase in personal income, and a 0.1% increase in GDP. [See Laitner, Skip, "Energy Efficiency as Both a Climate Change Action Strategy and an Economic Development Initiative for the United States," *Proceedings from the June 1996 White House Climate Change Analysis Workshop.*] Also, new energy efficiency investments should be seen as a down payment toward economic well-being. Michael Porter, a professor at the Harvard Business School, notes that "the underlying cause of sustained national advantage is improvement and innovation" [Porter, Michael E., *The Competitive Advantage of Nations* (New York, NY: The Free Press, 1990), page 652].

3. Many industrial efficiency improvements also offer important productivity benefits. As an example, in 1990 a North Carolina textile firm installed a radio frequency dryer to replace a gas dryer which was used to dry cashmere wool. The project reduced the energy required for drying by almost half, and reduced fibre loss from over drying by more than 5 percent. The energy savings was about $0.05 per pound of cashmere was more than $1.50 per pound. While the so-called "cashmere effect" at first may seem to be an extreme example of larger productivity benefits, it is not a case in isolation. Indeed, many other examples can be cited. For instance, the average total annual savings from efficiency projects from the Louisiana Division of Dow Chemicals were 3 to 13 times as large as the energy savings alone. Based on this example and other industrial experiences looking at groups of projects, the average total savings can be assumed to be as high as 4 to 6 times as large as the energy savings for projects that are implemented.

4. The Office of Technology Assessment (1991) study indicates a potential of over 400 MMTCE of reductions possible through 2010 or 2015 with a net savings to the economy. The National Academy of Sciences (1991) study shows as much as 450 MMTCE potential for emissions reductions at a cost savings. *America's Energy Choices* (1990), a study by the ACEEE, the Union of Concerned Scientists and others, concluded that energy use could be cut by over 500 MMTCE in its least aggressive "Market Case," in which only cost-effective investments are made.

5. Derived from current information on the Green Lights program. The original CCAP estimated even higher returns for all of the CCAP programs combined: $75 in private investment and $300 in energy savings for every $1 spent by the government on CCAP programs. Energy savings are cumulative through 2010. All numbers are undiscounted.

Historical Forces Leading to Market Barriers to Energy Efficiency in the Buildings Market

Type of Barrier	Nature of Barrier	Examples of Barrier
Imperfect Competition		
Natural Monopoly	Economies of scale	Electric utilities
Market Power (Monopoly and Oligopoly)	Bargaining power; Interdependent conduct	Uniqueness of building location; few development firms in one area
Anti-Competitive Conduct	Collusion; predation	Manipulation of permit process to the detriment of competitors
Information Availability		
Information Costs	Transaction costs	High cost of customized audit (cheaper if done en masse); collecting product info; finding credible information sources
Asymmetric Information	Unequal bargaining	Developer's superior knowledge of building
Misinformation	Misinformed exchange	Belief: "no efficiency increase is possible"
Lack of Information	Uninformed exchange	No knowledge of efficient technologies
Economic Non-Rationality		
Bounded Rationality, Satisficing	Using rules of thumb to reduce transaction costs; not maximizing profits	Ignore costs that are < 5% of rent; use a two year payback; seek acceptable profits
Other Non-Rationality	Cultural reasons for taking actions that affect business practice	Preferring energy production to cost-cutting because it is more congruent with management culture
Risk Aversion	Resistance to change	Avoid changes in suppliers and technologies; avoid new technologies
Side Effects	Negative externalities from power production	Pollution from power generation; dependence on imported oil; risks of nuclear energy
Split Incentives	Utility costs not paid by purchaser and user of equipment	Landlord-tenant problem; builder-buyer problem
Public Goods		
R&D	Non-excludability, zero marginal costs	Too little R&D performed
Expertise and Training	Non-excludability, zero marginal costs	Too little training on efficient design, installation and maintenance; too little information dissemination
Cash Flow Constraints	Lack of access to capital	Small business tenants on the edge; developer's reluctance to take on more debt
Regulatory Distortions		
Regulatory Bias	More profits for energy production than for efficient use	Utility reluctance to install conservation even when cheaper than new supply
Average Cost Pricing	Price signals do not reflect cost, leading to inefficient usage	Utility regulation in the US
Building Codes	Obsolete codes and poor code enforcement inhibit innovation and efficiency; # of inconsistent codes inhibits achieving economies of scale	Local US building codes contain requirements that interfere with efficient construction; thousands of building codes in the US

The Role of R&D in Limiting Greenhouse Gas Emissions

Achieving greenhouse gas levels that are not harmful to humans or the environment will require major advances in technology in every sector of the economy. Fortunately the necessary advances are within plausible pathways of current research and development efforts. Federal R&D is already pursuing most of the important CO2-mitigating technologies because they provide other benefits to the Nation that have long been the basis of national policy, such as achieving dramatic reductions in the criteria air pollutants and other environmental harms; decreased dependence on foreign oil; increased competitiveness of domestic industries and reduced inflation; and leadership in industries likely to achieve an international market of several hundred billion dollars per year in the next century.

Achieving these goals will nonetheless be difficult at a time of constrained federal spending and sharp reductions in long-term private sector R&D. Since 1978, federal investment in energy R&D has declined 75%. Energy R&D investment by industry fell 33% from 1983 to 1993; the electric utility and the gas industry have cut their R&D investments sharply. Industry as a whole has reduced its basic and applied research from 27% of its total R&D in 1988 to 17% in 1994.

The need for major technology advances can be seen from the following equation:

Emissions = *Population* x *Affluence* (GDP/capita) x *Technology* (Emissions/GDP)

From 1990 to 2060, we may well see global population double and affluence increase by a factor of four. At the same time, the world may ultimately need to *lower* emissions from 1990 levels, requring the average emissions-related technology to improve by more than a factor of ten during the next few decades and then be rapidly deployed throughout the world.

Any R&D effort is intrinsically valuable but inherently risky. We can confidently expect significant benefits (based on empirically high returns on federal, private or blended investment) and some

unexpected benefits: much of the gas turbine technology that is today generating cleaner, low-cost electricity had its roots in government-funded work on jet engines. We cannot predict ahead of time the technology "winners" from R&D. The operational risks are making premature decisions that are actually technical or economic dead ends (the breeder reactor or synfuels). At the other extreme, underfunding the most promising areas, as we did during the 1980s in energy efficiency and renewable energy R&D, misuses scarce resources while foregoing substantial progress. Lessons learned form the the past two decades have shaped our current R&D strategy, which chart a middle course between the two extremes.

This paper will examine the most promising R&D for mitigating CO2, focusing on four strategic thrusts: (1) Clean power generation, (2) Energy efficiency, (3) Carbon sequestration accompanying a transition to a hydrogen-based economy, and (4) Very advanced research, such as superconductivity, nanotechnology, and photosynthetic mechanisms. Responding to the climate problem may require breakthroughs in all of these areas. The high-risk nature of R&D requires the pursuit of multiple pathways. Successful (i.e. low-cost) climate stabilization will require accelerated diffusion of existing low-CO2 technologies by 2010 (see "Market Transformation" paper); significant penetration of new very-low-CO2 technologies from 2010 to 2020 (which is the period of greatest economic risk in the current negotiations); followed by deployment of near-zero-CO2 technologies in the succeeding decades (where the possibility exists of fundamental alterations in the energy system).

If these R&D efforts are to succeed, the government's current R&D spending in these areas, roughly $1.3 billion, will need a large boost. Also, partnerships with industry, market pull, improved regulations, and other policies will be required to ensure technological success and accelerated market penetration. The benefits could be enormous, including the avoidance of the costs associated with the other approaches to CO2 mitigation—higher taxes and regulation. A 1997 study by Pacific Northwest Laboratory found that developing and deploying advanced technologies over the next 15 to 30 years could lower the present value cost to the global economy of stabilizing the atmosphere at 550 ppm CO2 from one trillion dollars

down to nearly zero.

Clean Power Generation

Natural gas technologies now set the benchmark for low cost, cleaner power generation. But a spectrum of renewable technologies are becoming competitive: photovoltaics (PV), which convert sunlight into electricity, have dropped from 90 cents per kilowatt-hour in 1980 to under 20 cents today while wind power has dropped from 25 cents per kWh to 5.

Advances in natural gas turbines will yield overall energy conversion efficiencies of 60% or more in the next decade, doubling the efficiency of traditional coal-fired plants. Fuel cells, which generate electricity directly from hydrogen derived from fuels such as natural gas, are promising because of their high efficiency and low emissions. High temperature fuel-cells, such as molten carbonate and solid oxide, may have significant application in power generation with further R&D. Molten carbonate fuel cells are expected to reach 50–60% efficiency by 2000, and perhaps 70% by 2005.

High efficiency coal-fueled power plants, such as integrated gasification combined cycle (IGCC) are now being demonstrated at efficiencies (40 to 43 percent) that are competitive with more traditional coal fired power plants but with much lower emissions, including 35–45% lower CO2 emissions. The efficiency of the next generation IGCC plant could exceed 55%, and, in combination with a fuel cell, achieve 60% by 2015.

While electricity from fossil fuels continue to become cleaner and cheaper, expanded R&D and deployment could make a number of renewable technologies competitive on purely economic grounds in the next two decades: wind power, PV, biomass power, PV, biomass power, solar thermal, and geothermal. In a greenhouse-gas constrained world, these zero-CO2 emitting sources of power would be even more competitive. One plausible set of prices over the next two decades is shown in Figure 1 (from Royal Dutch/Shell).

These cost-reductions will occur not just because of R&D, such as advances in thin film PV, but also

through economies of scale and improvements in manufacturing that come with increased production. Both wind and PV are experiencing a 20% cost reduction for every doubling of cumulative production.

Therefore, a key element of a low-CO2 power generation strategy is to increase the market penetration of technologies such as PV and fuel cells. That strategy needs an international component, since many renewables are cost-effective today in countries without an electricity grid. Domestically, the Climate Change Action Plan contains a number of measures to reduce costs through accelerated deployment for wind, PVs, geothermal, and fuel cells. Besides lowering costs, many of these efforts give utilities experience using these new technologies in niche markets, helping to remove barriers to more expanded use in the future as the technology improves. The old linear model of R&D, where research could be divorced from application, must be thrown out if we are to achieve the desired end: rapid market penetration of clean technologies.

A new government partnership with utilities may be necessary, as the industry is reducing R&D and deployment of renewables and fuel cells in the face of increased competitive pressure and the prospect of a more competitive, restructured industry, which in turn drives short-term cost-cutting efforts. Congressional legislation to restructure the utility industry may well be enacted in the next two years and that will be a crucial opportunity to find alternative means to support R&D and deployment of low-CO2 power.

Nuclear power plants emit no CO_2. Today, the United States operates 109 nuclear power plants, which provide about 22% of our electricity (second only to coal). Between 1973 and 1994, our nuclear power plants enabled the U.S. to avoid about 1,700 million metric tons of carbon emissions. Nuclear's contribution to reducing global climate change gases is increasing. As U.S. plants become more efficient over the next decade, they will reduce carbon emissions more than any other single source. Just since 1994, increases in nuclear power plant availability have reduced annual carbon emissions by 25 million

metric tons. Today, U.S. nuclear plants operate about 80% of the time and may reach 85% by the end of the decade. Every one percent increase in utility-wide nuclear power plant availability results in an annual reduction of carbon emissions of nearly two million metric tons.

To keep nuclear power a viable option for future electricity production, the Department has developed a program to address critical technology issues that could impact the continued operation of U.S. nuclear power plants. Nearly completed is a program to complete and gain Nuclear Regulatory Commission certification of advanced nuclear reactor designs. Nuclear plants similar to these advanced designs have been built or are under construction in countries such as Japan, South Korea, Taiwan. A plant was recently completed in Japan in just over four years, at a cost of about $3 billion, under half the time and about half the cost to complete the most recently finished U.S. nuclear plants. The successful, timely, and low-cost construction of advanced U.S.-designed nuclear plants overseas, coupled with recent reports that nuclear plant operating and maintenance costs have dropped to the same level as for coal plants, have improved the prospects for economical nuclear power generation in the future.

A major R &D effort aimed at improving low-CO2 power generation could have a significan impact on greenhouse gas emissions. The "sustained growth" scenario developed by Royal/Dutch Shell shows one "plausible archetype" (see Figure 2). New energy technologies achieve annual sales of a few hundred *billion* dollars per year in a few decades. Figure 3 shows global CO2 emissions through 2100. Emissions of the criteria air pollutants would show an even sharper decline. Carbon dioxide content in the atmosphere would stabilize at about 550 to 600 ppm.

Given the uncertain nature of R&D, the level of funding necessary to achieve such a world cannot be known, but is likely to be considerably higher than today's investment levels, especially if the Nation seeks to maintain world leadership in these technologies. In PVs, deep R&D cuts in the 1980s have left us with only 40% of the world market. The Japanese outspend our $60 million R&D effort in PVs by more than two to one. The relatively high price for electricity in other developed nations, and the far greater

financial incentives they offer industry, means alternative energy will be cost-effective in foreign countries before it is here. Our primary competitive advantage can come only from technological leadership.

Energy Efficiency

Another key response to climate change is R&D to improve the efficiency of energy use. Three sectors are particularly important: transportation, industry, and buildings.

Transportation

Transportation R&D is essential because the sector uses very little electricity, so advances in clean power offer little hope of lowering its CO2 emissions. Also, two other major national problems—urban air pollution and dependence on foreign oil—stem largely from the transportation sector. The current federal strategy is to develop cars and trucks that are highly fuel-efficient as well as ones that run on fuels other than petroleum, including natural gas, electricity, and biofuels (ethanol).

The partnership for a New Generation of Vehicles (PNGV) is a collaboration among federal agencies, national laboratories, and the auto industry to design and build a prototype clean car by 2004 with three times the fuel efficiency of existing cars and very low emissions, but comparable or improved performance, safety, and cost. Multiple technology paths are being pursued to build a hybrid vehicle that has both an advanced engine (such as a clean diesel, Stirling or gas turbine) and an energy storage device (such as a battery, fly-wheel or ultracapacitor). Supporting R&D includes lightweight, super-strong materials such as composites; high-temperature ceramics; regenerative breaking; and advanced power electronics.

Biofuels are one of the most attractive options for lowering transporation's CO2 emissions. Federal R&D has brought the cost of ethanol from $3.60 per gallon in 1980 to $1.20 per gallon. With continued R&D in bio-engineered organisms and fast-growing crops, the biofuels program is expected to produce ethanol from waste paper, crop waste, and dedicated crops for under 70 cents a gallon by 2005, competitive with oil at $25 a barrel, its current price. Significant penetration of biofuels is possible in the next two decades.

Proton-exchange membrane (PEM) fuel cells have perhaps the greatest long-term potential for reducing transportation CO2. Recently PNGV developed an on-board reformer for converting gasoline into hydrogen to run a PEM fuel cell, which would have a 50% increase in fuel efficiency over an internal combustion engine, half the CO2, and a 99% reduction below ultra-low emission vehicle standards. A PEM fuel cell running on ethanol would have virtually no net CO2 emission. A decade of R&D may be needed to bring costs down and integrate the fuel cell into a commercial vehicle. Maximum efficiency and emissions reductions would come from running the car on hydrogen directly, which will require even more research.

The ultimate low-CO2 vehicles and the fuels they would use cannot be known today. To ensure that the R&D leads to commercially viable vehicles, a number of programs are needed to ensure that the infrastructure is available to support vehicles that run on non-traditional fuels.

INDUSTRY

The industrial sector consumes about one-third of the nation's energy. The seven most energy-intensive industries—steel, aluminum, petroleum refining, chemicals, pulp and paper products, glass, and metal casting—account for about 80% of the energy consumed in U.S. manufacturing and more than 90% of the hazardous waste. They represent the largest opportunity for reducing industrial CO2 emissions.

The Department of Energy has formed partnerships with each of these industries to develop visions of energy-efficient, low-polluting, highly competitive "Industries of the Future" and then technology roadmaps to identify the best R&D opportunities. These include advanced materials development, such as ceramic composites; separation technology, such as advanced membranes; catalysis; bioprocessing, biocatalysis, and renewable feedstocks; sensors and controls; and industrial cogeneration of electricity and heat, which can achieve overall efficiencies of more than 80% and ultimately utilize biomass.

These industries (except chemicals) significantly underinvest in R&D compared to the industry average.

What R&D they have devoted to the environment has traditionally been focused on compliance—end-of-pipe treatment and control, as opposed to prevention—since that is how our regulatory system is designed. While increased R&D is needed, if federal pollution prevention technology development is to achieve maximum industry cost-share, market penetration, and significant greenhouse gas reduction, the Administration must complete its regulatory reinvention revolution, exploring innovative approaches through Project XL, the Common Sense Initiative, and the Environmental Leadership Program.

Tradtional point-source controls that address a single waste at a time and only afte the waste has been generated must be replaced by prevention-based, innovation friendly strategies. These include basing standards on desired performance, not "best available technology"; focusing on facilities, communities, and ecosystems, not the waste, the media nor the pipe; emphasizing multi-media solutions that address all wastes; emphasizing continuous improvement, not bright-line fixed compliance; expanding the use of information, measurement, and feedback, such as the Toxic Release Inventory; and wherever possibly, using fiscal tools and market mechanisms such as trading schemes and bankable emissions credits.

Prevention R&D, as opposed to end-of-pipe R&D, is the key to CO2 mitigation, and prevention-oriented regulations can help unleash billions of private-sector dollars in the industrial sector to low-CO2 industrial technologies.

BUILDINGS

The buildings sector consumes one-third of the nation's energy and two-thirds of its electricity. Federal R&D into buildings technologies has been remarkably successful. Consider just five technologies developed or advanced by the national laboratories in the past two decades at a cost of roughly $40 million—building design software and advanced lighting, windows, oil burners, and refrigerator compressors. These have provided cumulative net savings of more than $15 *billion* to consumers and businesses, which exceeds the $14 billion spent on all energy efficiency R&D since 1978. They are today

providing more than 10 million metric tons of annual CO2 savings.

Continued R&D in the buildings sector is likely to prove just as cost-effective. Key near-term technologies include improvements in lighting, superwindows, advanced design software, high-efficiency clothes washing, heat-pump water heaters, gas heat pumps, improved insulation and duct systems, more efficient cooling including gas cooling, solar heating and cooling, and daylighting. Urban heat island mitigation R&D could enable deep and highly cost-effective energy savings in air conditioning, while dramatically reducing smog formation. Relevant R&D includes developing highly reflective roofing and road materials, and modeling the impact of those materials and shade trees on buildings and cities.

Longer term R&D needs include electrochromic glazings for windows, building-integrated PV systems, and PEM fuel cells. In 2010, a building using efficient technologies with electricity and hot water provided by an 80% efficient fuel cell could have no first-cost penalty with well under half the energy of a typical 1990 building and one-tenth the CO2 emissions.

Dematerialisation

A major R&D effort aimed at improving energy efficieny could have a significant impact on greenhouse gas emissions. Shell's "Dematerialisation" scenario imagines such a world with improvements in energy intensity reaching a sustained 2% per annum, which has been seen for only limited periods in the past, from a "New Generation Vehicle" and other relentless advances in efficient technology (see Figure 4).

The market for clean technologies could be a few hundred billion dollars per year. Figure 5 shows global CO2 emissions through 2100. Again, emissions of the criteria air pollutants would show an even sharper decline. National and world dependence on Persian Gulf oil would be severely reduced. Carbon dioxide content in the atmosphere would stabilize at about 550 to 600 ppm.

Capture and Sequestration

A relatively simple series of chemical reactions can take coal, oil, natural gas or biomass and convert them into relatively pure streams of carbon dioxide and hydrogen. If R&D makes it possible to find bulk means of sequestering CO2 safely and cost-effectively, and if advances continue in hydrogen utilization, particularly in PEM fuel cells, then the possibility would exist for a long-term transition to a nearly

pollution-free economy with sharply reduced levels of greenhouse gas emissions.

A number of sequestering options are worth exploring further, including the deep ocean, depleted gas and oil reserves, and underground aquifers. In September 1996, Statoil of Norway began storing CO2 from a gas field into a sandstone aquifer a kilometer beneath the North Sea at a rate equal to the CO2 produced from a 140 megawatt coal-fired power plant. Pilot studies had shown that most of the CO2 will react to form solid calcite, with some dissolving in the groundwater and some remaining as gas. While cost information has not been shared, Statoil has stated it is less than the Norwegian carbon tax of $50 per ton of CO2.

A long-term R&D strategy would include demonstration of a number of sequestration options and research into their possible environmental impacts; converting CO2 into an industrial chemical feedstocks; other novel sequestration options, such as C02 fixation by microalgae; selectively permeable membranes for CO2 capture; processes for converting fossil fuels and biomass into CO2 and hydrogen; development of hydrogen infrastructure technology, including transportation and storage; and PEM fuel cells.

As noted earlier, R&D into clean power generation and energy efficiency support many long-standing national goals and have been pursued for years. Carbon dioxide capture and sequestration, however, makes sense on a massive scale only in a greenhouse-gas constrained world. So, at least in this country, this area has been relatively underfunded. Since 1990, Japan has spent more than 30 times what we have on CO2 capture and sequestration.

Other Advanced Research

A number of areas of basic research could prove crucial to responding to climate change, including photosynthetic mechanisms, biotechnology, fermentation microbiology, combustion research, polymer and ceramic science, process engineering, supercritical CO2, new materials synthesis, and nanotechnology.

One essential area for expanded R&D is superconductivity. Superconductors offer the possibility of nearly lossless energy storage and transmission, with potential savings of 5% to 10% of all electricity presently generated by utilities. Highly efficient superconducting motors could have an even larger impact since motors currently consume 60% of all electricity. While U.S. and German funding is roughly $40 million annually, Japan spends nearly $70 million, not including their superconducting MagLev train program, where some $3.5 billion is being spent over five years. Significant increases in both basic and applied research in superconductivity should be an essential part of a low-CO2 R&D strategy.

Summary

New technologies offer the prospect of dramatically lowering the cost of CO2 mitigation while achieving many other national benefits. The roughly $1.3 billion the federal government is currently spending on relevant R&D will likely have to be increased substantially. At the same time, a number of regulatory and other policy tools will be needed both to maximize private sector investment in this R&D and to help create conditions needed for these technologies to achieve rapid marketplace penetration.

Options (These are not mutually exclusive, but demonstrate the range of possibilities)

1) Augment Federal energy R&D budgets, emphasizing most promising low- or zero- CO2 technologies

- within a zero-sum constraint toward Federal R&D resources that would necessitate reducing investments in other R&D areas, or
- expand the overall Federal R&D effort

2) Expand current partnerships with industry to focus on key CO2 objectives through initiatives e.g.electric utilities, natural gas industry, industrial processes (Industries of the Future), transportation (PNGV), and buildings.

3) Lay the R&D foundation for longer-term radical energy system shifts, e.g. hydrogen economy or building in CO2 sequestration technologies into the energy system.

4) Market adjustments (not contemplated in this paper), e.g. accelerated depreciation for low-carbon technologies, tax credits for low-carbon technology development and deployment

5) Design legislation to support CO2 goals, including regulatory reinvention. Ensure that expect legislation, such as utility restructing, supports C02 goals.

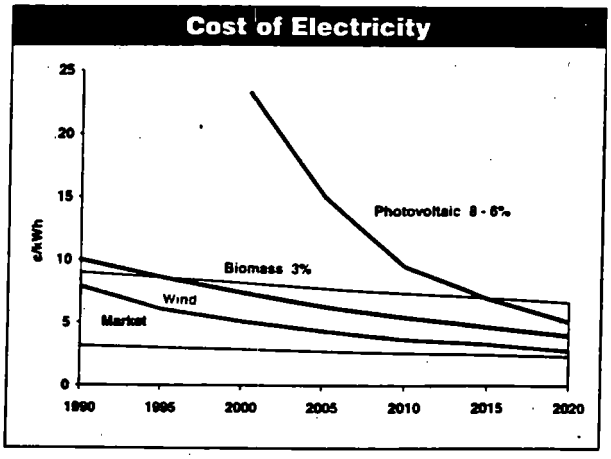

Fig 1

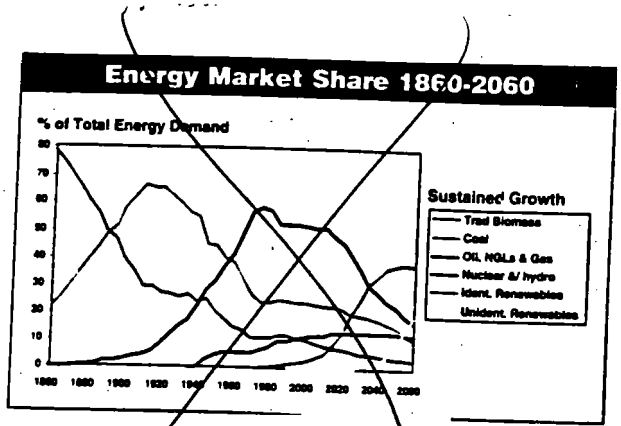

Fig 2

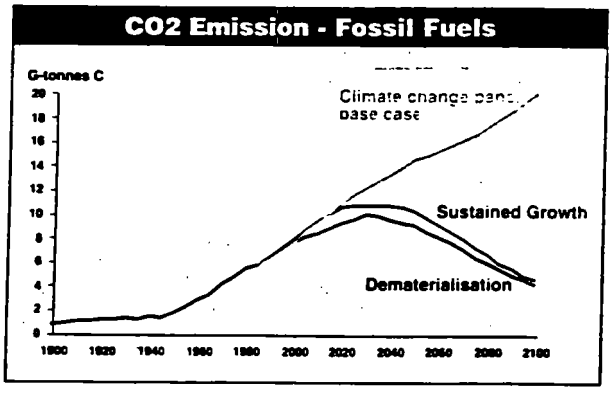

Fig 3

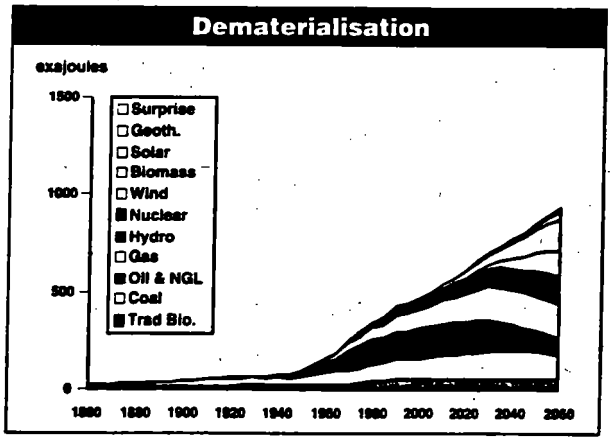

Fig 4

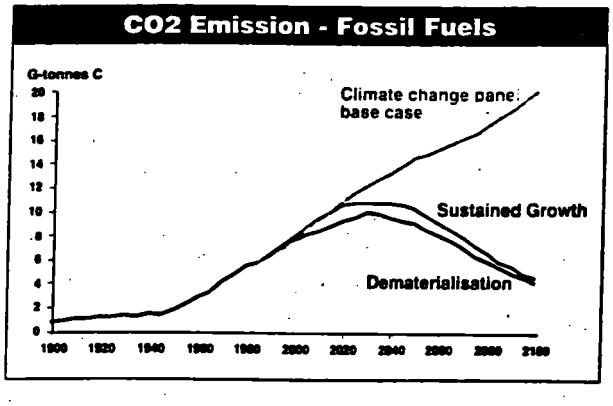

Fig. 5

United States Department of State

Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs

Washington, D.C. 20520

cc: AW JAF JS MM

JAN 16 1997

TO: *Distribution

FROM: OES - Eileen B. Claussen

SUBJECT: U.S. Climate Change Submission

Attached for your information and use are copies of the following:

(1) U.S. Submission (Proposed Proposal) of January 17 to the Secretariat of the U.N. Framework Convention on Climate Change

(2) Fact Sheet on U.S. Climate Change Proposal

(3) Negotiations Background and Calendar

I will brief Congressional staff tomorrow morning at 10:00 a.m., and distribute these documents at that time. They should be treated as "close hold" until after the Congressional briefing. I will brief representatives of U.S. environmental organizations and the private sector tomorrow afternoon at 2:00 p.m. here at the State Department.

Please accept my thanks for your help in developing the U.S. Submission against a difficult deadline.

Attachments:
As stated.

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FROM: Eileen B. Claussen

1/17/97

U.S. DRAFT PROTOCOL FRAMEWORK
(submitted without prejudice to ultimate form of agreement)

The Parties to this Protocol,

Have agreed as follows:

Article 1
Definitions

For purposes of this Protocol:

1. "The Convention" means the United Nations Framework Convention on Climate Change done at New York on 9 May 1992.

2. "Party" means Party to this Protocol.

3. "Greenhouse gas" means any greenhouse gas for which a global warming potential is set forth in Annex C of this Protocol.

4. "Tonne of carbon equivalent" means one metric tonne of carbon, or a quantity of one or more other greenhouse gases equivalent to one metric tonne based on the global warming potentials set forth in Annex C of this Protocol.

5. "Net anthropogenic emissions" of greenhouse gases is the calculated difference between emissions by sources and removals by sinks.

6. [other definitions to be developed or cross-referenced to the Convention as necessary]

Article 2
Emissions Budgets

1. Each Annex A and Annex B Party shall ensure that its net anthropogenic emissions of greenhouse gases do not exceed its emissions budget for any applicable budget period, as specified in this Article.

2. For each Annex A and Annex B Party, its emissions budget shall be denominated in tonnes of carbon equivalent emissions allowed and shall equal:

   (a) the tonnes of carbon equivalent emissions it is allowed under paragraph 3 or 4 below, plus

(b) any tonnes of carbon equivalent emissions allowed that are carried over from a prior budget period under paragraph 5 below, plus

(c) up to [__ percent] of the tonnes of carbon equivalent emissions allowed under paragraph 3 or 4 below, such as may be borrowed from the subsequent budget period under paragraph 6 below, plus

(d) any tonnes of carbon equivalent emissions allowed that are acquired from another Party under Article 6 (International Emissions Trading) or Article 7 (Joint Implementation), minus

(e) any tonnes of carbon equivalent emissions allowed that are transferred to another Party under Article 6 (International Emissions Trading).

3. (a) For the first budget period, [20__ through 20__], each Annex A Party shall have a number of tonnes of carbon equivalent allowed equal to [a percentage of] its net anthropogenic emissions of tonnes of carbon equivalent in 1990, multiplied by [the number of years in this budget period].

(b) For the second budget period, [20__ through 20__], each Annex A Party shall have a number of tonnes of carbon equivalent emissions allowed equal to [a percentage equal to or less than the percentage in subparagraph 3(a)] of its net anthropogenic emissions of tonnes of carbon equivalent in 1990, multiplied by [the number of years in this budget period].

(c) [possible subsequent budget period(s)]

4. For the budget period [20__ through 20__], each Annex B Party (see Annex B for States included) shall have a number of tonnes of carbon equivalent emissions allowed equal to [options for Annex B Parties include: budget periods, baseyears, and/or percentages different from those applicable to Annex A Parties].

5. At the end of a budget period applicable to a Party, any amount by which the Party's emissions of tonnes of carbon equivalent is under its emissions budget for that period may be carried over and added to its emissions budget for the next budget period.

6. At the end of a budget period applicable to a Party, any amount of tonnes of carbon equivalent emissions allowed that is borrowed from the subsequent budget period shall be subtracted at a rate of [1.2:1] from the subsequent budget period.

7. [Provision requiring control of greenhouse gases not listed in Annex C.]

8. Any State not listed in Annex A may, in its instrument of ratification, acceptance, approval or accession, or at any time thereafter, notify the Depositary that it intends to be bound by obligations of Annex A Parties. It will then be an Annex A Party. The Depositary shall inform the other signatories and Parties of any such notification.

9. Any State not listed in Annex A may, in its instrument of ratification, acceptance, approval, or accession, or at any time thereafter, notify the Depositary that it intends to be bound by obligations of Annex B Parties. It will then be an Annex B Party. The Depositary shall inform the other signatories and Parties of any such notification.

Article 3
Measurement and Reporting

1. Each Annex A and Annex B Party shall have in place by [the first year of its first budget period] a national system for the accurate measurement of anthropogenic emissions by sources, and removals by sinks, of greenhouse gases.

2. For the purposes of implementing paragraph 1 and promoting comparability, consistency, and transparency, the Parties shall, not later than their second Meeting, decide on minimum standards for the measurement of anthropogenic emissions by sources, and removals by sinks, of greenhouse gases.

3. Each Annex A and Annex B Party shall put in place, if it has not already done so, national compliance and enforcement programs relevant to its implementation of the obligations under this Protocol.

4. Each Annex A and Annex B Party shall submit to the Secretariat, as part of its communication under Article 12 of the Convention, information on its implementation of this Protocol, including policies and measures it is taking to meet its obligations in Article 2. Such submission shall be in accordance with guidelines which the Parties adopt at their first Meeting, taking into account any relevant guidelines adopted by the Parties to the Convention. Such submission shall also contain the following information:

   (a) once the obligation in paragraph 1 above becomes effective, a description of the national measurement system that it has in place;

(b) once the obligation in paragraph 1 above becomes effective, the results of its national measurement system;

(c) a quantitative projection of its net anthropogenic emissions of greenhouse gases through the budget periods; and

(d) a description of relevant national compliance and enforcement programs it has in place pursuant to paragraph 3 above, as well as a description of their effectiveness, including actions taken in cases of non-compliance with national law.

5. In addition to the information required to be submitted under paragraph 4, each Annex A and Annex B Party shall submit to the Secretariat, on an annual basis and in accordance with the guidelines referred to in paragraph 4, its current calculation corresponding to each of the subparagraphs in Article 2.2 and its remaining emissions budget for that budget period. With respect to any tonnes of carbon equivalent emissions allowed that are acquired or transferred under Articles 6 or 7, the Party shall specify the quantity, Party of origin or destination, and the relevant budget period.

6. The first of the submissions referred to in paragraph 5 shall be part of a Party's first communication that is due after the Protocol has been in force for that Party for two years. The frequency of subsequent submissions shall be determined by the Parties.

7. Information communicated by Parties under this Article shall be transmitted by the secretariat as soon as possible to the Parties and to any subsidiary bodies concerned.

8. Without prejudice to the ability of any Party to make public its communication at any time, the secretariat shall make information communicated by Parties under this Article publicly available at the time it is submitted to the Parties.

Article 4
Review and Compliance Process

1. In addition to the review of communications conducted under Article 10.2(b) of the Convention, the Meeting of the Parties shall consider the information submitted by Annex A and Annex B Parties under Article 3 in order to assess those Parties' implementation of their obligations.

2. Reviews will be conducted by expert review teams, which will be coordinated by the secretariat and composed of experts selected from those nominated by Parties and, as appropriate, by intergovernmental organizations.

3. Reviews will be in accordance with guidelines to be adopted by the Meeting of the Parties. These guidelines shall, inter alia, provide for how information will be made available to the public and define mechanisms by which observers and the public may provide comments, supplemental data or other information to facilitate and improve reviews. The guidelines shall be periodically reviewed by the Parties for appropriate revision.

4. Review teams will review all aspects of a Party's implementation of this Protocol, including the likelihood that a Party will achieve its emissions budgets obligations. They will prepare a report assessing a Party's implementation of its obligations, identifying any areas of apparent non-compliance, as well as potential problems in achieving obligations. Reports will be provided to a Meeting of the Parties.

5. Based on such reports, a Meeting of the Parties may make recommendations to a Party. In such case, the Party shall review its implementation, take appropriate action, and report back to the next Meeting of the Parties on its action.

6. There would also be provisions setting forth various consequences for non-compliance with obligations, as determined by a Meeting of the Parties. Consequences would correspond to the type, degree, and frequency of non-compliance. Some would be automatic, while others might be discretionary. Examples of consequences could include, e.g.:

   (a) denial of the opportunity to sell tonnes of carbon equivalent emissions allowed through international emissions trading and/or joint implementation;

   (b) loss of voting rights and/or other opportunities to participate in processes under the Protocol.

Article 5
Advancement of the Implementation of Article 4.1 of the Convention

Recognizing the progress that has been made to date in implementing commitments under Article 4.1 of the Convention:

1. The Parties reaffirm their commitments under Article 4.1 of the Convention and the need to continue to advance the implementation of such commitments.

2. Each Party shall strengthen its legal and institutional framework to advance the implementation of its commitments under Article 4.1 of the Convention.

3. Each Party shall take measures to facilitate investment in climate-friendly technologies.

4. Each Party shall report, as part of its communication under the Convention, on how it is promoting public education and participation in the development of climate change policy.

5. Each Party that is neither in Annex A nor Annex B shall identify and implement "no-regrets" measures for mitigating net anthropogenic emissions of greenhouse gases, including any identified through the review process under paragraph 7 below. In this regard, each such Party shall also:

   (a) quantify the effects of the measures it implements;

   (b) evaluate barriers to the adoption of potential measures; and

   (c) report to the Secretariat, as part of its communication under the Convention, on the measures it has implemented, plans to implement, and barriers to the adoption of potential measures.

6. Each Party that is neither in Annex A nor Annex B shall submit to the Secretariat, on an annual basis, its inventory of greenhouse gas emissions. Such inventory shall be consistent with any guidelines adopted by the Parties.

7. The Parties shall establish a process for reviewing communications received under the Convention from the Parties identified in paragraphs 5 and 6. The process shall be designed to:

   (a) enable the review of the effects of individual measures described in paragraph 5;

   (b) assist such Parties in identifying and implementing "no-regrets" measures for mitigating net anthropogenic emissions of greenhouse gases;

   (c) seek to identify key sectors and technological options within them;

(d) consider possibilities for promoting voluntary arrangements with industry aimed at identifying and encouraging implementation of "no regrets" measures; and

(e) explore various means through which such Parties could obtain both the know-how and the technology needed to implement options identified.

Article 6
International Emissions Trading

1. An Annex A or Annex B Party that is in compliance with its obligations under Article 3 (Measurement and Reporting) and that has in place a national mechanism for certification and verification of trades, may transfer to, or receive from, any Annex A or Annex B Party, any of its tonnes of carbon equivalent emissions allowed for a budget period, for the purpose of meeting its obligations under Article 2.

2. A Party may authorize any domestic entity (e.g., government agencies, private firms, non-governmental organizations, individuals) to participate in actions leading to transfer and receipt under paragraph 1 of tonnes of carbon equivalent emissions allowed.

3. A Meeting of the Parties may further elaborate guidelines to facilitate the reporting of emissions trading information.

Article 7
Joint Implementation

1. Any Party that is neither in Annex A nor B may generate tonnes of carbon equivalent emissions allowed through projects that meet the criteria set forth in paragraph 2.

2. In addition to any criteria adopted by the Parties to this Protocol, the following criteria shall apply to projects:

   (a) Projects must be compatible with and supportive of national environment and development priorities and strategies, as well as contribute to cost-effectiveness in achieving global benefits;

   (b) Projects must provide a reduction in emissions that is additional to any that would otherwise occur.

3. [Additional provisions to be added on calculation, measurement, monitoring, verification, review, reporting]

4. Any Party that generates tonnes of carbon equivalent emissions allowed consistent with this Article may:

   (a) hold such tonnes of carbon equivalent emissions allowed; or

   (b) transfer any portion thereof to any Party.

5. An Annex A or Annex B Party may acquire tonnes of carbon equivalent emissions allowed under this Article for the purpose of meeting its obligations under Article 2, provided it is in compliance with its obligations under Article 3 (Measurement and Reporting).

6. A Party may authorize any domestic entity (e.g., government agencies, private firms, non-governmental organizations, individuals) to participate in actions leading to generation, transfer and receipt under this Article of tonnes of carbon equivalent emissions.

7. Any Party that is neither in Annex A nor Annex B that generates or acquires tonnes of carbon equivalent emissions allowed under this Article shall notify the Secretariat annually of the quantity, origin, and destination of such tonnes.

Article 8
Science

The Parties shall periodically review this Protocol, and guidelines established thereunder, in light of evolving scientific knowledge related to climate change.

Article 9
Progress Toward Long-Term Goal

The Parties shall cooperate in the establishment of a long-term goal with respect to atmospheric concentrations of greenhouse gases.

Article 10
Meetings of the Parties

1. The Parties shall hold meetings at regular intervals. The secretariat shall convene the first meeting of the Parties not later than one year after the date of the entry into force of this Protocol and in conjunction with a meeting of the Conference of the Parties to the Convention.

2. Subsequent meetings of the Parties shall be held, unless the Parties decide otherwise, in conjunction with meetings of the Conference of the Parties to the Convention. Extraordinary meetings of the Parties shall be held at such other times as may be deemed necessary by a meeting of the Parties, or at the written request of a Party, provided that within six months of such a request being communicated to them by the secretariat, it is supported by at least one third of the Parties.

3. The Parties, at their first meeting, shall:

(a) adopt, by consensus, rules of procedure for their meetings;

(b) [other].

4. The functions of the meetings of the Parties shall be to:

(a) review the implementation of this Protocol, including the information submitted in accordance with Article 3;

(b) periodically review the adequacy of this Protocol;

(c) [other].

5. The United Nations, its specialized agencies and the International Atomic Energy Agency, as well as any State not party to this Protocol, may be represented at meetings of the Parties as observers. Any body or agency, whether national or international, governmental or non-governmental, qualified in fields relating to climate change which has informed the secretariat of its wish to be represented at a meeting of the Parties as an observer may be admitted unless at least one third of the Parties present object. The admission and participation of observers shall be subject to the rules of procedure adopted by the Parties.

Article 11
Secretariat

1. In accordance with Article 8.2(g) of the Convention, the secretariat of this Protocol shall be the secretariat of the Convention.

2. The functions of the secretariat shall be:

(a) ...

Article 12
Subsidiary Body for Scientific and Technological Advice

1. The Subsidiary Body for Scientific and Technological Advice of the Convention shall serve as the Subsidiary Body for Scientific and Technological Advice of the Protocol.

2. When the Subsidiary Body for Scientific and Technological Advice exercises its functions with regard to matters concerning the Protocol, decisions shall be taken only by those of its members that are, at the same time, Parties to the Protocol.

3. When the Subsidiary Body for Scientific and Technological Advice exercises its functions with regard to matters concerning the Protocol, any member of the bureau of the Subsidiary Body for Scientific and Technological Advice representing a Party to the Convention, but, at the same time, not a Party to the Protocol, shall be substituted by an additional member to be elected by and from the Parties to the Protocol.

Article 13
Subsidiary Body for Implementation

1. The Subsidiary Body for Implementation of the Convention shall serve as the Subsidiary Body for Implementation of the Protocol.

2. When the Subsidiary Body for Implementation exercises its functions with regard to matters concerning the Protocol, decisions shall be taken only by those of its members that are, at the same time, Parties to the Protocol.

3. When the Subsidiary Body for Implementation exercises its functions with regard to matters concerning the Protocol, any member of the bureau of the Subsidiary Body for Implementation representing a Party to the Convention, but, at the same time, not a Party to the Protocol, shall be substituted by an additional member to be elected by and from the Parties to the Protocol.

Article 14
Multilateral Consultative Process

[The Parties, at their first Meeting or as soon as practicable thereafter, shall consider the establishment of a multilateral consultative process to promote effective implementation of the Convention.]

Article 15
Dispute Settlement

[silence, with the result that Article 14 of the Convention would apply to this Protocol.]

[in addition, mandatory, binding dispute settlement [with specific consequences flowing from a violation] among Annex A and Annex B Parties, as well as against other Parties as appropriate (e.g., host countries under Article 7)]

Note: this process would be without prejudice to the review and compliance process under Article 4

Article 16
Evolution

The Parties shall adopt, by [2005], binding provisions so that all Parties have quantitative greenhouse gas emissions obligations and so that there is a mechanism for automatic application of progressive greenhouse gas emissions obligations to Parties, based upon agreed criteria.

Views on Certain Final Clauses

Adoption and Amendments of Annexes

Depending upon what type of material is eventually included in annexes, it may not be appropriate to restrict the content of all annexes to "lists, forms and any other material of a descriptive nature that is of a scientific, technical, procedural or administrative character." For any substantive annex, it may not be appropriate to provide for tacit adoption/amendment.

Signature

This provision should state that only Parties to the Convention may be Parties to the Protocol.

Entry into Force

To ensure effective implementation, as well as to minimize the potential "free rider" problem, this provision may need to stipulate an entry into force trigger that requires ratification by States that account for a particular percentage of global emissions of greenhouse gases.

Annex A

This Annex would include the same States as those listed in Annex I of the Convention, plus those that join subsequently pursuant to Article 2.

Annex B

This Annex would include those States not listed in Annex A that indicate before adoption of the protocol that they want to be included in this Annex, plus those that join subsequently pursuant to Article 2.

Annex C

This Annex would list greenhouse gases not covered by the Montreal Protocol, with the exception of gases, or particular sources and sinks, for which there is insufficient knowledge of the GWP or inability to accurately measure emissions or removals. GWPs would be those developed by the IPCC.

January 17, 1997

FACT SHEET ON U.S. CLIMATE CHANGE PROPOSAL

In July, 1996 the United States outlined a broad framework for negotiation of next steps under the Framework Convention on Climate Change. In December, 1996, the U.S. further elaborated its ideas by describing the key elements that should be discussed for inclusion in a protocol to guide greenhouse gas emissions reduction efforts in the post-2000 period. The attached document represents further elaboration of the proposed framework. Today, the United States will present to the Convention's Secretariat draft text for consideration in international negotiations that will occur throughout 1997. Consistent with previous U.S. statements and proposals, the U.S. Submission addresses the following key topics:

EMISSIONS TARGETS

- A new concept is set forth to guide the establisment of developed country emissions targets. Building on the concept of cumulative and averaged emissions, the U.S. proposes creation of an "emissions budget". Multiple emissions budget periods are proposed, including a second period in which emissions are equal to or less than the first period, thus assuring continued progress toward achievement of the Convention's objective.

  -- For a given period, each developed country Party would be allocated an emissions budget.

  -- The submission does not identify either the size of the budgets or the duration of the periods.

  -- Parties would be allowed to "bank" for future use emissions not used during a given period; to "borrow" a limited amount of emissions (with a penalty) from a subsequent period; and to trade emissions.

  -- A new category is proposed to encourage rapidly developing countries to voluntarily adopt emissions budgets.

REPORTING AND COMPLIANCE

- The proposal establishes procedures to ensure adequate reporting, measurement, review and compliance.

  -- Countries would have to set national systems for measuring emissions accurately, achieving compliance and ensuring enforcement.

  -- Annual reports on measurement, compliance and enforcement efforts for the relevant budget period would be required and made available to the public.

-- Implementation efforts would be reviewed under the Convention by expert teams and discussed at appropriate meetings of the Parties.

-- The Parties would be assigned responsibility for determining the consequences of non-compliance, for example: denial of emissions trading/joint implementation rights; loss of voting and other decision-making rights.

ADVANCING DEVELOPING COUNTRY EFFORTS

- The proposal advances implementation of developing country commitments under the Convention by:

  -- Requiring developing countries to identify and adopt "no-regrets" measures to mitigate net greenhouse gas emissions.

  -- Requiring developing countries to prepare annual emissions inventories and report on steps taken to reduce emissions.

  -- Establishing a process for reviewing developing country reports and improving emissions reduction strategies.

EMISSIONS TRADING AND JOINT IMPLEMENTATION

- The U.S. submission provides for full emissions trading among countries with emissions budgets (provided they are in compliance with all obligations under the agreement); it also provides for "joint implementation", through which countries without emissions budgets could create and transfer emissions reduction credits achieved by qualified projects.

LONG-TERM EFFORTS UNDER THE CONVENTION

- The proposal calls for periodic review of the agreement as scientific knowledge and information grows; it also requires the Parties to seek establishment of a long-term goal for atmospheric greenhouse gas concentrations.

- The proposal calls for establishment of a date certain for negotiation of emissions obligations for all Parties, and calls for development of graduation mechanisms to strengthen the obligations of developing nations.

NEGOTIATIONS BACKGROUND AND CALENDAR

Over 160 countries are now Parties to the U.N. Framework Convention on Climate Change (the Convention), adopted May 9, 1992, opened for signature at the Earth Summit in Rio de Janeiro in June, and ratified by the United States in October of that year, after receiving the advice and consent of the Senate. The United States was the fourth nation overall, and the first industrialized nation, to ratify the Convention.

The Convention entered into force on March 21, 1994, and the Parties held their first meeting in April 1995 in Berlin. There, they launched a negotiating process designed to produce a new legal instrument to deal with the threat of climate change in the post 2000 period. They called for the instrument (either an amendment or a protocol) to be adopted at their third meeting, scheduled for Kyoto, Japan, in December 1997.

The negotiating process began in August 1995, in accordance with the decision of the Parties (known as the "Berlin Mandate"). It is taking place in a temporary subsidiary body of the Convention known as the Ad Hoc Group on the Berlin Mandate (AGBM). The AGBM has met four times since its first meeting (in October 1995 and in February, July and December 1996). It will next meet from March 3-7, 1997, in Bonn, Germany. After that, it will meet again in August and October 1997 before the Parties assemble in Kyoto in December.

At the AGBM's 5th meeting in December 1996, Parties were requested to submit proposals, preferably in the form of agreement text, to the Secretariat by January 15, 1997. The proposals received from various Parties will be compiled in a document and circulated to all Parties before the March AGBM meeting. In addition, the AGBM Chair will prepare a "framework compilation" that will also be circulated to all Parties before the March meeting.

Early AGBM meetings focused largely on analysis and assessment. Since July 1996, these meetings have shifted their emphasis toward negotiations, although analysis and assessment are continuing. While the U.S. submission represents a significant step forward, much work remains to be done if the Parties are to adopt a new legal instrument in Kyoto.

The Convention's secretariat moved to its new headquarters in Bonn, Germany, in August 1996. Future meetings of the Convention will take place there, unless otherwise agreed by the Parties.

The U.S. submission represents the latest U.S. contribution to the international negotiating effort. It follows from the policy announced by the United States last July at the Second Conference of the Parties and further elaborated at the last

negotiating session in December 1996. The United States has proposed a three-part framework for a target to limit and reduce greenhouse gas emissions among developed countries: (1) the target should be binding; (2) it should focus on the medium term (i.e., 2010 to 2020); and (3) countries should have flexibility nationally in implementation. In addition, the United States said that it will be critical to include developing countries in next steps because finding a solution to the climate change problem will require a concerted global effort. In the U.S. view, all four of these concepts are linked and all four must be included in the new legal instrument; they are part of the U.S. draft protocol proposal.

CALENDAR OF MAJOR FCCC EVENTS AND MEETINGS

1992	
May	Adoption of the UN Framework Convention on Climate Change - New York
June	Convention signed at the Earth Summit - Rio de Janeiro, Brazil
October	Convention ratified by the United States
1994	
March	Convention enters into force
1995	
March-April	First Conference of the Parties (COP-1) - Berlin
1996	
July	Second Conference of the Parties (COP-2) - Geneva
December	Negotiating session - Geneva
1997	
Feb 25-March 7	Negotiating session - Bonn
July 28-August 7	Negotiating session - Bonn
October 20-31	Negotiating Session - venue to be determined
Dec 1-12	Third Conference of the Parties to the UN Framework Convention on Climate Change (COP-3) - Kyoto, Japan

United States Department of State
Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs
Washington, D.C. 20520

JAN 16 1997

TO: *Distribution

FROM: OES - Eileen B. Claussen

SUBJECT: Questions and Answers on the U.S. Climate Change Submission (Protocol Proposal) of January 17, 1997

Attached for your information and use, as appropriate, are a set of questions and answers we developed regarding the U.S. Submission of January 17 to the Secretariat of the U.N. Framework Convention on Climate Change. We plan to use these questions and answers but not to distribute them publicly.

Attachment:
As stated.

Questions and Answers on the U.S. Submission under the Climate Convention

January 17, 1997

Impact on the Economy

Q 1) Why is the Administration submitting such a detailed U.S. proposal for emissions budgets and budget periods when the results of the U.S. analysis and assessment are not yet available? Aren't you closing off options? Aren't decisions like these likely to have adverse impacts on the U.S. economy, jobs and competitiveness?

A 1) No, we are not closing off options or making decisions with adverse impacts on the U.S. economy. For example, it would not be possible, based on what we are submitting now, to make any assessment of the impact of our framework on the economy, jobs or competitiveness. Moreover, we are proposing specific elements designed to enhance implementation flexibility, including multi-year emissions budgets, emissions trading and joint implementation.

What we are doing is fleshing out the framework we proposed last July; the framework does not yet contain any specifics as to what the first emissions budget should be or the time frame over which it should apply. Decisions on these matters await the results of our ongoing analysis and assessment effort.

1990 Base Year

Q 2) Without the results of the analysis and assessment, why is the Administration proposing a 1990 base year -- won't this limit flexibility?

A 2) No. The year 1990 now serves as the base year in the Convention for commitments of developed countries up to the year 2000. To suggest that we might seek to vary the base year after the year 2000 would call into question the serious resolve of the United States to act responsibly to address the significant environmental threat posed by global warming. Besides, our proposal contains numerous elements designed to promote flexibility, including multi-year emissions budgets, emissions trading and joint implementation.

Comprehensive Approach

Q 3) Your proposal lists greenhouse gases in Annex C, but that annex would exclude some gases. Does this mean that the Administration has jettisoned the "comprehensive approach" which has been a main tenet of U.S. climate change policy for many years?

A 3) We have called for binding commitments, including emissions budgets, with strict accounting requirements. To accomplish this, it is vital that greenhouse gases that are included in emissions budgets be quantifiable and verifiable. Annex C would list all greenhouse gases not covered by the Montreal Protocol, with the exception of gases, or particular sources and sinks, for which there is insufficient knowledge of the Global Warming Potential (GWP) or an inability accurately to measure emissions or removals. The GWPs we have in mind are those developed by the Intergovernmental Panel on Climate Change (IPCC).

That said, it should also be noted that Article 2, paragraph 7, of the U.S. proposal anticipates the inclusion of a provision requiring control of greenhouse gases not listed in Annex C.

Thus, we remain strongly committed to the comprehensive approach, and intend that all greenhouse gases, their sources and sinks, will be addressed under the agreement.

First Budget Period

Q 4) Last July, the Administration rejected short-term targets and subsequently said that short-term means anything before the year 2010; from this can we infer that the first emissions budget period under your proposal will be from 2000 to 2010?

A 4) We have made no decision as to the initial, or subsequent, budget period. What we have decided is that emissions budgets over multi-year periods are preferable to single-year targets because they increase flexibility for countries in how they use their budgets. And as we indicated last July, short-term targets would be unnecessarily burdensome to national and global economic growth and development. They could also mean that few, if any, countries would ratify the agreement.

Target v. Emissions Budget

Q 5) Last July you advocated a binding, medium-term target. Now you are advocating an emissions budget? Have you changed your position? What is the difference?

A 5) We are defining a budget as a multi-year target. For some time we have been persuaded that the target should cover a multi-year period because such a target has several advantages. First, a multi-year target would smooth year-to-year variability in weather and economic cycles. Second, a multi-year target would give countries important flexibility to determine the pace at which they would use their emissions (evenly, front-loaded or back-loaded). This flexibility will help countries reduce their compliance costs in view of differing national circumstances.

In our view, a target that extends over a multi-year period and an emissions budget are synonymous, but using the term "emissions budget" may help clarify what we mean. Thus, the United States has not changed its position.

Second Budget Period

Q 6) Why does Article 3(b) of the U.S. submission propose that the budget for the second budget period should be equal to or less than the budget for the first budget period? Is this realistic? How can you make such a proposal before your analysis and assessment is completed?

A 6) We are proposing that emissions budgets in the second period be equal to or less than those in the first period because it is important to signal our resolve to address the significant threat of climate change seriously. Science now tells us that significant reductions in greenhouse gas emissions are needed to stabilize atmospheric concentrations and avoid the potentially devastating impacts that will otherwise occur. What is critical is that this step of the climate convention be as clear as possible about long-term direction -- this will facilitate public and private sector investment in the new technologies that will be needed to address this problem effectively over time.

Third Budget Period?

Q 7) The Administration is proposing that the emissions budget for the second period be equal to or less than the emissions budget for the first period. What about the emissions budget for the third period -- will it be equal to or less than the budget for the second period?

A 7) The Administration has reached no decision about the emissions budget for a third budget period, but the science of this issue makes clear that we must begin now to reduce greenhouse gas emissions if we are to avoid the potentially devastating impacts of global warming in the future.

Borrowing

Q 8) Your proposal seems to allow developed countries to "borrow" from their future emissions budgets? If you are serious about global warming, isn't borrowing just letting them off the hook, and aren't we all just kidding ourselves?

A 8) We believe that some degree of borrowing against a future emissions budget should not be ruled out. In spite of their best intentions, countries are dealing with big variables in controlling their greenhouse gas emissions. These include, for example, economic growth and world fuel prices. In this sense, borrowing may provide a margin of safety.

On the other hand, we believe that borrowing should be limited to a very small percentage of a country's emissions budget. Under our proposal, if a country went over its emissions budget by the very small percentage we are suggesting, it would need to pay back that overage with interest in the next budget period. If a country were to go over its emissions budget by a larger percentage, it would be in non-compliance with its obligations.

Extent of Borrowing

Q 9) How much do you think countries should be able to borrow?

A 9) Very little.

Annex A and B

Q 10) Which countries would be included in your proposed Annex A, and which countries, if any, are likely to volunteer for Annex B and accept having an emissions budget of some kind?

A 10) We anticipate that all developed countries now listed in Annex I of the Convention would be included in Annex A. We anticipate that advanced developing countries, particularly those that have joined or will soon join the ranks of developed countries, will volunteer to take on the commitments of Annex B countries. Under the U.S. proposal, only countries with emissions budgets would be eligible to engage in emissions trading.

Annex B "Volunteers"

Q 11) Given how vehemently some of the more advanced developing countries have opposed any effort to have them shoulder responsibilities consistent with their economic status, what makes you think any of them will sign up for Annex B?

A 11) The United States and other developed countries have long maintained that, as countries develop to -- and beyond -- a certain point, they must graduate to assume responsibilities commensurate with their development. This view is entirely consistent with the Convention's concept of "common but differentiated responsibilities and capabilities." If we are to deal meaningfully with the threat of climate change, there can be no "free-riders" -- all countries must play an appropriate role. We believe that Annex B provides opportunities for advanced developing countries, on a voluntary basis, to graduate to a level of responsibility commensurate with their level of economic development. We believe that a number of such countries understand this view, share our concern about global warming and will volunteer for Annex B status.

Migration: Annex I to Annex B?

Q 12) Several countries have called for "differentiated" targets based on their concerns about the different economic welfare losses uniform reductions in greenhouse gas emissions would impose, yet the United States has opposed differentiated targets for developed countries. In your view, what is to keep these countries from volunteering for Annex B and opting out of Annex A?

A 12) Let us be clear. We understand the concerns that give rise to calls for "differentiated" targets. We believe those concerns can best be addressed by building in various elements of flexibility, including emissions budgets, emissions trading, and joint implementation. We do not believe that any country currently listed in Annex I would seek to avoid its responsiblities by opting out of Annex A and signing up for Annex B. Our proposal would not permit this, nor would we accept it.

Waiting for Godot

Q 13) The United States has rejected short-term targets before 2010 and is calling for multi-year emissions budgets. Won't we have to wait until 2010 at the earliest to know whether a country with an emissions budget has met its commitment?

A 13) No. Under the U.S. proposal, there would be strong reporting requirements for each country with an emissions budget. Each such country will need to have a national system in place by the beginning of the first budget period to measure its emissions accurately. It will also need to have in place national compliance and enforcement programs. Moreover, each country with an emissions budget will need to report on its national measurement system, the results of its measurement efforts, its projected emissions for the budget period, its national compliance and enforcement programs, including their effectiveness and the actions taken to deal with non-compliance.

Each year, each country with an emissions budget would need to submit a report on how much of its emissions budget remained for the rest of the budget period, and on how many tons of carbon equivalent it had obtained through emissions trading or joint implementation. All of this information would need to be reported on the basis of agreed guidelines and would be publicly available.

Review and Compliance

Q 14) How do we know that anything will happen to the information reported by countries with emissions budgets? Won't that information just sit around on some shelf in Germany gathering dust?

A 14) Under the U.S. proposal, the information reported by each country with an emissions budget would be considered by the Parties periodically to assess implementation efforts. Based on agreed guidelines, teams of experts would review the information submitted by these countries and assess their implementation efforts, including the likelihood that they will achieve their emissions budget obligations, in written reports. A meeting of the Parties could then make recommendations to individual Parties, which would then need to review their implementation efforts and report back to the next meeting of the Parties. In addition, the Parties would decide what consequences should apply to instances of non-compliance, including, for example, denial of emissions trading rights or rights to engage in joint implementation, loss of voting rights or other rights to participate in decision-making.

New Commitments for Developing Countries?

Q 15) The U.S proposal would require that developing countries identify and implement "no-regrets" measures for mitigating net human emissions of greenhouse gases, including any identified in a new review process. It also would require developing countries to quantify the effects of the measures they implement, evaluate barriers to adoption of potential measures and report to the Secretariat on measures implemented, planned for implementation and barriers to adopting potential measures. Aren't these new commitments that are not currently in the Convention? If so, don't they violate the Berlin Mandate's clear proscription against new commitments for developing countries?

A 15) No, in our view, these are not new commitments. The Convention's Article 4.1 already requires all Parties to take a series of actions, including formulating and implementing national or regional programs containing measures to mitigate climate change by addressing human greenhouse gas emissions by sources and removals by sinks. In our view, the elements contained in the U.S. proposal "continue to advance the implementation" of these existing commitments, and are fully consistent with the Berlin Mandate. They do so by being more specific, requiring action and reporting at the level of a specific action or activity.

Developing Country Inventories

Q 16) But the U.S. proposal also would require developing countries to submit inventories of greenhouse gas emissions on an annual basis. Currently, the Convention only requires developing countries to submit these inventories in their first national communication. How can you say that this isn't a new commitment?

A 16) The Convention's Article 12 addresses the frequency of reporting. It authorizes the Conference of the Parties to determine the frequency of communications, after the initial communication, for all Parties. The U.S. proposal is thus entirely consistent with existing Convention provisions in this regard.

Review Process for Developing Countries

Q 17) The U.S. proposal contains a rather extensive review process that would apply to developing countries. In particular, it would be designed to enable the review of the effects of individual measures. Doesn't Article 10 of the Convention limit the review of developing country communications to the "overall, aggregated effect of the steps taken by developing countries? Isn't this thus a "new commitment" that violates the proscription against new commitments for developing countries in the Berlin Mandate?

A 17) First, Article 10 authorizes the Convention's existing Subsidiary Body for Implementation (SBI), under the guidance of the Conference of the Parties, to consider emissions inventories submitted by developing countries to assess the overall aggregated effects of the steps taken by the Parties. It is difficult to see how the SBI can consider these inventories and assess the overall aggregated effects of steps taken without considering the individual steps taken.

Second, Article 7 requires the Conference of the Parties to keep under regular review the implementation of the Convention and any related legal instrument and make decisions within its mandate necessary to promote the effective implementation of the Convention. In particular, Article 7.2(e) requires the Conference of the Parties to assess, on the basis of all information made available to it under the Convention, the implementation of the Convention.

These provisions thus already authorize the Conference of the Parties and the Subsidiary Body for Implementation to review the effects of individual measures taken by all Parties. There is nothing in the U.S. proposal that strays from this or that violates the proscription against new commitments for developing countries.

What is Emissions Trading?

Q 18) What exactly is meant by emissions trading in the U.S. proposal?

A 18) We mean that any country with an emissions budget would be able to trade as much of its budget as it chooses to another country with an emissions budget.

Who Could Trade?

Q 19) Who would be authorized to engage in emissions trading under the U.S. proposal?

A 19) Under the U.S. proposal, any country with an emissions budget that was otherwise in compliance with its obligations would be able to trade with any other country with an emissions budget that was also in compliance with its obligations.

In addition, the U.S. submission proposes that any such country may authorize any domestic entity (e.g., government agencies, private firms, non-governmental organizations, individuals) to participate in actions leading to the transfer and receipt of tons of carbon equivalent. However, only countries with emissions budgets would be able to register such trades.

Barrier to Trading?

Q 20) Under the U.S proposal, won't emissions trading have to await a meeting of the Parties to the protocol and a decision by them on guidelines to facilitate the reporting of emissions trading information?

A 20) No. Emissions trading would be fully authorized in the protocol itself; only the reporting of emissions trading information would need to await a decision on guidelines by the Parties to the protocol. In our view, this ensures that the Parties will have a strong incentive to develop such guidelines quickly.

Joint Implementation

Q 21) The U.S. proposal contains extensive provisions authorizing joint implementation for credit. Don't these provisions contravene the decision taken at the First Conference of the Parties establishing a pilot phase for Activities Implemented Jointly and specifically prohibiting credit?

A 21) No, the decision of the Conference of the Parties on Activities Implemented Jointly provides for the Parties to reach a conclusive decision on the pilot phase and the continuation beyond it no later than the end of the current decade. There is nothing in that decision that prohibits the Parties to the Convention or the current round of negotiations from including provisions, along the lines of those proposed by the United States, in the new legal instrument. Moreover, we believe that the Parties have strong incentives to do so. For developed country Parties, joint implementation will help promote cost-effective emissions reductions. Joint implementation will also enable developing country Parties to generate tons of carbon equivalent emissions that they will be free to hold or transfer as they see fit, and such transfers will support sustainable development efforts in developing countries that choose to make them.

Additionality

Q 22) Like the U.S. Initiative on Joint Implementation, the U.S. proposal would require that projects provide a reduction additional to any that would otherwise occur. Isn't it impossible to determine this, and doesn't it work as a disincentive to companies interested in joint implementation?

A 22) Under the U.S. Initiative on Joint Implementation, additionality is determined on the basis of a comparison of the project in the absence of the specific measures taken or to be taken to reduce greenhouse gas emissions and as a consequence of those measures. Making such comparisons can be complex in some cases, but it is not impossible. In fact, the "additionality" requirement of the U.S. Initiative on Joint Implementation has not been a problem in practice for participants. In our view, a similar common sense approach can and should be adopted in the new legal instrument. The additionality requirement is fundamental, however, if we are to achieve real reductions in greenhouse gas emissions; otherwise, projects might just be old wine in new bottles -- or worse, they might actually increase greenhouse gas emissions.

Controversy over Joint Implementation

Q 23) Given the controversy that has raged over joint implementation for several years, and the utter hostility of many developing countries to joint implementation, how likely do you think it is that this feature of the U.S. proposal will survive the negotiating process and actually appear in some form in the new legal instrument? Aren't you really kidding yourselves?

A 23) We are facing a time that may extend well into the future of limited public sector resources and declining government budgets. However important they may be, funds available under the Convention's financial mechanism from the Global Environment Facility also are limited and will be wholly insufficient to support the kind of massive global effort needed to avert the threat of significant global warming. Joint implementation holds enormous potential to help solve this problem in ways that are good for the economies of developed and developing countries. Joint implementation projects will spur

investment in developing countries and sustainable development. Sustainable development, in turn, will facilitate taking the actions necessary to avert global warming and other threats to the environment.

Many developing countries already recognize these realities. We are confident that, with time and positive results from joint implementation projects, others will join them.

Scientific Review

Q 24) Article 8 of the U.S. proposal provides for periodic review of the protocol and the guidelines established under it, in light of evolving scientific knowledge related to climate change. Could this Article and its periodic reviews lead to further actions in the future to address global warming?

A 24) Yes. The Convention's ultimate objective is to stabilize atmospheric concentrations of greenhouse gases in the atmosphere at a level that would prevent dangerous human interference with the climate system. No matter how significant the next steps taken under this protocol, they will be only a milestone along a much longer path to attainment of the Convention's ultimate objective.

Long Term Goal

Q 25) What is meant by the "long term goal" with respect to atmospheric concentrations of greenhouse gases contained in Article 9 of the U.S proposal? Could this goal be different from the level mentioned in Article 2 of the Convention concerning the ultimate objective?

A 25) Yes. We need ultimately to establish a path that will result in bringing global emissions well below current levels and stabilizing atmospheric concentrations at a level that will prevent dangerous human interference with the climate system. Article 9 of the U.S. proposal calls on the Parties to the protocol to cooperate in establishing a trajectory for this reduction.

Dispute Settlement

Q 26) What is contemplated under Dispute Settlement? Is it akin to WTO dispute settlement?

A 26) Dispute Settlement in this context refers to bilateral State-to-State dispute settlement. The FCCC provides for mandatory conciliation for all Parties, i.e., a Party must go to dispute settlement upon the request of another Party, and the result is non-binding. That process will apply to the new legal instrument, unless the instrument provides otherwise. As in the case of the WTO, the instrument could provide for binding dispute settlement, particularly for Parties with emissions budgets; this is an option we want to see included in the Secretariat's compilation of proposals.

Evolution

Q 27) The U.S. proposal provides that the Parties to the protocol will adopt by 2005 legally binding provisions so that all Parties have quantitative greenhouse gas emissions obligations and so that there is a mechanism for automatic application of progressive greenhouse gas emissions obligations to Parties, based on agreed criteria. Doesn't this proposal obligate any developing countries that sign up to the protocol to adopt by 2005 quantitative commitments regarding their greenhouse gas emissions? If so, isn't this a new commitment in and of itself that violates the Berlin Mandate proscription against new commitments for developing countries? Even if not, why would any developing country intent on growing economically and reaching a level of development comparable to that of developed countries agree to such a commitment in this protocol?

A 27) In our view, this element of the U.S. proposal does not represent a new commitment on the part of developing countries. The Convention establishes an ultimate objective that can only be met if all countries participate appropriately in seeking to achieve it, recognizing their common but differentiated responsibilities and capabilities. Nowhere does the Convention suggest that any Party will forever be exempt from taking responsibility for its own greenhouse gas emissions.

The U.S. proposal in this regard recognizes the need for a global effort under which all countries take responsibility to reduce their greenhouse gas emissions. The U.S. proposal calls for the negotiation of a mechanism for automatic application of progressive greenhouse gas emissions obligations to Parties, on the basis of agreed criteria. This proposal is fully consistent with the "common but differentiated responsibilities and capabilities" of Parties already reflected in the Convention.

Entry into Force

Q 28) The U.S. proposal acknowledges the potential for "free-riders" and suggests that the protocol's entry into force provision may need to stipulate an entry into force trigger that requires ratification by States that account for a particular percentage of global emissions of greenhouse gases. Since U.S. emissions now account for about 22 percent of the total, will the U.S. propose that at countries representing, say, at least 85 percent of global emissions would need to ratify the protocol before it could enter into force? Given the significant differences between Congress and the Administration over the global warming issue, how likely is it that the Senate would give its advice and consent to the U.S. protocol proposal?

A 28) This is a complicated issue that will require considerable further study. On the one hand, the Administration takes the threat of global warming seriously and seeks to promote effective global action. Toward this end, too high a percentage requirement might thwart the efforts of countries to move forward. On the other hand, a protocol that is not ratified by countries representing a significant percentage of the world's emissions will not be effective in addressing this significant threat to our environment.

The Administration intends to continue working with the Congress to highlight the dimensions of the environmental problem we face and to find a solution that will be viewed as in the best interest of the United States, both environmentally and economically.

Public Consultation

Q 29) Despite its promises to the contrary, the Administration has developed its protocol proposal without consultation either with the Congress or with affected groups in the United States, whether from the environmental community or the private sector. When does the Administration intend to engage in a meaningful dialogue with the Congress and with non-governmental organizations? Can you amend the U.S. proposal before the next negotiating session?

A 29) The Administration has been involved in an intense dialogue with the Congress and with affected groups in both the environmental community and the private sector since 1993. It is simply not true to suggest otherwise. Moreover, the U.S. proposal is fully consistent with U.S. positions taken at each of the previous negotiating sessions, positions that have been developed with the input of the Congress and affected groups and positions that have been publicly stated on numerous occasions.

While we plan to continue efforts to refine the U.S. proposal prior to future negotiating sessions, in particular, by filling in various blanks in several areas noted in the U.S. text, we have no plans to amend the U.S. submission prior to the next negotiating session.

Development of the U.S. Proposal

Q 30) Who participated in developing the U.S. submission? Was this something done by staffers at the State Department, or were other agencies involved? At what level?

A 30) The U.S. submission was developed in a broad interagency process that began even before the end of the last negotiating session in Geneva on December 7 last year. It has been fully vetted within the Federal Government at working levels and at high policy levels. It has the full backing and support of the Administration, and represents a consensus of many different actors with many different points of view.

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THE WHITE HOUSE
WASHINGTON

cc: AM
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January 13, 1997

MEMORANDUM FOR DISTRIBUTION

FROM: Kristen Panerali
National Economic Council

SUBJECT: Climate Change Deputies Meeting

Attached please find the agenda and the paper for tomorrow's Climate Change Deputies meeting at 4:30 pm. in 231 OEOB.

Deputies plus one are invited to attend. If you have not done so yet, please call Kristen Panerali at 456-5353 with your clearance information by COB Monday, January 13.

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CLIMATE CHANGE AGENDA
January 14, 1996, 4:30 p.m., 231 OEOB

I. Introduction

II. Submission of draft protocol language

III. Review of modeling effort

IV. Development of domestic implementation policies

THE WHITE HOUSE

WASHINGTON

January 13, 1997

MEMORANDUM FOR CLIMATE CHANGE DEPUTIES

FROM: ELGIE HOLSTEIN, NEC

RE: **Paper for 1/14 Deputies Meeting**

Attached is a revised draft climate change protocol, based on discussions among the assistant secretaries group. In addition, I am attaching a paper prepared by the State Department regarding the issue of borrowing.

REV. 5, 1/13/97, 8 am

U.S. DRAFT PROTOCOL FRAMEWORK

(submitted without prejudice to ultimate form of agreement)

The Parties to this Protocol,

Have agreed as follows:

Article 1
Definitions

For purposes of this Protocol:

1. "The Convention" means the United Nations Framework Convention on Climate Change done at New York on 9 May 1992.

2. "Party" means Party to this Protocol.

3. "Greenhouse gas" means any greenhouse gas for which a global warming potential is set forth in Annex C of this Protocol.

4. "Tonne of carbon equivalent" means one metric tonne of carbon, or a quantity of one or more other greenhouse gases equivalent to one metric tonne based on the global warming potentials set forth in Annex C of this Protocol.

5. "Net anthropogenic emissions" of greenhouse gases is the calculated difference between emissions by sources and removals by sinks.

6. [other definitions to be developed or cross-referenced to the Convention as necessary]

Article 2
Emissions Budgets

1. Each Annex A and Annex B Party shall ensure that its net anthropogenic emissions of greenhouse gases do not exceed its emissions budget for any applicable budget period, as specified in this Article.

2. For each Annex A and Annex B Party, its emissions budget shall be denominated in tonnes of carbon equivalent emissions allowed and shall equal:

   (a) the tonnes of carbon equivalent emissions it is allowed under paragraph 3 or 4 below, plus

(b) any tonnes of carbon equivalent emissions allowed that are carried over from a prior budget period under paragraph 5 below, plus

(c) any tonnes of carbon equivalent emissions allowed that are acquired from another Party under Article 6 (International Emissions Trading) or Article 7 (Joint Implementation), minus

(d) any tonnes of carbon equivalent emissions allowed that are transferred to another Party under Article 6 (International Emissions Trading).

3. (a) For the first budget period, [20__ through 20__], each Annex A Party shall have a number of tonnes of carbon equivalent allowed equal to [a percentage of] its net anthropogenic emissions of tonnes of carbon equivalent in 1990, multiplied by [the number of years in this budget period].

(b) For the second budget period, [20__ through 20__], each Annex A Party shall have a number of tonnes of carbon equivalent emissions allowed equal to [a percentage equal to or less than the percentage in subparagraph 3(a)] of its net anthropogenic emissions of tonnes of carbon equivalent in 1990, multiplied by [the number of years in this budget period].

(c) [possible subsequent budget period(s)]

4. For the budget period [20__ through 20__], each Annex B Party (see Annex B for States included) shall have a number of tonnes of carbon equivalent emissions allowed equal to [options for Annex B Parties include: budget periods, baseyears, and/or percentages different from those applicable to Annex A Parties].

5. At the end of a budget period applicable to a Party, any amount by which the Party's emissions of tonnes of carbon equivalent is under its emissions budget for that period may be carried over and added to its emissions budget for the next budget period.

6. [Provision requiring control of greenhouse gases not listed in Annex C.]

7. Any State not listed in Annex A may, in its instrument of ratification, acceptance, approval or accession, or at any time thereafter, notify the Depositary that it intends to be bound by obligations of Annex A Parties. It will then be an Annex A Party. The Depositary shall inform the other signatories and Parties of any such notification.

8. Any State not listed in Annex A may, in its instrument of ratification, acceptance, approval, or accession, or at any time thereafter, notify the Depositary that it intends to be bound by obligations of Annex B Parties. It will then be an Annex B Party. The Depositary shall inform the other signatories and Parties of any such notification.

Article 3
Measurement and Reporting

1. Each Annex A and Annex B Party shall have in place by [the first year of its first budget period] a national system for the accurate measurement of anthropogenic emissions by sources, and removals by sinks, of greenhouse gases.

2. For the purposes of implementing paragraph 1 and promoting comparability, consistency, and transparency, the Parties shall, not later than their second Meeting, decide on minimum standards for the measurement of anthropogenic emissions by sources, and removals by sinks, of greenhouse gases.

3. Each Annex A and Annex B Party shall put in place, if it has not already done so, national compliance and enforcement programs relevant to its implementation of the obligations under this Protocol.

4. Each Annex A and Annex B Party shall submit to the Secretariat, as part of its communication under Article 12 of the Convention, information on its implementation of this Protocol, including policies and measures it is taking to meet its obligations in Article 2. Such submission shall be in accordance with guidelines which the Parties adopt at their first Meeting, taking into account any relevant guidelines adopted by the Parties to the Convention. Such submission shall also contain the following information:

   (a) once the obligation in paragraph 1 above becomes effective, a description of the national measurement system that it has in place;

   (b) once the obligation in paragraph 1 above becomes effective, the results of its national measurement system;

   (c) a quantitative projection of its net anthropogenic emissions of greenhouse gases through the budget periods; and

(d) a description of relevant national compliance and enforcement programs it has in place pursuant to paragraph 3 above, as well as a description of their effectiveness, including actions taken in cases of non-compliance with national law.

5. In addition to the information required to be submitted under paragraph 4, each Annex A and Annex B Party shall submit to the Secretariat, on an annual basis and in accordance with the guidelines referred to in paragraph 4, its current calculation corresponding to each of the subparagraphs in Article 2.2 and its remaining emissions budget for that budget period. With respect to any tonnes of carbon equivalent emissions allowed that are acquired or transferred under Articles 6 or 7, the Party shall specify the quantity, Party of origin or destination, and the relevant budget period.

6. The first of the submissions referred to in paragraph 5 shall be part of a Party's first communication that is due after the Protocol has been in force for that Party for two years. The frequency of subsequent submissions shall be determined by the Parties.

7. Information communicated by Parties under this Article shall be transmitted by the secretariat as soon as possible to the Parties and to any subsidiary bodies concerned.

8. Without prejudice to the ability of any Party to make public its communication at any time, the secretariat shall make information communicated by Parties under this Article publicly available at the time it is submitted to the Parties.

Article 4
Review and Compliance Process

1. In addition to the review of communications conducted under Article 10.2(b) of the Convention, the Meeting of the Parties shall consider the information submitted by Annex A and Annex B Parties under Article 3 in order to assess those Parties' implementation of their obligations.

2. Reviews will be conducted by expert review teams, which will be coordinated by the secretariat and composed of experts selected from those nominated by Parties and, as appropriate, by intergovernmental organizations.

3. Reviews will be in accordance with guidelines to be adopted by the Meeting of the Parties. These guidelines shall, inter alia, provide for how information will be made available to the public and define mechanisms by which observers and the public may provide comments, supplemental data or other information to facilitate and improve reviews. The guidelines shall be periodically reviewed by the Parties for appropriate revision.

4. Review teams will review all aspects of a Party's implementation of this Protocol, including the likelihood that a Party will achieve its emissions budgets obligations. They will prepare a report assessing a Party's implementation of its obligations, identifying any areas of apparent non-compliance, as well as potential problems in achieving obligations. Reports will be provided to a Meeting of the Parties.

5. Based on such reports, a Meeting of the Parties may make recommendations to a Party. In such case, the Party shall review its implementation, take appropriate action, and report back to the next Meeting of the Parties on its action.

6. There would also be provisions setting forth various consequences for non-compliance with obligations, as determined by a Meeting of the Parties. Consequences would correspond to the type, degree, and frequency of non-compliance. Some would be automatic, while others might be discretionary. Examples of consequences could include, e.g.:

   (a) denial of the opportunity to sell tonnes of carbon equivalent emissions allowed through international emissions trading and/or joint implementation;

   (b) loss of voting rights and/or other opportunities to participate in processes under the Protocol.

Article 5
Advancement of the Implementation of Article 4.1 of the Convention

Recognizing the progress that has been made to date in implementing commitments under Article 4.1 of the Convention:

1. The Parties reaffirm their commitments under Article 4.1 of the Convention and the need to continue to advance the implementation of such commitments.

2. Each Party shall strengthen its legal and institutional framework to advance the implementation of its commitments under Article 4.1 of the Convention.

3. Each Party shall take measures to facilitate investment in climate-friendly technologies.

4. Each Party shall report, as part of its communication under the Convention, on how it is promoting public education and participation in the development of climate change policy.

5. Each Party that is neither in Annex A nor Annex B shall identify and implement "no-regrets" measures for mitigating net anthropogenic emissions of greenhouse gases, including any identified through the review process under paragraph 7 below. In this regard, each such Party shall also:

   (a) quantify the effects of the measures it implements;

   (b) evaluate barriers to the adoption of potential measures; and

   (c) report to the Secretariat, as part of its communication under the Convention, on the measures it has implemented, plans to implement, and barriers to the adoption of potential measures.

6. Each Party that is neither in Annex A nor Annex B shall submit to the Secretariat, on an annual basis, its inventory of greenhouse gas emissions. Such inventory shall be consistent with any guidelines adopted by the Parties.

7. The Parties shall establish a process for reviewing communications received under the Convention from the Parties identified in paragraphs 5 and 6. The process shall be designed to:

   (a) enable the review of the effects of individual measures described in paragraph 5;

   (b) assist such Parties in identifying and implementing "no-regrets" measures for mitigating net anthropogenic emissions of greenhouse gases;

   (c) seek to identify key sectors and technological options within them;

(d) consider possibilities for promoting voluntary arrangements with industry aimed at identifying and encouraging implementation of "no regrets" measures; and

(e) explore various means through which such Parties could obtain both the know-how and the technology needed to implement options identified.

Article 6
International Emissions Trading

1. An Annex A or Annex B Party that is in compliance with its obligations under Article 3 (Measurement and Reporting) and that has in place a national mechanism for certification and verification of trades, may transfer to, or receive from, any Annex A or Annex B Party, any of its tonnes of carbon equivalent emissions allowed for a budget period, for the purpose of meeting its obligations under Article 2.

2. A Party may authorize any domestic entity (e.g., government agencies, private firms, non-governmental organizations, individuals) to participate in actions leading to transfer and receipt under paragraph 1 of tonnes of carbon equivalent emissions allowed.

3. A Meeting of the Parties may further elaborate guidelines to facilitate the reporting of emissions trading information.

Article 7
Joint Implementation

1. Any Party that is neither in Annex A nor B may generate tonnes of carbon equivalent emissions allowed through projects that meet the criteria set forth in paragraph 2.

2. In addition to any criteria adopted by the Parties to this Protocol, the following criteria shall apply to projects:

(a) Projects must be compatible with and supportive of national environment and development priorities and strategies, as well as contribute to cost-effectiveness in achieving global benefits;

(b) Projects must provide a reduction in emissions that is additional to any that would otherwise occur.

3. [Additional provisions to be added on calculation, measurement, monitoring, verification, review, reporting]

4. Any Party that generates tonnes of carbon equivalent emissions allowed consistent with this Article may:

   (a) hold such tonnes of carbon equivalent emissions allowed; or

   (b) transfer any portion thereof to any Party.

5. An Annex A or Annex B Party may acquire tonnes of carbon equivalent emissions allowed under this Article for the purpose of meeting its obligations under Article 2, provided it is in compliance with its obligations under Article 3 (Measurement and Reporting).

6. Any Party that is neither in Annex A nor Annex B that generates or acquires tonnes of carbon equivalent emissions allowed under this Article shall notify the Secretariat annually of the quantity, origin, and destination of such tonnes.

Article 8
Science

The Parties shall periodically review this Protocol, and guidelines established thereunder, in light of evolving scientific knowledge related to climate change.

Article 9
Progress Toward Long-Term Goal

The Parties shall cooperate in the establishment of a long-term goal with respect to atmospheric concentrations of greenhouse gases.

Article 10
Meetings of the Parties

1. The Parties shall hold meetings at regular intervals. The secretariat shall convene the first meeting of the Parties not later than one year after the date of the entry into force of this Protocol and in conjunction with a meeting of the Conference of the Parties to the Convention.

2. Subsequent meetings of the Parties shall be held, unless the Parties decide otherwise, in conjunction with meetings of the Conference of the Parties to the Convention. Extraordinary meetings of the Parties shall be held at such other times as may be deemed necessary by a meeting of the Parties, or at the written request of a Party, provided that within six months of such a request being communicated to them by the secretariat, it is supported by at least one third of the Parties.

3. The Parties, at their first meeting, shall:

(a) adopt, by consensus, rules of procedure for their meetings;

(b) [other].

4. The functions of the meetings of the Parties shall be to:

(a) review the implementation of this Protocol, including the information submitted in accordance with Article 3;

(b) periodically review the adequacy of this Protocol;

(c) [other].

5. The United Nations, its specialized agencies and the International Atomic Energy Agency, as well as any State not party to this Protocol, may be represented at meetings of the Parties as observers. Any body or agency, whether national or international, governmental or non-governmental, qualified in fields relating to climate change which has informed the secretariat of its wish to be represented at a meeting of the Parties as an observer may be admitted unless at least one third of the Parties present object. The admission and participation of observers shall be subject to the rules of procedure adopted by the Parties.

Article 11
Secretariat

1. In accordance with Article 8.2(g) of the Convention, the secretariat of this Protocol shall be the secretariat of the Convention.

2. The functions of the secretariat shall be:

(a) ...

Article 12
Subsidiary Body for Scientific and Technological Advice

1. The Subsidiary Body for Scientific and Technological Advice of the Convention shall serve as the Subsidiary Body for Scientific and Technological Advice of the Protocol.

2. When the Subsidiary Body for Scientific and Technological Advice exercises its functions with regard to matters concerning the Protocol, decisions shall be taken only by those of its members that are, at the same time, Parties to the Protocol.

3. When the Subsidiary Body for Scientific and Technological Advice exercises its functions with regard to matters concerning the Protocol, any member of the bureau of the Subsidiary Body for Scientific and Technological Advice representing a Party to the Convention, but, at the same time, not a Party to the Protocol, shall be substituted by an additional member to be elected by and from the Parties to the Protocol.

Article 13
Subsidiary Body for Implementation

1. The Subsidiary Body for Implementation of the Convention shall serve as the Subsidiary Body for Implementation of the Protocol.

2. When the Subsidiary Body for Implementation exercises its functions with regard to matters concerning the Protocol, decisions shall be taken only by those of its members that are, at the same time, Parties to the Protocol.

3. When the Subsidiary Body for Implementation exercises its functions with regard to matters concerning the Protocol, any member of the bureau of the Subsidiary Body for Implementation representing a Party to the Convention, but, at the same time, not a Party to the Protocol, shall be substituted by an additional member to be elected by and from the Parties to the Protocol.

Article 14
Multilateral Consultative Process

[The Parties, at their first Meeting or as soon as practicable thereafter, shall consider the establishment of a multilateral consultative process to promote effective implementation of the Convention.]

Article 15
Dispute Settlement

[silence, with the result that Article 14 of the Convention would apply to this Protocol.]

[in addition, mandatory, binding dispute settlement [with specific consequences flowing from a violation] among Annex A and Annex B Parties, as well as against other Parties as appropriate (e.g., host countries under Article 7)]

Note: this process would be without prejudice to the review and compliance process under Article 4

Article 16
Evolution

The Parties shall adopt, by [2005], legally binding provisions so that all Parties have quantitative greenhouse gas emissions obligations and so that there is a mechanism for automatic application of progressive greenhouse gas emissions obligations to Parties, based upon agreed criteria.

Views on Certain Final Clauses

Adoption and Amendments of Annexes

Depending upon what type of material is eventually included in annexes, it may not be appropriate to restrict the content of all annexes to "lists, forms and any other material of a descriptive nature that is of a scientific, technical, procedural or administrative character." For any substantive annex, it may not be appropriate to provide for tacit adoption/amendment.

Signature

This provision should state that only Parties to the Convention may be Parties to the Protocol.

Entry into Force

To ensure effective implementation, as well as to minimize the potential "free rider" problem, this provision may need to stipulate an entry into force trigger that requires ratification by States that account for a particular percentage of global emissions of greenhouse gases.

Annex A

This Annex would include the same States as those listed in Annex I of the Convention, plus those that join subsequently pursuant to Article 2.

Annex B

This Annex would include those States not listed in Annex A that indicate before adoption of the protocol that they want to be included in this Annex, plus those that join subsequently pursuant to Article 2.

Annex C

This Annex would list greenhouse gases not covered by the Montreal Protocol, with the exception of gases, or particular sources and sinks, for which there is insufficient knowledge of the GWP or inability to accurately measure emissions or removals. GWPs would be those developed by the IPCC.

BORROWING

Currently, the draft text provides no language on "borrowing", although the December paper tabled by the United States at the AGBM session suggested we would be exploring the potential for borrowing as well as banking. While the Assistant Secretary-level discussion agreed that at least in some form the issue of borrowing might be included, no agreement was reached as to the form that a borrowing regime would take -- nor, consequently, for what text should be inserted. Three possibilities for inclusion of borrowing in the text, covering the range of alternatives discussed, are suggested below:

Option 1: Right to Borrow

Allow an Annex A or B Party to borrow from the second budget period to meet its obligations in the first budget period (and from the third period for the second, if there is a third period specified in the Protocol). Borrowing would be limited in amount, and borrowed emissions would be repaid with interest in the subsequent period. Note that reporting and review of borrowed emissions, and the possible development of additional guidelines would already be covered by language in the existing articles. Non-compliance would be affected as follows: a Party would be in non-compliance if it exceeded its allowed borrowing quota; if it borrowed within allowed limits, whether it ultimately complied (i.e., repaid the tonnes) would not be known until the end of the subsequent budget period.

Option 2: Debt Carryover

Restrict borrowing to a "debt carryover" so that it would not be used as a planning device, but only as a safety valve in case budget obligations were not met. Unlike Option 1, a Party exceeding its emissions budget would be in non-compliance. This option could be additional to that described in Option 1 above; there would be a right to borrow up to a certain percentage; beyond that, exceedences would be penalized.

Option 3: Continue to Explore

Insert general language indicating that the United States is still interested in exploring allowing Parties to borrow against future emissions budgets in order to increase their current emissions budgets. Borrowing would require a credible accounting and repayment mechanism, and could entail additional restrictions (e.g., to limit the proportion of emissions reductions postponed). A borrowing regime might also be used to provide funds to assist developing countries (e.g., requiring Parties wishing to borrow to escrow a portion of the funds that might be required to purchase emissions in case of default, and using the funds to provide loan guarantees or grants to developing countries).

TEXTUAL OPTIONS

Right to Borrow

Language to this effect could be inserted in Article 2 as a new paragraph 2(b-bis), and a new paragraph 5 bis:

> Article 2(b-bis): "Up to [10 percent] of the tonnes of carbon equivalent emissions allowed under paragraphs 3 or 4 below such as may be borrowed from the subsequent budget period under paragraph 5 bis below."
>
> Article 2(5 bis): "At the end of a budget period applicable to a Party, any amount of tonnes of carbon equivalent emissions allowed that is borrowed from the subsequent budget period shall be subtracted at a rate of [1.2:1] from the subsequent budget period."

Debt Carryover

The notion of treating borrowing as a penalty rather than a right could be inserted into Article 4.6 as follows:

> Article 6(a): If an Annex A or Annex B Party exceeds its emissions budget in a particular budget period, it would have an additional emissions obligation (i.e., tonnes not achieved plus additional tonnes) for the following budget period."

Continue to Expore

Text similar to that in the description above would be inserted into Article 2 as paragraph 2(5bis).