RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Joseph E. Aldy (CN=Joseph E. Aldy/OU=CEA/O=EOP [CEA])

CREATION DATE/TIME: 1-OCT-1997 17:02:55.00

SUBJECT: temperature chart

TO: Janet L. Yellen (CN=Janet L. Yellen/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

TEXT:
========== ATTACHMENT 1 ==========
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:
Unable to convert ARMS_EXT:[ATTACH.D17]MAIL46680737L.216 to ASCII,
The following is a HEX DUMP:

Clinton Presidential Records Automated Records Management System [EMAIL]

Hex Dump file is not in a recognizable format, has been incorrectly decoded or is damaged.

File Name: p_k7370865_cea_html_1.pre

Attachment Number: [ATTACH.D17]MAIL46680737L.216

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: DAVID.FISCHER@MS01.DO.treas.sprint.com@INET@LNGTWY (
DAVID.FISCHER@MS01.DO.treas.sprint.com@INET@LNGTWY [UNKNOWN])

CREATION DATE/TIME: 1-OCT-1997 09:49:30.00

SUBJECT: draft of summers climate change memo

TO: Janet L. Yellen@eop (Janet L. Yellen@eop [CEA])
READ:UNKNOWN

TEXT:
Date: 10/01/1997 09:36 am (Wednesday)
From: David Fischer
To: EX.MAIL."yellen_j@a1.eop.gov"
Subject: draft of summers climate change memo

Attached is the latest draft of the Summers climate change memo.========== ATTACHMENT 1
==========
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:
Unable to convert ARMS_EXT:[ATTACH.D37]MAIL48956337F.216 to ASCII,
The following is a HEX DUMP:

Global Climate Change: Which Way Forward?

Executive Summary

There is now a compelling scientific case that the build-up of greenhouse gases poses sufficiently great risks to justify international policy action to contain their growth. A central question is whether our course of action weighs appropriately the environmental benefits and the countervailing economic and political costs. This memo argues that American acceptance of the kind of ambitious targets and timetables envisioned in the Kyoto process would have highly adverse economic, political and, ultimately, environmental implications. In particular, adopting a strict target and timetable would require reductions in energy use exceeding those from the OPEC price shocks, implying a tax on energy use over five times as large as our 1993 BTU tax proposal. These costs cannot plausibly be claimed to be lowered by technology policy nor by international trading of permits. As a result, such a policy approach would leave us open to criticism along many fronts, and may set back for many years our ability to constructively tackle the climate change issue.

I go on to highlight the advantages of more gradual alternatives that are more consistent with sound economic performance, political realism and environmental protection and are at the same time do not contradict with commitments we have made. In particular, I note that a much more gradual approach can provide nine-tenths of the environmental benefits at one-tenth of the economic costs.

I. The Economics of Reducing Emissions

A central fact that should frame discussions of emissions control is this: *Between 1973 and 1985, the combination of two OPEC price shocks; a Presidential commitment that the energy issue was the moral equivalent of war; and extensive regulation, incentives and research was only sufficient to stabilize energy usage and carbon emissions.* Since 1985 and the end of the OPEC shock, energy demand has increased rapidly.

This example illustrates what virtually all economic models and reviews of historical evidence have concluded. *It will not be possible to stabilize let alone reduce carbon emissions in the United States without substantial and continuous increases in the price of carbon fuels.* Relevant rules of thumb based on optimistic but credible estimates are:

- Carbon efficiency is expected to increase by about 0.9 percent per year if no policies are undertaken to boost it. Assuming trend GDP growth of about 2.5 percent per year, carbon emissions will therefore rise about 1.6 percent per year in the absence of policy intervention, or about 16 percent over the course of a decade.

- It requires a $4-$8 per ton increase in the price of carbon to reduce emissions by about 1 percent after a decade.

Therefore, holding emissions steady for a decade would require the price of carbon fuels to rise

by the equivalent of $64-128 per ton of carbon emissions. Reducing emissions to their 1990 level from their year 2000 level would require price increases of an additional $48-$96 per ton in order to offset the 12 percent increase between 1990 and 2000.

Carbon price increases on this order of magnitude would have major economic and political implications:

- The 1993 BTU tax was the equivalent of only a $20-per-ton carbon tax, so this amounts to *more than 5 BTU taxes.*

- Even a $50-per-ton carbon tax would reduce the standard of living of the average family by about $550; this is roughly equivalent to more than one week's take-home pay. An increase in the price of carbon would be highly regressive in its impact; the burden on the lowest fifth of the population would be 6 times as great as the burden on the highest fifth.

- Depending on the means and pace of implementation and the use of any revenues generated, higher fuel prices could have significant impacts on economic performance. Unlike the question of whether substantial price increases are needed to reduce emissions growth, there is divided expert opinion on how serious the economic effects of price increases be. A conservative guess is that they would over each 15-year period be the equivalent of adding one mild recession to the economy's performance.

As a result of analyses like this, and environmental considerations noted below, none of the lead signatories on the recent economists' letter supporting action on climate change believes that stabilizing at 1990 levels by 2010 is warranted.

- Some have claimed on the basis of the S02 experience that current projections regarding the costs of a CO2 program are far too pessimistic. *We have not been able to find any outside expert who is willing to validate this tempting argument.* The S02 program is 1 percent of the size of a likely CO2 program. Its success is traceable to the fact that it replaced an enormously burdensome and inefficient command-and-control system. It also benefitted importantly from the deregulation of the freight railway system, which transformed the economics of using low-sulfur western coal.

Technology

In the very long run, technology determines what can be achieved in reducing carbon emissions, so major new research funding and perhaps funding for diffusing technology is important. But, it is very doubtful that even a concerted effort on technology could significantly alter the analysis just presented.

- The "5 Labs Study" is regarded as indefensibly optimistic by John Deutch and all your economic advisers. The study invokes a host of unrealistic assumptions about technology penetration rates and ludicrously high rates of return on public R&D expenditure (roughly 1700% for transportation R&D, for example). It plans through a

series of government actions to redirect firms to invest an additional $50-$90 billion per year in energy efficient technologies, beyond what they would now choose to invest. Not only would drain about 7 percent of total investment away from the other purposes to which it might be put, but it is simply implausible to imagine that this could occur without hugely costly government incentives.

- Yet even this highly optomistic study concludes that emissions cannot be reduced by more than 30% of the way from their baseline 2010 level towards their 1990 level without a substantial increase in price of roughly $50/ton.

International Trading

There is a strong case for seeking international flexibility in any global approach to greenhouse problems. But even under the most optimistic plausible assumptions, international flexibility is unlikely to radically alter the preceding analysis.

- It is doubtful that other countries will let the United States buy its way out of a large share (more than one-third) of its emissions control obligation, and even more doubtful that Congress would appropriate the $5-10 billion for the US to buy emissions rights from other countries. While it may be possible, we are not aware of any model that has been put forward for firms to buy emissions rights directly from foreign governments.

- Joint implementation shows enormous promise in pilot projects. But there has been no demonstration to date that it can be brought to scale in a way that is acceptable to developing countries. It only works if Americans are given credit for reductions in other countries' emissions--something foreign governments are likely to resist if they are covered by binding targets.

Conclusion: Recognizing the enormous uncertainty associated with long run projections, and the likelihood of positive innovations, we are convinced that it will not be possible to claim that the US is going to restore 1990 emissions levels without very large energy price increases that are many multiples of those contemplated by the BTU tax. These costs will be borne by consumers regardless of whether an auction permit, tax or "grandfathering scheme". The only difference is that the first two schemes make it possible to compensate consumers for these costs, and avoid what your economic advisers regard as enormous administrative problems with an allocated permit system.

Despite the economic impacts, committing to ambitious goals in Kyoto might nonetheless be justified if this would result in meaningful action in the US and abroad, and if it was necessary scientifically. We turn next to these questions.

II. The Politics of Ambitious Commitments

The effects of ambitious commitments in Kyoto depend on whether a treaty is agreed or not. I begin by considering the impact of ratified treaty, and then the effects of ambitious commitments

that are followed by a breakdown of the process.

Ratifying a Treaty

Barring radical changes in the natural or political environment, it is very unlikely that the Senate would ratify any treaty embodying ambitious commitments, especially given the absence of a fast track mechanism to hold off amendments. The attempt would be a great gamble since a Senate rejection would risk a "League of Nations" effect of knocking serious American global warming action off the agenda for a decade.

Beyond special interest pleading about continuing scientific uncertainty, arguments that likely to be persuasive in the political arena, though not necessarily valid, against an ambitious Kyoto treaty include:

- ***There They Go Again:*** Whether the mechanism is literally a tax, or is some kind of permit scheme that raises all residential energy prices, it will be very difficult to persuade people that higher energy prices are not essentially like a tax. This will play into stereotypes that we have worked to break down over the last 4 years.

- ***Large Economic Costs***: This policy would immediately be recognized as five times the BTU tax. The recent EPI study warning of the loss of 2 million jobs while highly questionable is typical of the firestorm that would come forth. The group opposing ambitious Kyoto commitments would include, most large companies, all energy using small businesses, organized labor, consumer groups, and those fearful about competitiveness. It is likely that moderate sources of analysis (e.g. Brookings, CBO, IIE, AEI, mainstream Democratic economists like Alan Blinder or Bill Nordhaus) would be unfavorable to ambitious commitments.

- ***Unfair to America:*** Any "1990 by some date" goal will require far more radical action relative to the baseline in the US than in other Annex I signatories. For example a 1990 by 2010 treaty would require US actions to reduce emissions by 28 percent relative to the baseline, compared 9 percent for the remainder of Annex I, 19 percent for the EU, and nothing for the UK, Germany, or Russia.

- ***A Giveaway to Developing Countries:*** Even if we agree not to submit any treaty for ratification until developing countries take on binding commitments, problems will remain. It is inconceivable that they will take on obligations nearly as severe as stabilization at 1990 levels. We will be open to the charge that we sacrificed all our leverage by making our commitment before they had made any commitment at all. China in particular will stand out as a major problem.

- ***Will Others Comply?:*** Because of our openness, transparency, and legal system, America will comply with any treaty it ratifies. It will be difficult to be convincing that China or many other countries will be bound by their treaty commitment. And it is hard to see what mechanism will be used to punish countries that emit too much. In market economies,

governments do not control emissions directly so it will be difficult to hold them responsible. Compliance with international fines in the billions of dollars range will seem problematic to say the least.

It is sobering to compare the political alignments on fast track and global warming. On an ambitious Kyoto treaty, the business support we have on fast track will largely turnout against us, and the support of elites will be very divided with economically oriented elites likely to turn strongly against us. Small business is likely to be much more negative on global warming as well. Against this, the environmental organizations are likely to be much more positive on global warming than fast track.

No Kyoto Agreement

A cynical but plausible argument holds that if Kyoto will fail because of developing country issues, and issues of implementation, it is better for us to have endorsed ambitious commitments so that we shift some responsibility for failure and at least keep faith with the environmental community. In fact, I fear we won't reap much environmental benefit and we will incur large political costs.

- Even with a 1990 by 2010 commitment we will still have been seen as unconstructive by Europe and by domestic environmental groups, particularly if we insist on the Byrd amendment. So we do not escape much of the responsibility for the failure to reach an agreement in Kyoto.

- Much of the cost of ambitious commitments is borne even if there is no treaty. Public disclosure of our domestic implementation plan will be demanded. Any failure in Kyoto will lead to a new scheduled meeting and great pressure from the business community not to keep our offer on the table. And it is hard to see how we can raise the profile of the issue without also giving profile to the economic consequences of whatever goal we set.

III. Environmental Arguments

Despite the economic costs they would engender, and the political risks involved, there might still be a compelling case for ambitious commitments in Kyoto if a strong Kyoto treaty was likely to be the difference between a successful and unsuccessful international efforts to prevent the costs of global warming.

The situation is more complex however. The Figure below depicts projected increases in global temperature in a baseline "do nothing" case, an ambitious Kyoto agreement case, where industrialized countries stabilize at 1990 levels in 2010 and developing countries stabilize in 2030, and a gradual agreement case where industrialized countries only get back to 1990 levels in 2040 and developing countries stabilize in 2050.

The results are striking. A human lifetime from now in 2070, the temperature rises 1.5 degrees if nothing is done, 1.4 degrees with ambitious efforts, and 1.3 degrees with gradual

efforts. In *2070, the ambitious Kyoto strategy reduces temperatures by only 0.1 degrees more than the gradual strategy, or only one-fifteenth of the baseline temperature increase.* Yet as the background paper to this one demonstrates, it requires ten times as great increases in energy prices over the next decade as the "gradual" strategy.

The basic point that great ambition now produces relatively small incremental environmental benefits relative to more gradualism can be made in another way. A number of studies have framed the question: Given a goal of stabilizing global concentrations at twice pre-industrial levels, what is the least cost emissions path? In all cases they conclude that a path far less ambitious than those implicit in a Kyoto agreement is justified. Essentially, this is because a least cost approach to carbon reduction forces the replacement of worn out plants with new technologies but not the scrapping of existing plants.

Politics and the Kyoto process aside, the question is not one of economic costs versus the existence of global warming -- it is one of the economic costs of alterantive policy paths versus their precise degree of environmental benefit. While the idea of stabilizing emissions at 1990 levels by a near term date has taken on political significance in the years since Rio, it is not a necessary part of program to achieve even ambitious long term environmental goals. It is clear from this discussion that much more gradual approaches have essentially the same environmental benefit at only a small fraction of the economic cost.

IV. What Should be Done?

This analysis argues that: (i) any attempt to stabilize US carbon emissions at 1990 levels anytime near 2010 would require large increases in energy prices with substantial consequences, (ii) that such a commitment if offered would have highly adverse political consequences for the prospect of actually legislating emissions reductions, and (iii) that such a commitment would not yield large environmental benefits relative to the whole global warming problem and is not necessary to achieve ambitious environmental objectives.

I seriously doubt that these points can be finessed within any proposal that is anywhere near the proposals floated by the other parties to Kyoto. Pushing dates back from 2010 does not help that much substantively because baseline emissions rise; for example, the economic costs of delaying to 2020 are 90% as large as those of setting a 2010 timetable. Moreover, to the extent that such delay is domestically politically feasible because pain becomes remote, it also becomes internationally unacceptable.

The conclusion is that Kyoto should become a "turning point" rather than a "finishing point" in the global effort to control greenhouse gases. Given current realities the US should consider as an alternative to offering a target and timetable working with others for a "Kyoto mandate" that would:

- Articulate that it was in the interest of all nations to have a "global least cost" approach to stabilizing greenhouse gas concentrations. Propose an IPCC-like exercise to determine how this could best be done. Issues of JI, traceable permits, and phasing could be

considered.

- Recognize the political and analytical reality that to be effective any global approach to this problem must involve all major emitters, and invite them to participate going forward. Insist that a global effort for phased elimination of energy subsidies must be agreed upon prior to countries being required to introduce new energy taxes

- Recognize the increasing irrelevance of 1990 emissions levels by setting targets relative to the ratification date, not a subjective past date. Similarly, recognize issues of international equity by proposing targets that are differentiated on the basis of progress attainable through own-country domestic implementation (e.g. neither Germany nor the remainder of the EU should get credit for shutting down East German emitters).

- Establish a global research facility that is funded to explore the application of renewables, techniques of sequestration, methods of conservation, and guaging the seriousness of the global warming problem.

Domestic Implementation

Beyond international acceptance of a Kyoto Mandate, we must consider our domestic strategy going forward. Any long range plan should include several key features:

- A call for a Treasury Department report, or a National Commission, to suggest proposals for moving towards a strategy of "taxing bads, not goods" as a means of collecting government revenues.

- A concerted public education effort as to the seriousness of the problem.

- A climate-friendly electricity deregulation bill

- Major investements in R&D to help minimize the economic costs of reducing emissions

Beyond these initiatives, there are two alternative strategies for global warming policies:

Small but Concrete Policy Initiative: The first is to pursue a concrete domestic price-based policy, such as a small carbon tax. This strategy involves an explicit up-front committment and cost. It also explicitly acknowledges that Kyoto has blown up, and that we are sending the system back to the drawing board. But it leaves time for education before we pursue a more aggressive strategy, and it avoids a political firestorm.

Gradual Target and Timetable: The second is to combine a soft target and timetable (e.g. stabilize emissions growth by 2015; 1990 by 2040) with a vague policy approach, a position on developing countries that delays a Byrd ammendment battle, and ambitious rhetoric about the seriousness of the problem and of our response to it. But this approach *faces a serious risk of satisying no constituency, domestic or international:*

- There is no Kyoto agreement or real satifisfaction of the environmental community

- There is an avalance of criticism about being prepared to put the economy at risk before there is public appreciation of the seriousness of the issue.

- There is a major loss of credibility from our inability to be explicit about the details and costs of our policy approach.

These risks are typified by the option of an aggressive "escape clause", which would appear to allow us to have it both ways by both having a strict target and timetable and capping the economic costs of our policy, but in fact satisfies no one. We would obtain no international satisfaction with such an approach, and our domestic adversaries will still play up the implicit tax increase inherent in the strict target and timetable.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Janet L. Yellen (CN=Janet L. Yellen/OU=CEA/O=EOP [CEA])

CREATION DATE/TIME: 1-OCT-1997 20:29:46.00

SUBJECT: Revised Summers memo-

TO: Jeffrey A. Frankel (CN=Jeffrey A. Frankel/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

CC: Adele C. Morris (CN=Adele C. Morris/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

CC: Randall W. Lutter (CN=Randall W. Lutter/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

CC: Joseph E. Aldy (CN=Joseph E. Aldy/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

TEXT:
Attached are George's and my revisions of the Summers memo. Comments would be appreciated.

========== ATTACHMENT 1 ==========
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:
Unable to convert ARMS_EXT:[ATTACH.D33]MAIL49798737C.216 to ASCII,
The following is a HEX DUMP:

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There is now a compelling scientific case that the build-up of greenhouse gases poses sufficiently great risks to justify international policy action to contain their growth. This memo argues that American acceptance of the kind of ambitious targets and timetables envisioned in the Kyoto process would have deleterious economic, political, and environmental implications. In particular, adopting a strict target and timetable would require reductions in energy use much greater than those following the OPEC price shocks and requiring a tax on energy use more than six times as large as our 1993 BTU tax proposal. These costs cannot plausibly be claimed to be reduced by technology policy nor by international trading of permits.

We propose an alternative target and timetable that is more gradual and more consistent with sound economic performance, political realism, environmental protection, and previous international commitments. A much more gradual approach can provide nine-tenths of the environmental benefits at one-third to one-tenth of the economic damage. But even this much more gradual response entails meaningful action now. It will require a significant early price signal to discourage carbon emissions and the price signal must rise over time.

I. The Economics of Reducing Emissions

A central fact that should frame discussions of emissions control is this: *Between 1973 and 1985, the combination of two OPEC price shocks, a Presidential commitment that the energy issue was the moral equivalent of war, and extensive regulation, incentives and research was only sufficient to stabilize energy usage and carbon emissions.* Since 1985 and the end of the OPEC shock, energy demand has increased rapidly.

This example illustrates what virtually all economic models and reviews of historical evidence have concluded. *It will not be possible to stabilize let alone reduce carbon emissions in the United States without substantial and continuous increases in the price of carbon fuels.* Relevant rules of thumb based on optimistic estimates are:

- Carbon efficiency is expected to increase by about 0.9 percent per year if no policies are undertaken to boost it. Assuming trend GDP growth of about 2.4 percent per year, carbon emissions will therefore rise about 1.5 percent per year in the absence of policy, or about 16 percent over the course of the decade.

- A $4 to $8 per ton increase in the price of carbon fuels is required to reduce emissions by about 1 percent after a decade.

Therefore, holding emissions steady for a decade would require the price of carbon fuels to rise by the equivalent of $64 to $128 per ton of carbon emissions. Reducing emissions to their 1990 levels from their year 2000 level would require price increases of an additional $60 to $120 per ton in order to offset the 15 percent increase between 1990 and 2000.

Carbon price increases of this order of magnitude would have major economic and political implications:

- The 1993 BTU tax was the equivalent of only a $20-per-ton carbon tax.

- Even a $50-per-ton carbon tax would reduce the standard of living of the average family by about $550; this is roughly equivalent to more than one week's take-home pay. Preliminary evidence also suggests that an increase in the price of carbon would be highly regressive in its impact.

As a result of analyses like this, and environmental considerations noted below, none of the lead signatories on the recent economists' letter supporting action on climate change believes that stabilizing at 1990 levels is warranted.

Technology

In the very long run, technology determines what can be achieved in reducing carbon emissions, so major new research funding and perhaps funding for diffusing technology is important. But, it is very doubtful that even a concerted effort on technology could significantly alter the analysis just presented.

- DOE's "5 Labs Study" is regarded as indefensibly optimistic by all your economic advisers. The study invokes a host of unrealistic assumptions about technology penetration rates and ludicrously high rates of return on public R&D expenditure (roughly 1700% for transportation R&D, for example). It plans through a series of government actions to redirect firms to invest an additional $50-$90 billion per year in energy efficient technologies, beyond what they would now choose to invest. It is simply implausible to imagine that this could occur without hugely costly government incentives.

- Yet even this highly optimistic study concludes that emissions cannot be reduced by more than 30 percent of the way from their baseline 2010 level towards their 1990 level without a substantial increase in price of roughly $50/ton.

International Trading

The potential for global international trading of permits has been greatly exaggerated. If successfully implemented, permit trading amongst Annex I countries could reduce the carbon tax needed to attain 1990 emissions by 2010 by half, with further significant reductions in costs from joint implementation with developing countries. But the practical difficulties of establishing such a system make it, at best, a marginal contributor in the near future. The possibilities of international trading therefore should have virtually no bearing on the preceding analysis.

- Both international permit trading and joint implementation incur severe difficulties of both enforcement and monitoring. For example, every country in the system would be tempted to allow its firms to fraudulently sell their emissions rights into the international market, garner the resulting revenue, and exceed their allowed level of emissions.

- It is doubtful that governments choosing to implement their own domestic emissions reductions through regulatory approaches or through energy taxes will be willing to tighten these domestic restrictions in order to profit from permit sales to the United States.

- *Larry: I think this is misleading because the government would be purchasing foreign permits on behalf of domestic entities who would pay for them. The U.S. govt. would be an intermediary.* ~~It is doubtful that other countries will let the United States buy its way out of a large share (more than one-third) of its emissions control obligation, and it is yet more doubtful that Congress would appropriate the $5-10 billion for the US to buy emissions rights from other countries. Furthermore, while it may be possible, we are not aware of any proposal that would allow firms to purchase emissions rights directly from foreign governments.~~

- There is some scope for joint implementation in which emissions credits would be given for carbon savings investments in developing countries. Such an approach should be explored thoroughly but cautiously. The major difficulty in such programs is that they may entail paying for investments that would have been made even in the absence of the foreign subsidy, with no reduction in greenhouse gas emissions.

Conclusion: Recognizing the enormous uncertainty associated with long run projections, and the likelihood of positive innovations, it will not be possible for the US to restore 1990 emissions without very large energy price increases that are many multiples of those contemplated by the BTU tax. These costs will be borne by consumers regardless of the form of implementation, although some means are better than others. For example, in the choice between an auction permit, a tax, or a "grandfathering scheme," the first two schemes make it possible to compensate consumers for these costs out of revenues, and avoid what your economic advisers regard as enormous administrative problems with an allocated permit system.

Despite the harsh economic impacts, committing to ambitious goals in Kyoto might nonetheless be justified if this would result in meaningful action in the US and abroad, and if it was necessary scientifically. We turn next to these questions.

II. The Politics of Ambitious Commitments

The effects of ambitious commitments in Kyoto depend on whether a treaty is agreed or not. We begin by considering the impact of a ratified treaty, and then the effects of ambitious commitments that are followed by a breakdown of the process.

Ratifying a Treaty

Barring radical changes in the natural or political environment, it is very unlikely that the Senate would ratify any treaty embodying ambitious commitments, especially given the absence of a fast track mechanism to hold off amendments. The attempt would be a great gamble since a Senate rejection would risk a "League of Nations" effect of knocking serious American global warming action off the agenda for a decade.

Beyond special interest pleading about continuing scientific uncertainty, arguments that are likely to be persuasive in the political arena, though not necessarily valid, against an ambitious Kyoto treaty include:

- ***Large Economic Costs*:** This policy would immediately be recognized as six times the BTU tax. The recent EPI study warning of the loss of 2 million jobs is typical of the firestorm that would come forth. The group opposing ambitious Kyoto commitments would include most large companies, all energy using small businesses, organized labor, consumer groups, and those fearful about competitiveness. It is likely that moderate sources of analysis (e.g. Brookings, CBO, IIE, AEI, mainstream Democratic economists) would also be unfavorable to ambitious commitments.

- ***Unfair to America:*** Any "1990 by some date" goal will require far more radical action relative to the baseline in the US than in other Annex I signatories. For example a 1990 by 2010 treaty would require US actions to reduce emissions by 28 percent relative to the baseline, compared to 9 percent for the remainder of Annex I--including 19 percent for the EU, and nothing for the UK, Germany, or Russia.

- ***A Giveaway to Developing Countries:*** Even if we agree not to submit any treaty for ratification until developing countries take on binding commitments, problems will remain. It is inconceivable that they will take on obligations nearly as severe as stabilization at 1990 levels. We will be open to the charge that we sacrificed all our leverage by making our commitment before they had made any commitment at all. China in particular will stand out as a major problem.

- ***Will Others Comply?:*** Because of our openness, transparency, and legal system, America will comply with any treaty it ratifies. It will be difficult to be convincing that Russia, China or many other countries will be bound by their treaty commitment. And it is hard to see what mechanism will be used to punish countries that emit too much. In market economies, governments do not control emissions directly so it will be difficult to hold them responsible. Compliance with international fines of billions of dollars will seem problematic.

It is sobering to compare the political alignments on fast track and global warming. With an ambitious Kyoto treaty, the business support we have on fast track will largely turn out against us, and the support of elites will be divided, with economically oriented elites likely to turn strongly against us. Small business is likely to be much more negative on global warming as well. Against this, the environmental organizations are likely to be much more positive on global warming than fast track.

No Kyoto Agreement

A cynical but plausible argument holds that if Kyoto will fail because of developing country issues, and issues of implementation, it is better for us to have endorsed ambitious commitments so that we shift some responsibility for failure and at least keep faith with the environmental community. In fact, we fear we won't reap much environmental benefit and we will incur large political costs.

- *Most important of all, future negotiations are likely to begin where the last negotiations left off. A realistic negotiating stance for the present, even if no treaty is agreed in Kyoto, or subsequently ratified, is still the best for the future. Since it will* never *be acceptable to the Congress or desirable for the country unnecessarily to kill the economy, the place to begin is with a timetable and proposed implementation that will ultimately stabilize atmospheric carbon at realistic levels but with acceptable economic impact.*

- Even with a 1990 by 2010 commitment we will still have been seen as unconstructive by Europe and by domestic environmental groups, particularly if we insist on the Byrd amendment. So we do not escape much of the responsibility for the failure to reach an agreement in Kyoto.

- Much of the cost of ambitious commitments is borne even if there is no treaty. Public disclosure of our domestic implementation plan will be demanded. Any failure in Kyoto will lead to a new scheduled meeting and great pressure from the business community to take our offer off the table. And it is hard to see how we can raise the profile of the issue without also giving profile to the economic consequences of whatever goal we set.

III. Environmental Arguments

Despite the economic costs they would engender, and the political risks involved, there might still be a compelling case for ambitious commitments in Kyoto if a strong Kyoto treaty was likely to make the difference between a successful and unsuccessful international efforts to attenuate global warming.

The situation is more complex however. The Figure below depicts projected increases in global temperature in a baseline "do nothing" case, an ambitious Kyoto agreement case, where

industrialized countries stabilize at 1990 levels in 2010 and developing countries stabilize in 2030, and a gradual agreement case where industrialized countries only get back to 1990 levels in 2040 and developing countries stabilize in 2050.

The results are striking. A human lifetime from now in 2070, the temperature rises 1.5 degrees if nothing is done, 1.4 degrees with ambitious efforts, and 1.3 degrees with gradual efforts. In *2070, the ambitious Kyoto strategy reduces temperatures by only 0.1 degrees more than the gradual strategy, or less than one-fiftieth of the baseline temperature increase. .*

The basic point that great ambition now produces relatively small incremental environmental benefits relative to more gradualism can be made in another way. A number of studies have framed the question: Given a goal of stabilizing global concentrations at twice pre-industrial levels, what is the least cost emissions path? In all cases they conclude that a path far less ambitious than those implicit in a Kyoto agreement is justified. Essentially, this is because a cost-effective approach to carbon reduction forces the replacement of worn out plants with new technologies but not the scrapping of existing plants. And it waits for the development of superior technologies before forcing the replacement of exiting plant and equipment.

Politics and the Kyoto process aside, the question is not one of economic costs versus the *existence* of global warming--it is one of the economic costs of alternative policy paths versus their precise degree of environmental benefit. It is clear from this discussion that much more gradual approaches have essentially the same environmental benefit at only a small fraction of the economic cost.

IV. What Should be Done?

This analysis argues that: (i) any attempt to stabilize US carbon emissions at 1990 levels anytime near 2010 would require large increases in energy prices with substantial consequences, (ii) that such a commitment if offered would have highly adverse political consequences for the prospect of actually legislating emissions reductions, and (iii) that such a commitment would not yield large environmental benefits relative to the whole global warming problem and is not necessary to achieve ambitious environmental objectives.

We seriously doubt that these points can be finessed within any proposal that is anywhere near the proposals floated by the other parties to Kyoto. Pushing dates back from 2010 does not help that much substantively because baseline emissions rise; for example, the economic costs of delaying to 2020 are 90% as large as those of setting a 2010 timetable. Moreover, to the extent that such delay is domestically politically feasible because pain becomes remote, it also becomes internationally unacceptable.

The conclusion is that Kyoto should become a "turning point" rather than a "finishing point" in the global effort to control greenhouse gases. Given current realities the US should consider as an alternative to offering a target and timetable working with others for a "Kyoto

mandate" that would:

- Articulate a commitment to stabilizing greenhouse gas concentrations and not just emissions. Emphasize that it is in the interest of all nations to have a "global least cost" approach to achieving stabilization of concentrations. Propose an IPCC-like exercise to determine how this could best be done. Issues of JI, traceable permits, and phasing could be considered.

- Recognize the political and analytical reality that to be effective any global approach to this problem must involve all major emitters, and invite them to participate going forward. Insist that a global effort for phased elimination of energy subsidies must be agreed upon prior to countries being required to introduce new energy taxes

- Recognize the increasing irrelevance of 1990 emissions levels by setting targets relative to the ratification date, not a subjective past date. Similarly, recognize issues of international equity by proposing targets that are differentiated on the basis of progress attainable through own-country domestic implementation (e.g. neither Germany nor the remainder of the EU should get credit for shutting down East German emitters).

- Establish a global research facility that is funded to explore the application of renewables, techniques of sequestration, methods of conservation, and gauging the seriousness of the global warming problem.

Domestic Implementation

Beyond international acceptance of a Kyoto Mandate, we must consider our domestic strategy going forward. Any long range plan should include several key features:

- A call for a Treasury Department report, or a National Commission, to suggest proposals for moving towards a strategy of "taxing bads, not goods" as a means of collecting government revenues.

- A concerted public education effort as to the seriousness of the problem.

- A climate-friendly electricity deregulation bill

- Major investments in R&D to help minimize the economic costs of reducing emissions

Beyond these initiatives our recommendation is a *gradual target and timetable. We view this option as both environmentally and economically responsible. It addresses global warming in a serious and "economically smart" way.*

A gradual target and timetable would eliminate emissions growth in the decade 2010-2020 and reduce emissions thereafter with a return to 1990 emissions levels by 2040. The US would commit to implement this target with a system of auctioned permits, with increasing constriction in the number of permits in small, gradual, but predetermined steps. This system would result in a gradual increase in carbon emissions prices over time from about $10 in 2003 to $25-$30 in 2020. A ceiling could be set to guarantee that the emissions price is capped at a moderate level. A carbon tax could be used as an alternative. It should be emphasized that no new regulatory burdens will be imposed as part of the domestic implementation program.

We view this as a compromise that will, at least grudgingly, satisfy all parties except special interests.

- The Administration should get credit for taking forceful steps to deal with an important problem and showing leadership in dealing with it.

- Environmentalists should be pleased that this policy will result in a commitment to stabilize concentrations and a meaningful increase in the price of carbon emissions--serious action that they would not have expected. Although environmentalists would not get a 1990 by 2010 commitment, they should also understand that such an ambitious goal would have no chance whatsoever of passage in either House of Congress.

- The Congress should appreciate this approach because it has only modest effects on the economy, yet it is a start to dealing with the problem of global warming.

- The business community should appreciate a sensible, realistic economic policy based on a flexible, market-based approach along with the pledge of no new regulatory burdens.

- Consumers should appreciate this approach, especially if the revenues from the carbon tax will be recirculated in some appealing way. It can be presented as a taxing of a "bad", in this case carbon emissions, rather than a "good." It is a tax reform.

- Whereas the public previously had rejected a BTU tax, this tax has the rationale that this proposal will be the international contribution of the United States to deal with an important problem.

- The other members of the OECD should appreciate that for the first time the US is showing a willingness to take significant action to deal with our very large and disproportionate carbon emissions. In the past our use of energy has been a major factor in increasing the price of oil, at the cost of most other OECD countries, which are net importers.

- Although there will be some hue and cry that the US "blew up Kyoto," the US public will see instead that the Administration made a serious commitment to begin dealing with global warming.

- It is important that part of the revenues from the tax be used to help displaced workers, especially coal miners. The gradual nature of the displacement means that much of the loss in employment due to increases in coal prices will be matched with natural attrition.

The major benefit of this program is that it constitutes sound economic and environmental policy and therefore it is easy to defend. It is therefore a policy that if defeated can be taken up again. If rejected even noisily in Kyoto, the US can defend it as the best that we could do. If attacked in Congress it can be defended as a policy that is benign to the economy and at the same time will make a contribution to dealing with our responsibilities for global warming.

In contrast, the option of an aggressive "escape clause" with an ambitious target is much harder to defend because it is too tricky. It is necessary to explain why an ambitious target is a US aim, although straightforward analysis shows ambitious targets will be prohibitively costly. It will be necessary then to explain that our policy will not kill the economy because of the escape clause. But if we think the escape clause will be binding then why did we insist on the ambitious target? Most likely the Administration will be simultaneously damned both for the ambitious target that will kill the economy and for not intending to meet the target because of the insertion of the escape clause.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Janet L. Yellen (CN=Janet L. Yellen/OU=CEA/O=EOP [CEA])

CREATION DATE/TIME: 2-OCT-1997 17:54:27.00

SUBJECT: Rest of figures and tables

TO: Adele C. Morris (CN=Adele C. Morris/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

TEXT:
========== ATTACHMENT 1 ==========
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:
Unable to convert ARMS_EXT:[ATTACH.D19]MAIL46785647Y.216 to ASCII,
The following is a HEX DUMP:

Clinton Presidential Records Automated Records Management System [EMAIL]

This is not a presidential record. This is used as an administrative marker by the William J. Clinton Presidential Library Staff.

Hex Dump file is not in a recognizable format, has been incorrectly decoded or is damaged.

File Name: p_x7465875_cea_html_1.pre

Attachment Number: [ATTACH.D19]MAIL46785647Y.216

The Effects of Emissions Pathway on Consumption Losses by OECD Countries, No International Permit Trading (trillions of 1990 U.S. dollars)

Model	WRE	WG1	WRE/WG1
CETA	1.83	5.94	0.31
CPBRIVM	0.64	3.25	0.20
FUND	9.82	11.71	0.84
MERGE	0.85	6.12	0.14
MiniCAM	1.58	6.51	0.24
SGM	1.84	6.17	0.30
		Average:	0.34

The Effects of Emissions Pathway on Consumption Losses by OECD Countries, International Permit Trading (trillions of 1990 U.S. dollars)

Model	WRE	WG1	WRE/WG1
CETA	1.86	4.03	0.46
CPBRIVM	0.17	0.99	0.17
FUND	1.47	4.97	0.30
MERGE	0.60	3.24	0.19
MiniCAM	1.54	3.44	0.16
SGM	0.13	1.48	0.086
		Average:	0.23
		Average (Trading + No Trading):	0.28

Table 1

The Effects of International Permit Trading on Consumption Losses by OECD Countries, WRE Emissions Pathway to 550 ppmv Stabilization (trillions of 1990 U.S. dollars)

Model	Trading	No Trading	Trading/No Trading
CETA	1.86	1.83	1.02
CPBRIVM	0.17	0.64	0.27
FUND	1.47	9.82	0.15
MERGE	0.60	0.85	0.71
MiniCAM	0.54	1.58	0.34
SGM	0.13	1.84	0.07
		Average:	0.43

The Effects of International Permit Trading on Consumption Losses by OECD Countries, WG1 Emissions Pathway to 550 ppmv Stabilization (trillions of 1990 U.S. dollars)

Model	WRE	WG1	WRE/WG1
CETA	4.03	5.94	0.68
CPBRIVM	0.99	3.25	0.30
FUND	4.97	11.71	042
MERGE	3.24	6.12	0.53
MiniCAM	3.44	6.51	0.53
SGM	1.48	6.17	0.24
		Average:	0.45
		Average (Trading + No Trading):	0.44

Table 2

[Automated Records Management System Hex-Dump Conversion]

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Jeffrey A. Frankel (CN=Jeffrey A. Frankel/OU=CEA/O=EOP [CEA])

CREATION DATE/TIME: 2-OCT-1997 17:17:10.00

SUBJECT: Package 3

TO: Janet L. Yellen (CN=Janet L. Yellen/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

CC: Adele C. Morris (CN=Adele C. Morris/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

CC: Joseph E. Aldy (CN=Joseph E. Aldy/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

TEXT:
Here is the current version of the policy package, from Joe Minarik at OMB. Frank insists on not mentioning a carbon tax, not even in the qualified and euphmeistic form I was suggesting. (Add "The preferred policy instrument, were it politically feasible, would be a carbon tax [or euphemisim" more direct government measures to raise the price of energy]".) If you feel strongly about including this, you are going to have to call Frank directly.

Everyone wants to wrap this up this afternoon.
JF
---------- Forwarded by Jeffrey A. Frankel/CEA/EOP on 10/02/97 05:13 PM ----------

Joseph J. Minarik

10/02/97 05:09:53 PM
Record Type: Record

To: Jeffrey A. Frankel/CEA/EOP
cc: Franklin D. Raines/OMB/EOP, T J. Glauthier/OMB/EOP, Jill M. Blickstein/OMB/EOP, Alecia Ward/OMB/EOP
Subject: Package 3

I hope that this version is the charm. It incorporates, by the way, late-arriving comments from Jeff Hunker at Commerce, where Secretary Daley is engaged and would be a helpful ally.

We have covered your latest comments. On your reruns from this morning, we gave you two out of four. Frank does not want to mention taxes (the obvious; plus, isn't it wishy-washy to say we really want A even though we are asking for B?) and doesn't like the euphemism of "more direct

government action" (because it would conjure up regulation as easily as taxes). Also he believes (as do I, and T.J.) that the sooner we get off of "escape clause," the better off we are; the more we mention it, the more it becomes a part of the subconscious lexicon.

Can we go with this one?

========== ATTACHMENT 1 ==========
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:
Unable to convert ARMS_EXT:[ATTACH.D56]MAIL425636478.216 to ASCII,
The following is a HEX DUMP:

PACKAGE 3

TARGET AND TIMETABLE

- The long-term goal of the treaty is to *stabilize concentrations* of greenhouse gases in the atmosphere at a level that will prevent dangerous anthropogenic interference with the climate system. This goal could be achieved with concentrations at or somewhat above a doubling of pre-industrial levels in the next one hundred years.

- Concentrations can be stabilized through the following:

  Reduce emissions growth in the near term (for example, growth from 2000-2010 less than growth over 1990-2000); then

  Eliminate emissions growth in developed countries 10 to 20 years after treaty is signed (e.g., 2010-2020); then

  Reduce emissions levels in developed countries gradually to reach — and then to decline below — 1990 levels in later years to be decided, stabilizing concentrations.

- This timetable begins effective action soon to establish Presidential leadership.

- The schedule of reducing emissions and emissions growth is determined by the degree of economic cost that is acceptable, coupled with a resulting assumed robust rate of improvement in emissions-reduction technologies.

- This approach also includes periodic review of the underlying science, the data on the path of emissions, and the economic impact, to allow for adjustments in the policy.

- Insist on the current U.S. flexibility positions of international trading, multiple multi-year targets, joint implementation (subsidies of non-carbon energy sources in developing countries), banking, and borrowing. The United States would lead toward a global ban on fossil fuel subsidies.

DEVELOPING COUNTRIES

- The goal is the least-cost global approach to stabilization of carbon concentrations in the atmosphere.

- Negotiate and begin a new Kyoto Mandate, requiring developing country participation (in stages), starting with more-advanced (Annex B) developing countries, with graduation as countries develop. Developing countries commit to reduce the rate of growth of emissions consistent with stabilizing carbon concentrations and continued economic growth, with ceilings on costs.

- In a one-step process, the United States will not initial the agreement until the Annex B countries have binding commitments.

DOMESTIC IMPLEMENTATION

- Develop a tradable permits system, with auction of all permits (rather than grandfathering), in the near term; impose the system early at a level of emissions near the baseline (for example, with an implied permit price of perhaps $10 per ton), with enactment as soon as possible, to show U.S. leadership.

- Reduce the number of permits in small, gradual, predetermined steps, based on economic cost and aggressive technological progress (with the implied permit price rising to perhaps $30 per ton by 2010), subject to periodic review.

- A portion of funds raised would be used for cost-effective technology research and diffusion programs, including basic research. The bulk would be available for a range of domestic priorities (tax relief for individuals; business investment incentives; the solution to the fiscal effects of the demographic imbalance; infrastructure; etc.) chosen to make the program attractive.

- Begin a series of voluntary industry programs (perhaps modeled after PGNV) to develop plans to meet the targets.

- Provide for banking and borrowing to deal with short-term fluctuations. Borrowed permits would be issued at a premium cost, and banked permits could be resold later at higher prices. Provide economic growth insurance or a cost cap on permits that would allow the sale of additional permits. The price would be set consistent with our estimate of the acceptable economic cost, and would be high enough to encourage emissions-efficient investment choices in the near term. (If the cost cap were in effect over an extended period, the target would not be met.)

- These policies are market-oriented. There would be no inefficient, command-and-control regulations used to reduce emissions.

Include common components listed elsewhere.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Jeffrey A. Frankel (CN=Jeffrey A. Frankel/OU=CEA/O=EOP [CEA])

CREATION DATE/TIME: 2-OCT-1997 14:56:01.00

SUBJECT: GCC option from OMB

TO: Janet L. Yellen (CN=Janet L. Yellen/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

CC: Adele C. Morris (CN=Adele C. Morris/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

CC: Randall W. Lutter (CN=Randall W. Lutter/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

CC: Joseph E. Aldy (CN=Joseph E. Aldy/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

TEXT:
---------- Forwarded by Jeffrey A. Frankel/CEA/EOP on 10/02/97
02:55 PM ----------

Joseph J. Minarik

10/02/97 02:33:56 PM
Record Type: Record

To: Franklin D. Raines/OMB/EOP, Jeffrey A. Frankel/CEA/EOP
cc: Jill M. Blickstein/OMB/EOP
Subject: GCC option

Attached is T.J.'s redo of the opening bullet.
---------- Forwarded by Joseph J. Minarik/OMB/EOP on 10/02/97
02:32 PM ----------

T J. Glauthier
10/02/97 02:16:30 PM
Record Type: Record

To: Joseph J. Minarik/OMB/EOP@EOP
cc: Alecia Ward/OMB/EOP@EOP
Subject: GCC option

Joe, here is the revised opening paragraph. I am still trying to double check the scientific accuracy with OSTP so we can have some support, but go with it for now.

========== ATTACHMENT 1 ==========
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:
Unable to convert ARMS_EXT:[ATTACH.D21]MAIL45405547R.216 to ASCII,
The following is a HEX DUMP:

PACKAGE 3

TARGET AND TIMETABLE

- Focus on achieving the long term goal of the treaty, which is to stabilize *concentrations* of greenhouse gases in the atmosphere at a level that will prevent dangerous anthropogenic interference with the climate system, and to do so within a timeframe that will allow ecosystems to adapt naturally. A long term target that is consistent with that goal would be to limit concentrations to approximately a doubling from pre-industrial levels in the next one hundred years. Limiting emissions to that target level can be achieved through a long-term path of: eliminating emissions *growth* in developed countries 10 to 20 years after treaty is signed (e.g., 2010-2020), reducing developed country *emissions* after that gradually to reach 1990 levels in a later year (e.g., 2030), and reducing those *emissions* further in subsequent decades, while reducing the *growth rate* of emissions in developing countries below their projected rates of growth throughout the period. The schedule of constricting emissions and emissions growth is determined by the degree of economic cost that is acceptable, coupled with a resulting assumed robust rate of improvement in emissions-reduction technologies. This approach also allows for periodic review of the underlying science, the data on the path of emissions, and the economic impact of the constriction, to allow for adjustments in the policy.

- Insist on the current U.S. flexibility positions of international trading, multiple multi-year targets, joint implementation (subsidies of non-carbon energy sources in developing countries), banking, and borrowing.

DEVELOPING COUNTRIES

- Require developing country participation (in stages), starting with more-advanced developing countries. The United States will not ratify the agreement until these countries have binding commitments. The goal is the least-cost global approach to stabilization of carbon concentrations in the atmosphere. The Kyoto Mandate for negotiations, to be completed by 1999, would include a ceiling on costs of emissions reduction per ton of carbon, and would provide for graduation of countries into greater stages of responsibility as they develop.

DOMESTIC IMPLEMENTATION

- Develop a tradable permits system, with auction of all permits, in the near term; impose the system early at a level of emissions near the baseline, with enactment as soon as possible, to show U.S. leadership.

- Increase the constriction of the number of permits in small, gradual, but predetermined steps, based on economic cost and expected technological progress, and subject to periodic review, as noted above. There would be a cap on the cost of permits.

- A portion of funds raised would be used for small, cost-effective technology research and diffusion programs, including basic research. The bulk would be available for a range of domestic priorities (tax relief for individuals and businesses; the solution to the fiscal effects of the demographic imbalance; infrastructure; etc.) chosen to make the program attractive.

- Work with industry groups to encourage the development of plans to meet the targets.

- Provide for banking and borrowing to deal with short-term fluctuations. Borrowing would be repaid over an extended period. Provide economic growth insurance with a cost cap on permits for longer-term structural problems. The cost cap would allow the sale of additional permits at a pre-set price that rises over time; the price would be set consistent with our estimate of the acceptable economic cost, and would be high enough to encourage emissions-efficient investment choices in the near term.

- These policies are market-oriented. There would be no inefficient regulatory, command-and-control means used to reduce emissions.

Include common components listed elsewhere.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Jeffrey A. Frankel (CN=Jeffrey A. Frankel/OU=CEA/O=EOP [CEA])

CREATION DATE/TIME: 2-OCT-1997 17:24:39.00

SUBJECT: Sources of Greenhouse Gases

TO: Janet L. Yellen (CN=Janet L. Yellen/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

TEXT:
---------- Forwarded by Jeffrey A. Frankel/CEA/EOP on 10/02/97 05:23 PM ----------

From: Mark Bernstein on 10/02/97 05:21:15 PM
Record Type: Record

To: Jeffrey A. Frankel/CEA/EOP, Joseph E. Aldy/CEA/EOP
cc: Rosina M. Bierbaum/OSTP/EOP, Henry C. Kelly/OSTP/EOP
Subject: Sources of Greenhouse Gases

TO: Jeff Frankel and Joe Aldy

From: Mark Bernstein, Rosina Bierbaum and Henry Kelly

Date: 10/2/97

RE: Comments on Sources of Greenhouse Gases

Thanks for your comments on the Sources of Greenhouse Gases document. We find from your comments that we made a couple of errors, and also needed to clarify some items so that they would not be misinterpreted. Here are some responses to your comments:

On your first bullet - we have been working with an interagency team and OMB to develop new initiatives and expansions of programs to meet climate change objectives. There is considerable backup documentation on the potential programs and emissions savings which we would be happy to share. We think that keeping the options on the charts are important because it gives decision makers a visual perception of the types of programs that could address particular areas.

On your second bullet - the first part was a good catch - thanks. On the remaining greenhouse gases which are about 15%, we project that they remain about that into the future and when we reduce emissions of CO2, we scale back the portion of methane emissions from natural gas proportionally.

There seems to be some misunderstanding on the use of some numbers, and the wording of bullets. We generally use carbon coefficients as follows: coal = 25; oil = 20 and gas = 14.5. To that end, the relative carbon

impact of coal to gas is 25/14.5 or 72% as stated. The rest of that bullet was written improperly and should have said "and 22% more than oil"

On energy prices - we did take the numbers from AEO97 and in some cases we were looking at different numbers than you were - in particular we were looking at delivered coal which declines by 11% (which we had wrong and have corrected), and delivered natural gas which declines at 5% even though wellhead prices increase, and finally the last part should have been gasoline prices which are pretty flat (growing at less than .1% per year according to EIA).

Again, thanks for your review of the document. Let us know if we can answer any other questions.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Janet L. Yellen (CN=Janet L. Yellen/OU=CEA/O=EOP [CEA])

CREATION DATE/TIME: 2-OCT-1997 17:53:14.00

SUBJECT: Current draft of targets and timetables and associated figures and tables

TO: Adele C. Morris (CN=Adele C. Morris/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

TEXT:
========== ATTACHMENT 1 ==========
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:
Unable to convert ARMS_EXT:[ATTACH.D73]MAIL40665647W.216 to ASCII,
The following is a HEX DUMP:

CLOSE HOLD: PRELIMINARY
September 30, 1997

MEMORANDUM

FROM: Lawrence Summers
Janet Yellen

SUBJECT: Targets and Timetables for Reducing Greenhouse Gas Emissions

This memo assesses the economic consequences for the U.S. economy of a program to attain 1990 CO_2 emissions levels by 2010. In comparison to a more gradual target and timetable, such a program would impose enormous costs on the economy while yielding almost no environmental benefit. Attainment of 1990 emissions levels by 2010 would require a change in energy prices (or the equivalent) considerably in excess of what occurred in the oil shocks of the 1970s. However, the memo also has a positive message: It argues that a more back-loaded approach that delays attainment of 1990 levels of emissions until 2040 would impose much lower economic costs (by a factor of between 3 and 10) while capturing nearly as much environmental benefit as the more aggressive approach. Either path, to be credible, would require an early, increase in the price of carbon emissions.

The economic costs of 1990 by 2010

- In the absence of any scheme for international permit trading, "1990 by 2010" would entail a greater reduction in energy use than was achieved during the decade of the oil shocks, and would impose correspondingly greater damage on the economy. Accomplishing this objective would require a tax (or its economic equivalent) on carbon emissions of at least $100 per ton. This would translate into increases of at least 25 cents per gallon on the price of gasoline, and a tripling of coal prices.

- An *idealized* system of international permit trading among Annex I countries would cut the required price of permits in half. Such a system would entail paying Russia and Eastern European countries to reduce emissions in place of us. Joint implementation with non-Annex I countries could further reduce the required price of permits in the United States.

- However, both international permit trading and joint implementation incur severe difficulties of both enforcement and monitoring. For example, every country in the system would be tempted to allow its firms to fraudulently sell their emissions rights into the international market, garner the resulting revenue, and exceed their allowed level of emissions.

- The high cost of "1990 by 2010" stems from three primary causes. First, the increase in energy prices needed to attain such a goal results in a large stagflationary shock. Second, the program would force a large fraction of the capital stock to be scrapped prematurely -- that is before it had served out its intended lifetime. Third, it would forgo the opportunity to wait for the development of carbon-lean technologies.
- The costs to the domestic economy also depend importantly on the method of domestic implementation. The above estimates are derived under the assumption that an efficient mechanism is used--either a tax on carbon emissions or a system of tradeable permits that are distributed by auction. Any alternative mechanism (such as

performance standards or other forms of "command and control") would multiply the costs to the economy.

The environmental benefits of 1990 by 2010

- The environmental benefits of an aggressive program of emissions abatement are minuscule. *Regardless of whether an aggressive or delayed program of emissions reduction is adopted, a significant amount of global warming will occur over the next century--but there is almost no difference in warming with the adoption of a more aggressive policy.* In comparison to aggressive policies of emissions reduction, a delayed program would result in an increase in global mean temperatures that is uniformly less than .05 degrees Celsius. This difference is only three percent of the change in average temperature that is already fated even with the most aggressive intervention.

Thus, "1990 by 2010" would impose severe economic costs while yielding little environmental benefit.

A more efficient alternative

- There is a better alternative available to the Administration. A program designed to return carbon emissions to 1990 levels by 2040 is both economically and environmentally responsible and realistic. This program would require the United States to initiate meaningful actions now to create effective incentives to reduce carbon emissions over the next century. *Such incentives must entail an early increase in the price of carbon emissions along with a credible commitment to further emissions price increases over time.*

Such a program would attain nearly all of the environmental benefits of its more aggressive cousin, while imposing much lower economic costs.

→Global average atmospheric temperature under the less aggressive approach would *not be noticeably different.*

→Economic costs would be lower under the less aggressive approach, by a factor of between 3 and 10.

I. Introduction

The Framework Convention on Climate Change signed at the 1992 earth summit in Rio de Janeiro called for carbon dioxide emissions in 2000 at 1990 levels. Most countries, including the United States, are unlikely to achieve these emission reductions. But the Rio approach remains historically important, and most quantitative proposals that have been advanced in the run up to Kyoto can be understood as variants of the Rio target and timetable. In particular, a proposal to "stabilize CO_2 emissions at 1990 levels by 2010" (and variants thereof, including a more stringent proposal by several EU countries to stabilize at 10% below 1990 levels by 2010) has received considerable attention.

This memo assesses the consequences for the U.S. economy of a program to attain 1990 CO_2 emissions levels by 2010. It compares the costs and cost effectiveness of this baseline proposal with those of alternative targets and timetables that entail a less rapid initial reduction in CO_2 emission levels. The conclusions described here rely on the substantial body of economic analysis that has been conducted by researchers worldwide, including the Intergovernmental Panel on Climate Change (IPCC), and Administration economists.

II. 1990 by 2010: The Scope of the Task

To appreciate the ambitiousness of a program to curb U.S. emissions levels to 1990 by 2010 it is necessary to recognize that such a target involves a cutback of about 27 percent in energy use in 2010 relative to baseline. As of 1996, energy related carbon emissions were already 9 percent above 1990 levels. Growth in the economy through the end of the next decade would further raise carbon emissions. Even under an optimistic assumption concerning the pace of improvement of energy efficiency (0.9 percent per year), under constant relative energy prices, there would be further increases in carbon emissions by 2010 of about 18 percent if we continue with business as usual. The net required reductions to achieve 1990 emissions in 2010 thus amount to about 27 percent.

Comparison with the Oil Shocks. Increases in energy efficiency of this magnitude are considerably greater than those that were achieved during the 1970s and early 1980s. Figure 1 shows aggregate energy use in the United States and the relative price of energy over the period 1960 to 1990. During the oil-shock decade--1972 to 1982--energy use was virtually constant in absolute terms, while GDP grew in real terms at about 2.25 percent per year. Over this period, the relative price of energy more than doubled: it rose about 150 percent. This historical experience, and other empirical analysis, suggests that energy use does respond to changes in the price of energy, but the responsiveness (the price elasticity of demand for energy) over periods as short as a decade is low--no higher than 0.2. In contrast to the oil shock period, the "1990 by 2010" program would entail an even larger emissions cutback. To meet the 1990 by 2010 goal it would not be sufficient just to keep emissions constant between now and 2010: a further, roughly 10 percent rollback in emissions would be needed to offset the expansion that has already occurred since 1990. Thus, we would need to accomplish a reduction in energy use

considerably larger than what occurred over a decade in which the relative price of energy more than doubled. This suggests that energy prices would likely have to rise by more than 150% to attain 1990 emissions by 2010.

Model results. Numerous economic/energy models have been used to estimate the impact of a 1990 by 2010 program on energy prices. These models arrive at the same conclusion as was generated above using no model whatsoever: a program to achieve 1990 emissions by 2010 would entail at least a doubling of energy prices. A broad range of models place the carbon permit price required to achieve 1990 emissions by 2010 in the range of $80 to $200 per ton. If fully passed through to energy prices, a permit price of $100 per ton, for example, entails nearly a doubling of energy prices. The impact on the prices of different sources of energy are all large, but the effect on coal is particularly severe. The price of coal would more than triple, while the price of a barrel of petroleum would increase by about fifty percent. Gas at the pump would increase in price by about 26 cents. Relative to the BTU tax proposed by the Administration in 1993 a $100 implicit carbon tax is about 9 times as large. Thus, attaining a goal of 1990 by 2010 would have very large effects on our economy.

Evidence from International Comparisons. A final piece of evidence confirming the conclusion that a strong price signal over a long period of time is necessary to alter energy use comes from comparisons of energy usage between the United States and Europe. It should hardly be surprising that energy use per dollar of GDP is lower in Europe than the United States. Energy prices in Europe have long been substantially higher--roughly double U.S. energy prices. Moreover, major differences in living patterns between the United States and Europe result in higher European energy efficiency. In addition to the geographical "advantage", from an energy efficiency standpoint, of Europe's higher population density, resulting in lower transportation requirements, Europe has locked in place many long-run adaptations to high energy prices. Innovations in the design of housing and transportation systems and the configuration of residential areas have occurred in response to high energy prices. But in spite of its natural advantages and its long history of high energy prices, energy per dollar of GDP is only 44% lower in Europe than in the United States. This means that were the United States to become Europe--energywise per dollar of GDP--its energy savings, even in the long run, would be no greater than 44 percent. This U.S.-Europe comparison supports the conclusions drawn from the natural experiment of the oil shock: namely, a return to 1990 emissions will not occur in the absence of very major price measures over a long period of time.

The Role of Technology and the Scope for "No Regrets" Policies. According to the preceding assessment, a large price inducement is necessary to meet a 1990 by 2010 target. Your economic advisers agree on this conclusion. However several of your advisers are more optimistic about the chances of achieving a 1990 by 2010 target. They emphasize the current availability of "no regrets" (cost-saving) technologies that promise substantial opportunities for abatement. A recent report by the Department of Energy research laboratories, for example, catalogues emissions-savings technologies that, by their calculations, are currently "cost effective." If put in place now, such practices could allegedly reduce emissions by between 30

to 50 percent of the amount needed to reach a 1990 by 2010 target. Even so, the report finds that "aggressive" and "invigorated" government policies--including potentially costly and intrusive regulations and standards--as well as a $50 carbon tax would be necessary to reach the 1990 by 2010 target.

Your economic advisers agree that there now exist unused technological opportunities for emissions reduction, but we question by what means, over what time frame, and at what expense government policies could change private behavior if such opportunities are currently underutilized. Engineering studies generally ignore the sometimes subtle disadvantages of available cost-saving technologies or overestimate their hypothetical returns. An example is illustrative: significant energy and cost savings could result if consumers replace incandescent bulbs with compact fluorescents. Over the long lifetime of such bulbs there would also be a substantial monetary gain. However, actual adoption of these light bulbs has been slow to date, possibly due to pure inertia, possibly because consumers dislike their color, or perhaps because they apply a high "discount rate" when valuing energy savings that accrue after the purchaser may have switched residence. Several recent studies have demonstrated that the actual returns to home improvement investments, such as attic insulation, often fall short of those predicted by engineering studies.

Regardless of the reasons, if consumers have not adopted "no regrets" measures at a faster rate, it is likely that additional incentives will be necessary for them to change their minds. Rather than stressing the mere availability of alternative technologies, your economic advisers insist on realistic estimates of likely rates of adoption and diffusion and they stress the need for economic incentives--in the form of a higher implicit price for carbon emissions--to induce the adoption of emissions-savings technology. They point out too that the baseline energy demand estimates used to predict the price increase needed to attain a 1990 by 2010 target already assume substantial ongoing improvements in energy efficiency due to the diffusion of existing technologies and the development of new ones. Significant adoption of such technologies is necessary merely to meet this assumed baseline. Finally, it is important to note that the DOE labs study includes as part of its policy package to reach 1990 emissions by 2010 extensive regulations, including stringent CAFE and appliance standards and national building codes--command and control policies that your economic advisers would oppose--along with a $50 carbon tax.

To summarize, your economic advisers consider it unrealistic to predict a substantial increase in the pace of adoption of new emissions-savings technologies in the absence of a large increase in the price of carbon emissions--and hence of energy. Based in part on the evidence from the energy shocks of the 1970s, in part on international comparisons, and in part on model results, they are optimistic that such an increase in prices would bring forth a reduction in CO_2 emissions--with larger responses to a given price change likelier the longer the time period for response. The evidence is strong that a very large price increase will be necessary to attain emissions reductions of 20 to 30 percent over a period as short as a decade. *Moreover, other approaches that apparently do not involve large price increases (such as performance*

standards) will impose even higher costs on the American economy.

III. Why are the costs of early emissions reductions so high?

The previous section argued that a "1990 by 2010" target would entail high carbon emissions prices and significant economic costs. This section shows that the 1990 by 2010 timepath for emissions reductions is so aggressive as to be inefficient--in the sense of raising substantially the total projected economic cost of reaching a given environmental goal. There are three major reasons why an aggressive takeoff in curtailing emissions raises overall costs: (1) it induces premature obsolescence of the capital stock because it does not allow adequate time for the capital stock to turn over naturally; (2) it provides insufficient lead time to develop and implement new technologies; (3) it causes a significant stagflationary short-term macroeconomic shock. Additionally, an aggressive timetable for emissions reductions does not allow time for the resolution of uncertainty and it does not take advantage of the time-value of money (resources not spent on emission reductions early on can be invested at a positive return which could purchase more emission reductions later).

The Role of Turnover of the Capital Stock. The most clear-cut and easily quantifiable reason for the high price tag associated with rapid emissions reductions relates to the need for premature replacement of plant and equipment in response to large increases in the price of carbon emissions. It is expensive enough to replace plants that are fully depreciated, but vastly more so if those plants are still in the prime of their productive lives. Within 20 to 40 years, much of our existing plant and equipment will be ready for replacement anyway; therefore building in greater carbon efficiency at that time will be relatively cheap. *It is important to emphasize that the case we are making here is not based on procrastinating for the sake of avoiding the problem; rather, it is based on simple principles of hard-headed business efficiency.*

The advantage of a slower emissions reduction timetable in avoiding the large costs associated with premature obsolescence of the capital stock can be illustrated by considering electrical power generation. The case of electricity generation is important in its own right since this industry is responsible for 88% of coal use and more than one third of all carbon dioxide emissions in the United States. But the principle concerning the costs of premature replacement applies broadly because reduced greenhouse gas emissions may entail the accelerated retrofitting of housing and commercial structures, the premature scrappage of vehicles and appliances, and the premature replacement of plant and equipment in energy intensive industries.

Figure 2 illustrates the effect of an accelerated retirement schedule for today's U.S. electric power generation capacity installed during the last 40 years. Imagine, to take an extreme case, that a timetable is adopted that necessitates replacing all power plants with less-polluting technology within ten years. This would require retiring 630 out of 670 gigawatts of generating

capacity before the end of its normal life span, or 94 per cent of the total. If the timetable were extended so that all power plants instead had to be replaced within 20 years, the accelerated replacement of capacity would affect 450 gigawatts of capacity, or 67 per cent of the total. Allowing this additional 10 years for turnover avoids the premature retirement of 27 per cent of existing electric power plant capacity. With a 30 years horizon, complete turnover would mean accelerated retirement of only 21 per cent of the total capacity and, with a 40 year timetable, there would be almost no additional costs due to premature obsolescence.[1, 2]

The Advantage of Waiting for Superior Technologies. The example of electric power generation also illustrates a second important reason why a slow takeoff in curbing greenhouse gas emissions is ultimately less costly: new technologies take a long time to develop. Waiting until these new technologies are available before making expensive emissions-saving investments offers the potential of both lower economic costs and higher environmental payoffs. Under a tight target and timetable with its associated high carbon emissions price, electric utilities will be forced to replace existing capacity in the very near future and to rely on currently available lean-carbon technologies, likely gas-turbine plants. If some delay can be factored in, however, they will be able to install more effective and less costly alternative technologies. A rapid timetable forces long-term investments to be made before superior technologies have been developed and refined.

Implication: The Need for a Credible, Long-Term Price Increase. The example of electricity generation illustrates two general principles. First, the responsiveness of both demand and supply are greater in the long run than in the short run. This means that, with a longer horizon, any given amount of abatement can be accomplished with a smaller increase in carbon emissions prices. Second, and perhaps even more important for policy, any credible emissions reduction strategy must include both a price increase at the outset and also a clear commitment to maintain and likely increase prices further over time. Without such a commitment, the changes in behavior required to meet even a long-run target of emissions reduction will likely not occur. Consider a utility that today is drawing up its plans for a new power plant. That utility will choose among today's technologies, which vary in their costs and CO_2 emissions. In order to induce the utility to choose a more costly, lean-emissions technology today, it must be clear that CO_2 emissions will be costly enough over the 40 years or more

[1]The distribution has been truncated at 40 years, the average lifespan of existing electric power plants. A few plants of yet older vintage are still in use.

[2]The same exercise can be performed for coal-fired power plants. These generators produce the most carbon per kilowatt hour of electricity and thus will have a high incidence of replacement even under a moderate abatement plan. If a complete change-over of coal plants were to be accomplished in 10 years, 96 per cent of total capacity would be retired early. If retirement occurred over 20 years, only 64 per cent would be retired early. Allowing an additional 10 years for turnover would avoid premature retirement of one-third of existing coal-fired plant capacity.

lifetime of the plant to justify a more expensive investment option today. A large cumulative reduction in emissions can be achieved over the long term with only a modest carbon emissions price increase now, but only if the commitment to still higher prices in the future is credible and clear.

Stagflationary Macroeconomic Impact. From a macroeconomic perspective, increases in energy prices constitute an adverse "supply shock." Such developments are stagflationary--even if anticipated--because they raise both inflation and unemployment simultaneously, creating a painful macroeconomic dilemma. As noted above, a plan to attain 1990 emissions levels by 2010 would require a change in energy prices over the first decade of the 21st century at least comparable in magnitude to the two oil shocks of the 1970s. Those shocks are widely acknowledged to have raised both unemployment and inflation. Similarly, the energy price increases required by a 1990 by 2010 program would raise inflation, lower real wages, and raise unemployment. Unemployment in the four years after the first oil shock averaged 7.2 percent in comparison to 5.0 percent in the four years prior; and unemployment rose further, to an average of 8.6 percent, in the four-year aftermath of the second oil shock.[3] Although the increases in energy prices associated with a treaty to reduce greenhouse gases would be anticipated, rather than a surprise, we should nevertheless expect that the efforts of the Federal Reserve to contain inflation, coupled with likely efforts on the part of workers to recoup real wage losses will lead to a period of higher unemployment.

Furthermore, it is important to note that most model-based estimates of the costs of a program to attain 1990 emissions levels by 2010 assume that resources are fully employed, thereby ignoring these potential short-term effects. Such models therefore provide no assessment of the consequent increases in unemployment.

IV. Quantifying the Economic Costs of Slow versus Fast Take-off

[3] There is debate about how much of this was due directly to the oil shocks, because there was a simultaneous decline in productivity growth and transfers of real income to OPEC producers.

The relative costs of slow versus fast takeoff timetables in curbing CO_2 emissions has recently been analyzed by the Stanford Energy Modeling Forum (EMF-14).[4] The Stanford group used six large-scale economic/energy models to compare the total projected cost of two alternative emissions reduction time paths--one "frontloaded", the second more "backloaded". *Importantly, both paths were designed eventually to stabilize atmospheric concentrations of CO_2 at double the pre-industrial level--550 ppmv.*[5] Although a high degree of uncertainty is inherent in particular numerical estimates from individual models, the simulations nevertheless point to some robust qualitative conclusions. *The major conclusion to be drawn from this project is that an emission reductions path characterized by an aggressive initial phase is substantially more costly--3 to 10 times more costly--than a path with a slower takeoff but larger eventual reductions.*

To enable a comparison of the costs of slow and rapid takeoff strategies, the EMF investigators asked each of six modeling groups to simulate the economic impacts of two alternative strategies to attain stabilization of CO_2 concentrations at 550 ppmv. The first strategy (the WG-1 path) corresponds to an emissions pathway published in 1994 by Working Group 1 (WG-1) of the Intergovernmental Panel on Climate Change (IPCC). Using the Wigley model of the carbon cycle, the working group computed a set of global CO_2 emissions pathways consistent with stabilization of concentrations at 550 ppmv and several alternative concentration levels. The WG-1 path entails an immediate departure from the baseline or "business as usual" emission path. Subsequently, Wigley, Richels and Edmonds (WRE) published an alternative set of emission profiles to achieve the same concentration targets. In contrast to the WG-1 paths, the WRE emission path was constructed to follow the baseline or "business as usual" scenario in the early years with sharper reductions after this initial phase. Wigley, Richels and Edmonds hypothesized that their slower-takeoff emissions pathways would yield identical environmental objectives with substantially lower economic costs, for the reasons discussed above. The EMF-14 exercise validates this hypothesis.

The EMF-14 comparison project assessed the total costs to the OECD, the EEFSU (Eastern Europe and the former Soviet Union) and the non-Annex I countries of the WG-1 and WRE pathways to stabilization of CO_2 concentrations at 550 ppmv. The appropriate economic measure of total cost is the present discounted value of losses in future consumption

[4] To enable meaningful comparisons of results across models, the EMF has coordinated a series of projects in which a number of large scale energy models are used to estimate the impact of given, specified emission reduction scenarios under common standardized, benchmark assumptions concerning population and economic activity, discount rates, energy resource availability and prices and technology availability.

[5] All energy models make numerous simplifications and approximations in order to describe the energy sector globally and over the span of a century or more. In particular, all of the models assume full employment, thereby abstracting from the likely short-run macroeconomic costs of an emissions reduction program.

relative to a "Business as Usual" scenario. Estimates of regional costs depend on the extent of burden sharing--namely, the assumed "division of labor"--between Annex-I and non-Annex I countries in controlling emissions as well as the extent of international emissions trading. Recall that, by the end of the next century--by 2100-- assuming "business as usual"--non Annex 1 countries will have more than 90 percent of CO_2 emissions. Thus, developing country participation is absolutely essential to achieving stabilization of concentrations. Consistent with the Berlin Mandate, the simulations assumed that the burden of emissions reduction would fall on Annex I countries exclusively during the early decades; that by 2030, non-Annex I countries would begin to participate; and by 2050, a full transition to targets based on equal per capita emission rights is assumed.

Figure 3 plots the OECD emission paths in the WG-1 and WRE scenarios. Under the WG-1 scenario, OECD emissions begin to decline immediately and continue to decline for roughly four decades. For example, OECD emissions fall 10 percent below initial levels ten years after implementation--corresponding closely to the requirement of a "1990 by 2010" timetable, which requires a reduction of 9 percent from current emissions in roughly a decade. In contrast, OECD emissions along the WRE path continue to rise for roughly two decades--corresponding closely to a plan calling for emissions to peak around 2020--return to 1990 levels around 2040 and decline substantially further in subsequent decades.

Table 1 illustrates a robust conclusion that emerges from this exercise: fast takeoff in emission reduction greatly increases the costs. Table 1 shows the cost for both the aggressive (WG-1) and slow-paced (WRE) paths--both with and without idealized international trading of permits. In 10 out of 12 simulations--for six different models with and without permit trading--the costs on the slow-takeoff WRE path is less than a third of the cost on the corresponding fast take-off path. Taking account of the likely adverse short-run macroeconomic consequences of an aggressive path would further strengthen this conclusion.

Table 2 illustrates a second, robust conclusion from the EMF-14 exercise: a viable system of international permit trading would very much reduce OECD costs. With global permit trading, the sharp, early emission reductions required of OECD countries under the aggressive (WG-1) approach would be avoided through the purchase of emission permits from countries with lower abatement costs. The average reduction in cost is 56 percent.[6]

[6] The computations in Table 2 verify that the slow paced (WRE) path, which permits emissions to depart relatively little from business as usual for several decades, is a substantially less costly than the alternative WG-1 path with its sharper immediate reductions. Since both paths are arbitrarily chosen to conform with the 550 ppmv concentration target, a natural question concerns the characteristics of an optimal or least-cost path for achieving this concentration target. An important recent study by Alan Manne and Richard Richels uses their MERGE model (included in the EMF-14 project) to compute the least cost path with 550-stabilization in 2100 and international permit trading. The optimal path, while not identical to the WRE path, is similar in character. This least-cost path peaks approximately three decades

Finally, it is important to note that in most of the EMF models, policy actions to raise carbon emissions prices must be taken at the inception of the slow-paced (WRE) program and a commitment to increasing emissions prices over time is required to achieve additional emission reductions. Naturally, the required initial carbon emissions price is substantially lower, at the outset, under the slower-paced (WRE) than under the aggressive (WG-1) path. Thus, although the slower-paced emissions path initially approximates the business as usual baseline, credible incentives must be put into place immediately, and strengthened over time, to achieve the needed investments in carbon-efficient technologies.

V. The Environmental Consequences of Slow versus Fast Takeoff.

after the initiation of the program and declines thereafter.

While the excess cost of a fast, compared to a gradual emissions reduction path is large, the difference in projected global temperatures over the next century between the fast and the slow paths is quite small, both in absolute amount and relative to temperature changes expected even if an aggressive policy path is adopted. Under "business as usual" assumptions, average global temperatures are expected to rise about 1 degree Celsius by 2050 and about 2½ degrees Celsius by 2100. An aggressive emission reduction path that stabilizes emissions at 1990 levels by 2010 and maintains emissions at the 1990 level thereafter would mitigate this temperature increase by roughly 0.1 degrees by 2050 and 0.2 degrees by 2100. In contrast, a more gradual emissions path that peaks around 2015, stabilizes emissions at 1990 levels by 2040, and holds emissions constant at 1990 levels thereafter yields virtually identical environmental benefits: the temperature difference between the aggressive and gradual paths diverges by no more than 0.05 degrees at any time over the next century. Similarly, the temperature differences along the aggressive WG-1 and less aggressive WRE paths--both designed ultimately to stabilize concentrations at 550 ppmv--differ by a maximum of 0.2 degrees over the next several centuries.[7]

The limited climatological impact of even an extremely aggressive emission reduction program measured in terms of temperature impacts during the next century reflects the extremely long lags involved in the underlying physical processes and the dependence of temperature on the total stock of carbon dioxide in the atmosphere, rather than the flow of emissions at a given time. Emissions reductions do matter to temperature, but only over an extremely long horizon. The cumulative nature of the process suggests that there is little effect on global temperature from a slow rather than from a fast abatement takeoff. The addition to the total stock of carbon from a slow rather than a fast start to abatement adds relatively little to the total atmospheric stock of CO_2 between now and 2100 for four separate reasons: the difference in carbon emissions between a slow and a fast start over the initial decades of abatement is only a small fraction of total emissions in that period; the stock of CO_2 in the atmosphere is itself the result of many decades of emissions; some of the CO_2 emissions of the early decades will have been re-absorbed; and the most serious build-up in CO_2 under business as usual occurs late in the next century, as a consequence of burgeoning emissions from non-Annex I countries.

Even the potential for a catastrophic environmental event, such as the melting of the West Antarctic ice sheet, a runaway greenhouse effect (e.g., from release of trapped methane with the melting of the permafrost), or a structural change in ocean currents such as the Gulf Stream, which the preceding abstracts from, does not fundamentally affect the basic trade-offs between the high costs of fast vs. slow takeoff paths. These factors do, however, add--perhaps greatly--to

[7] If a model assumes that sulfur dioxide emissions decline with the decline in carbon dioxide emissions under climate policy (as predicted, given the extent of sulfur emissions associated with fossil fuel combustion, and incorporated in the IPCC's IS92 emissions projections), the WG-1 path will be *warmer* than the WRE path between 2000 and 2040. This result reflects the negative impact of sulfate aerosols on the greenhouse effect. Early and substantial cuts in fossil fuel combustion, while decreasing the carbon emissions that warm the atmosphere, also decrease the sulfate aerosols that cool the atmosphere.

the urgency of adopting moderate long-term greenhouse gas concentration targets and a program involving an immediate, albeit moderate, increase in the price of CO_2 emissions.

VI. International Trading of Permits

As has already been noted, an effective system of international carbon emission permit trading among Annex I countries could substantially diminish the cost of a CO_2 abatement program. An Annex I trading system could, potentially, reduce the size of the carbon emissions price to attain a 1990 by 2010 goal by about 50%. Moreover, joint implementation projects with non-Annex I countries could, hypothetically, reduce this figure by half again.

Although international trading and joint implementation--so-called "where flexibility"--has enormous advantages in theory, your economic advisers are concerned that substantial barriers would stand in the way of implementing any workable analogue of such an idealized system--at least in the near term. Consequently, they stress that Annex I international permit trading and joint implementation between the U.S. and non-Annex I countries realistically can serve only a limited role in reducing the costs associated with meeting a "1990 by 2010" target.

A hypothetical example shows how an international trading system would work, and why it would reduce each participant country's abatement costs. Suppose, ideally, that every country adopts a domestic permit system to implement its Kyoto target. Absent international trading, the price of emissions permits would surely differ across countries, reflecting differing marginal costs of abatement internationally. With different permit prices in different national markets, profit- seeking traders would be motivated to buy permits in countries where they are cheap and resell them in countries where they are more expensive. Such arbitrage activities would create an international permit market, bringing permit prices into equality worldwide. This idealized system promotes global efficiency in achieving any worldwide abatement goal. Countries with permit prices below world levels have the incentive to reduce emissions more than they otherwise would in order to profit in the international permit market. Countries with high permit prices would have the incentive to purchase permits, thereby relaxing their Kyoto emissions constraints. The U.S. government could avoid any direct participation in such a system as long as it deems foreign-issued permits presented to the U.S. government by U.S. carbon-emitting entities as valid as those issued by the U.S. government itself.

The preceding description of how an international permit trading system would work provides an idealized picture of its possibilities. But the actual benefits of such a system are apt to fall short of this utopian portrayal in part because countries are not obliged to fulfill their Kyoto commitments via a domestic permit trading scheme; indeed, few Annex I countries have indicated an intention to do so. For example, consider a government that has decided to limit domestic emissions through regulatory controls. International permit sales that result in tighter domestic constraints could well be politically unpopular so that a government would hesitate before selling its emission rights to the United States. Similarly, international permit sales by a

country that is meeting its Kyoto obligations through domestic carbon or energy taxes would necessitate a hike in those taxes. In either case, international trading would involve government to government negotiations, and difficult political decisions. In contrast, in the idealized system, trades result from profit oriented transactions among individuals, mediated through the market.

Monitoring and enforcement issues are also likely to be paramount in insuring the workability of international trading. If domestic enforcement is effective in all countries, so that, in the aggregate, consumers and firms in each country actually limit their emissions to the national permit levels, international permit sales by private agents in the country actually translate into lower domestic emissions. But consider the difficulties that can occur with imperfect enforcement. If the government of a country--country X--finds it difficult either to measure domestic emissions or to enforce the purchase of permits by domestic emitters, then reductions in X's emissions may be insufficient to reach the Kyoto target. Those firms or individuals in X that are lucky enough to have been assigned the rights to X's permits will be able to sell them, at a quick profit, on the international market. With imperfect enforcement, international sales, without corresponding domestic emissions reductions, could emanate from countries with the weakest systems of enforcement. To prevent such "paper trades", which profit some participants and increase emissions, many countries, including the United States, will want controls to ensure the integrity of international permits. Buyers, too, will want clear concrete guarantees of the validity of permits so as to be sure they are not being passed counterfeit goods. These controls and guarantees will surely inhibit the efficiency of the market and render some--possibly much--of the estimated savings illusory. In fact, most of the benefits projected from the international sale of permits come from inducing emissions reductions from countries in Eastern Europe and the former Soviet Union--countries with particularly weak tax collection and enforcement mechanisms. Without these countries in the scheme the gains from international trading of permits will be very small.

Joint implementation with non-Annex I countries also has the potential to reduce the U.S. burden of attaining any given timetable. Under this type of approach, U.S. businesses could receive credit for the construction of nuclear, oil, or natural gas electricity generation plants in China if it were confidently expected that China would instead have constructed coal-fired plants with much higher CO_2 emissions. Certification of such credits might be overseen by an international agency to ensure that the projects were emissions-replacing. Such a project-by-project system is likely the most that is feasible in the absence of quantitative targets. Your economics advisers have concerns about even this level of endeavor due to the inherent difficulty in establishing that a particular set of projects has actually reduced a country's emissions, absent a reference path enabling a clear quantitative comparison. For example, the construction of a nuclear power plant in place of a coal-powered plant in China could indirectly raise CO_2 emissions elsewhere in the Chinese economy--partially offsetting the direct CO_2 reducing effect of the project--if the reduced demand for coal lowers its domestic price and encourages greater use elsewhere in the Chinese economy. A project-oriented approach to joint implementation will, in effect, constitute a limited form of international trading with high transaction costs. As a result, it will probably capture only a small fraction of the total benefits

of full international trading. In contrast, model results concerning the benefits of joint implementation treat it as equivalent to full international trading.

VII. Recycling of Revenues

The ultimate economic cost of an emission abatement program depends upon how the revenues realized from carbon taxes or auctioned permits are used. It has been estimated that the efficiency loss from collecting an extra dollar of tax revenue amounts to around 30 cents. If the revenues from a carbon tax or auctioned permits are used to reduce inefficient taxes inhibiting work or investment, the resulting gains would partially offset the micro-efficiency losses from energy curtailment. The simple lesson is that the costs of emission abatement may be greatly reduced if the revenues from the taxes levied can be put to good use.

So far we have approached the recycling of revenues from the standpoint of microeconomic efficiency. There is also the potential for using the revenues to abate the macroeconomic consequences of the emissions program. The oil shocks are believed by many economists to have resulted in increased unemployment because workers resisted the fall in real wages that was associated with the inflationary impact of higher energy prices. Increased wage demands added inflationary pressures to the economy that could only be suppressed by tighter monetary policy. Thus it might be argued that the effects of the real wage shock on inflation and unemployment could be diminished by lowering payroll or other worker taxes to offset the real wage losses from higher energy prices.

But England's experience points to the need for caution in assessing the potential for revenue recycling to allay the macroeconomic consequences of the rising energy costs. In 1979, immediately after her election, Margaret Thatcher increased the VAT tax and simultaneously decreased the income tax. These two policy changes had offsetting effects on real after tax incomes, and therefore might have been expected to have had no effect on wage bargaining. However, the increase in the VAT tax resulted in an immediately noticeable increase in the CPI. A wage-price spiral ensued as workers attempted to maintain their pre-tax real wages.

VIII. Policy Implications

The foregoing arguments point to the attractiveness, from both an economic and environmental standpoint, of a U.S. policy to raise the price of carbon emissions--either through a carbon tax or a system of auctioned permits--by a moderate amount--for example, between $5 and $15 per ton of carbon--in the near term, with further increases scheduled over the longer term. A realistic target and timetable corresponding to such a program would entail continued emissions growth in the first decade of the program, say 200-2010; elimination of emissions growth in the second decade (2010-2020) and reductions in emissions thereafter This program entails significant, early policy action and is consistent with a strong U.S. commitment to attaining the ultimate objective of the Framework Convention--namely to stabilize atmospheric concentrations of CO_2 and hence global temperatures.

A program involving gradual increases in the relative price of carbon emissions over time would avoid the substantial macroeconomic consequences of a 1990 by 2010 program. The energy price increases associated with the more moderate program would have a modest impact on family income that could be offset by compensating cuts in other taxes.

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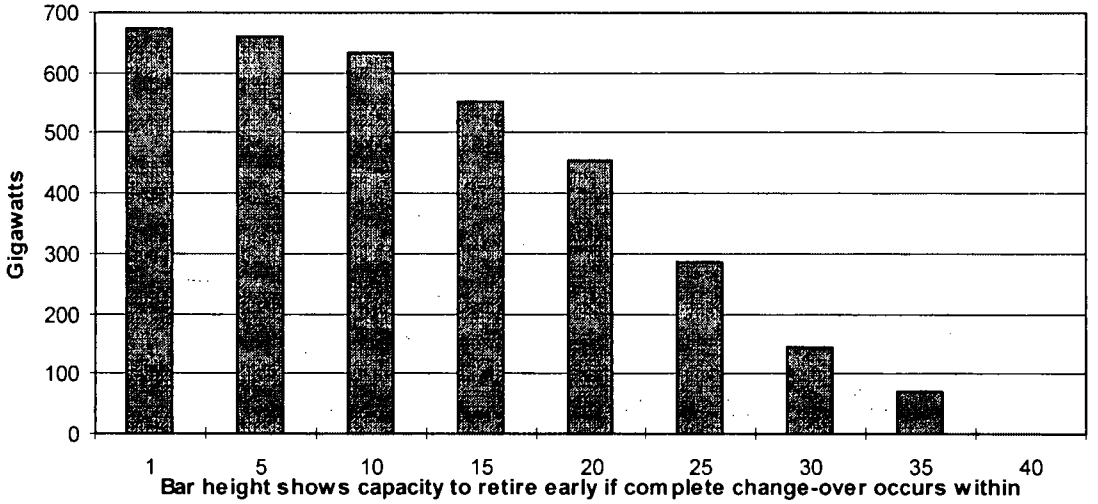
Figure 2: Accelerated Retirement of Electric Power Plant Capacity



Bar height shows capacity to retire early if complete change-over occurs within number of years indicated on the axis. Normal life span of a generator is 40 years.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Adele C. Morris (CN=Adele C. Morris/OU=CEA/O=EOP [CEA])

CREATION DATE/TIME: 2-OCT-1997 12:23:58.00

SUBJECT: OMB thinking and comments on the memos

TO: Jeffrey A. Frankel (CN=Jeffrey A. Frankel/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

TO: Janet L. Yellen (CN=Janet L. Yellen/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

CC: Joseph E. Aldy (CN=Joseph E. Aldy/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

CC: Randall W. Lutter (CN=Randall W. Lutter/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

TEXT:
OMB thinking:

I talked to Joe Minarik and asked him what Frank was thinking about climate change policy options. I take it that Frank is generally sympathetic to our argument for an extended target and timetable and a tax. He favors a very gradual increase in the tax, for example one cent per year on gasoline, so that the economy has plenty of time to adjust and very predictable price increases.

He is in favor less of revenue recycling than using the proceeds of our tax to fund medicare. He thinks an important opportunity will have been lost to solve the long term revenue problem if we lower other taxes when imposing the revenue burden from energy.

Larry's paper, as edited by you:

Europe will soon smell the espresso:

In more than one place we assert that we'll be slammed by the Europeans for a less aggressive target and timetable. Between Joe's Europe memo and the story about the EU Finance Ministers being heretofore completely clued out, I think we can reasonably assume that we are ahead of Europe in analyzing their economic costs of 1990 by 2010. When they figure this out, probably before Kyoto, I think there's a good chance they'll backpedal on their previously aggressive stance. If you agree, it might be worth pointing that out.

2. Escape clauses are now "safety valves":

At the escape clause meeting yesterday, an interagency willingness to consider the option has emerged. The consensus was to refer to them as "safety valves."

One might infer from the paragaph that we are categorically negative on escape clauses in principal. Rather, I think we wish to emphasize that they don't make an aggressive target and timetable more sensible. With a realistic target and timetable, a safety valve could serve to pacify to some extent the persons most worried about a large runup in price, while not concerning the optimists who insist that the price need not rise that much to induce a sharp reduction in emissions.

A lawyer from State indicated that Japan has proposed a ex post type of escape clause that would prompt an after-the-fact release from target obligations if emissions exceeded caps and economic hardship was demonstrated. This opens the dialog for other types of negotiated exceptions from a strict quantity target.

My suggested language for the final paragraph:

Some have suggested that an ambitious target and timetable could be made more palatable with a "safety valve" that would cap the effective price of emissions. The problem with an aggressive quantitative target matched with a safety valve is that it sends a mixed message; the Administration will be damned simultaneously for the ambitious target that will kill the economy and for not intending to meet the target because of the insertion of the safety valve.

The only credible approach is to propose, as suggested here, a realistic target and timetable that is environmentally and economically responsible. Once we have done that, we can examine the various policy options, including safety valves, that can prevent nasty economic surprises and still put us on a path to a healthier environment.

Yellen/Summers memo:

The section on international comparisons says that if the US became Europe, the energy savings would be no greater than 44%. Since a 44% reduction is plenty for us to meet a strict target and timetable, one might interpret this section as suggesting that doubling our energy prices would be sufficient to meet 1990 by 2010, in direct contrast to our arguments about the oil shocks. I'd clarify our point here.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Janet L. Yellen (CN=Janet L. Yellen/OU=CEA/O=EOP [CEA])

CREATION DATE/TIME: 2-OCT-1997 12:44:39.00

SUBJECT: Re: OMB thinking and comments on the memos

TO: Adele C. Morris (CN=Adele C. Morris/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

CC: Randall W. Lutter (CN=Randall W. Lutter/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

CC: Joseph E. Aldy (CN=Joseph E. Aldy/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

CC: Jeffrey A. Frankel (CN=Jeffrey A. Frankel/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

TEXT:
Many thanks for the comments on both papers. I understand that Larry's shop is engaged in some extensive editing of the shorter memo. I hope to get it by the end of the day and will distribute it. We will need to make sure that the numbers in both documents agree. Can you folks attend to that?

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Janet L. Yellen (CN=Janet L. Yellen/OU=CEA/O=EOP [CEA])

CREATION DATE/TIME: 2-OCT-1997 20:13:07.00

SUBJECT: New Executive Summary for T&T

TO: Adele C. Morris (CN=Adele C. Morris/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

TEXT:
========== ATTACHMENT 1 ==========
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:
Unable to convert ARMS_EXT:[ATTACH.D82]MAIL436437474.216 to ASCII,
The following is a HEX DUMP:

CLOSE HOLD: PRELIMINARY
September 30, 1997

MEMORANDUM

FROM: Lawrence Summers
Janet Yellen

SUBJECT: Targets and Timetables for Reducing Greenhouse Gas Emissions

Executive Summary

This memo provides a preliminary evaluation of the likely economic consequences for the United States of a program to attain 1990 CO_2 emissions levels by 2010. It concludes that the attainment of such a goal would necessitate at least a doubling in energy prices and impose substantial economic costs. In contrast, a more gradual emissions reduction path that eliminates emissions growth by 2010-2020 and reduces emissions to 1990 levels thereafter captures nearly identical environmental benefits as the more aggressive approach while entailing costs between one tenth and one third as large.

If attained through domestic emissions reductions alone the "1990 by 2010" target requires a reduction in CO_2 emissions of roughly 30% relative to projected 2010 emissions assuming "business as usual". The reduction in energy use needed to meet this goal would substantially exceed that achieved during the decade of the OPEC price hikes, so that energy price increases, at least comparable in magnitude, are likely. Economic analysis and historical precedent suggest energy price increases of this magnitude would have stagflationary consequences. As in the decade of the oil shocks, both unemployment and inflation would undoubtedly rise, at least for a time.

An "idealized" system of international permit trading among Annex I countries could hypothetically halve the change in carbon emissions prices needed to attain a 1990 by 2010 goal. This would mean paying Russia and other Eastern European countries to reduce emissions in place of the United States. However, such an arrangement could prove infeasible for a number of reasons, including difficulties in establishing adequate enforcement and monitoring mechanisms in the near term. Joint implementation with non-Annex I countries is likely to marginally reduce the impact on energy prices in the United States.

The memo argues that a more gradual timetable for emissions reduction can deliver virtually identical environmental benefits at a fraction of the cost. The aggressive "1990 by 2010" path is extremely inefficient because it requires premature scrappage of capital and foregoes the considerable advantages of waiting for the development of carbon-lean technologies before replacing existing plant and equipment. In contrast, a timetable that eliminates emissions growth in the second decade of the program (2010-2020) and reduces emissions to 1990 levels and below in subsequent decades is consistent with a long-term goal of stabilizing

atmospheric CO_2 concentrations. *The total cost of this "back-loaded" approach is likely one third to one tenth that of the "front-loaded" 1990 by 2010 program.* Implementation of the gradual timetable requires an early, modest increase in the price of carbon emissions, along with a credible commitment to further emissions price increases over time.

In comparison with a more gradual emissions reduction timetable, the environmental benefits of an aggressive abatement target are minimal. For example, the expected difference in global average temperature in 2100 along a fast-takeoff abatement path that attains 1990 emissions by 2010 and a slow-takeoff abatement path that peaks in 2015 and attains 1990 emissions by 2040 is less than 0.05 degrees Celsius. Between now and 2100, global average temperature is expected to rise about 2½ degrees Celsius irrespective of the path chosen for stabilization.

The body of this memorandum lays out the rationale for these conclusions.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: DAVID.WILCOX@MS01.DO.treas.sprint.com@INET@LNGTWY (
DAVID.WILCOX@MS01.DO.treas.sprint.com@INET@LNGTWY [UNKNOWN])

CREATION DATE/TIME: 3-OCT-1997 19:14:58.00

SUBJECT: attached paper

TO: Peter R. Orszag@eop (Peter R. Orszag@eop [OPD])
READ:UNKNOWN

TO: Janet L. Yellen@eop (Janet L. Yellen@eop [CEA])
READ:UNKNOWN

TO: Jeffrey A. Frankel@EOP (Jeffrey A. Frankel@EOP [CEA])
READ:UNKNOWN

TEXT:
Date: 10/03/1997 06:50 pm (Friday)
From: David Wilcox
To: peter, jon, janet, jeff, ray
Subject: attached paper

<WP Attachment enclosed>

Attached is the final version of the joint Treasury/CEA paper.

The respective staff members have now reached closure on fact
checking.========== ATTACHMENT 1 ==========
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:
Unable to convert ARMS_EXT:[ATTACH.D34]MAIL48910757J.216 to ASCII,
The following is a HEX DUMP:

Global Climate Change: Which Way Forward?

I. Economic costs

There is no doubt that we must take action to begin to stabilize and eventually reduce our emissions of greenhouse gases. Economic evidence indicates, however, that meeting the targets and timetables for emissions reductions that are currently on the negotiating table would require severe and unpopular actions. None of the lead signatories on the recent economists' letter supporting action on climate change believes that returning carbon emissions to 1990 levels by 2010 is warranted.

Achieving the 1990 level of emissions by 2010 would require imposing about as much restraint on energy consumption as resulted from the OPEC oil price increases of the 1970s. Moreover, it could only be accomplished by introducing an energy tax — or the economic equivalent thereof — more than four times larger than our 1993 BTU tax proposal. Advances in technology and mechanisms for international burden-sharing would help cushion this impact somewhat, but even with the most effective possible measures in place on these fronts, an aggressive program would still inflict considerable economic pain. For all these reasons, an ambitious approach would face severe Congressional opposition and have other highly adverse political consequences.

Regardless of how the restraint on carbon emissions is imposed, the costs will be passed down to consumers. A recent EPI study warning of the loss of 2 million jobs is typical of the reaction that an aggressive proposal would elicit. Other opponents of such a proposal would include most large companies, all energy-intensive small businesses, organized labor, consumer groups, and those fearful about competitiveness. It is likely that moderate sources of analysis (e.g., Brookings, AEI, IIE, and mainstream Democratic economists such as Alan Blinder, Richard Cooper, and William Nordhaus) would oppose ambitious commitments.

There is a better alternative available to the Administration: A more gradual program of emissions restraint would capture most of the environmental benefits of an ambitious program, and at only a small fraction of the economic cost.

Broadly speaking, there are two possible ways to satisfy the obligations we might sign onto in Kyoto: We can reduce our domestic use of carbon, or we can buy our way out of at least part of the obligation by paying other countries to reduce their emissions. The next several subsections consider five possible approaches to advancing these objectives: a tax on carbon emissions; a system of tradeable permits; command-and-control regulation; investment in technology; and international cost-reduction measures.

A. Carbon taxes

The most straightforward way to reduce carbon emissions is to tax them. Imposing a tax would increase the incentive to become "carbon-efficient."

The magnitude of the required tax would depend on the aggressiveness of the objective. If the objective is to return emissions to 1990 levels by 2010, then the tax would have to be between $80 per ton and $250 per ton of carbon emissions. This tax would have to be introduced within the next few years, ramp up to this level by 2010, and continue to rise thereafter.

- A tax of this magnitude would be 4-12 times larger than the BTU tax that was proposed in 1993.

- Even an $80-per-ton tax (i.e., a tax at the lower end of the estimated required range) would reduce the standard of living of the average family by about $880; this is roughly equivalent to 1-½ week's worth of take-home pay. Furthermore, a tax of this type would be highly regressive: the relative burden on the lowest fifth of the population would be 6 times as great as the burden on the highest fifth.

- A tax of this magnitude would damage the performance of the macroeconomy as well. It would produce stagflation — a period with higher inflation and more unemployment.

Notwithstanding these severe impacts, your economic advisers believe that a tax on carbon emissions compares favorably to other methods of restraining carbon emissions. With the exception of an auction-based permit approach — discussed below — other methods would impose greater costs on consumers and the overall economy.

B. Tradeable permits

Another approach to restraining emissions would involve creating a domestic emissions trading program. At the center of this type of program is a *permit*, which would entitle the holder to emit a certain amount of carbon into the atmosphere. Such a program could be implemented either by auctioning permits, or by giving them away. Many designs for the give-away are possible, but one much-discussed option would involve "grandfathering" existing emitters.

Grandfathering would probably be unworkable and would surely be unfair. It would publicly reward polluters. It would give as much as $200 billion per year to corporations. And it could be administratively extremely complex, depending on the details of implementation. Therefore, if a permit-based approach is selected rather than a tax-based approach, we would strongly prefer auctioning the permits rather than grandfathering them. Either permit-based approach (auctioning or grandfathering) would cause a large increase in the price of energy to consumers, and so would be perceived as equivalent to a tax.

Some observers have claimed that the sulfur-dioxide program serves as a good model for how a carbon trading program would work, and in particular illustrates that carbon emissions could probably be reduced at surprisingly low cost. This is not the case. A carbon trading

program would be 100 times as large as the sulfur-dioxide program, so extrapolation from one program to the other is extremely speculative. Moreover, a substantial portion of the acknowledged success of the sulfur-dioxide program derives from the fact that it replaced an enormously burdensome set of command-and-control regulations, and the fact that it enjoyed some good luck, notably in the form of a steep decline in freight rail rates. Neither of these factors can be expected to operate in the case of a carbon program.

C. Regulation

Reductions in emissions could be achieved by command-and-control regulation. But this approach would be tremendously inefficient, and could easily be circumvented.

The inefficiency of this approach is illustrated by the U.S. experience with CAFE standards, which: apply only to new vehicles, and therefore perversely increase the incentive to hold onto cheaper, dirtier used vehicles; reduce the cost of driving additional miles, and therefore perversely reduce the incentive to drive fewer miles; and apply more heavily to cars than "light trucks", and so perversely have induced some consumers to purchase low-mileage sport-utility vehicles, which are classified as light trucks and now account for half of new vehicle sales.

These standards impose high costs on the U.S. economy. One study estimated these costs at $11 for every gallon of gasoline saved and more than $100 for every ton of carbon saved. Moreover, new standards would involve very unpopular restrictions on the purchase of the type of vehicles preferred by new car consumers.

D. Technology

In the very long run, technology determines what can be achieved in reducing carbon emissions, so provision of major new research funding and perhaps funding for diffusing technology is important.

A recent Energy Department study (the "5 Labs Study) concludes that an ambitious program of investment in technology development and diffusion could move the nation one-third of the way toward meeting the 1990 level of emissions *at no net cost — or possibly even net benefit — to the economy.* Your economics advisers, John Deutch, and many other outside reviewers believe that this conclusion is founded on unrealistic assumptions. For example, the report assumes that firms can be induced to invest $50-90 billion per year beyond current levels in energy-efficient technologies and other measures for conservation. This is a large amount of investment (roughly 7 percent of total investment in new equipment), and it could only be called forth by offering costly incentives.

E. International cost-reduction measures

As you know, the United States has suggested two approaches for reducing what we

would have to do domestically to lower greenhouse-gas emissions: international permit trading, and "joint implementation." But the practical difficulties of establishing these mechanisms imply that they will only be able to make marginal contributions, at most, in the near future.

- International emissions trading has not been accepted by other nations. Even if such trading were to be accepted, other governments choosing to implement their own domestic emissions reductions through regulatory approaches or through energy taxes probably would not be willing to tighten those domestic restrictions in order to profit from permit sales to the United States.

- Both international permit trading and joint implementation raise difficult issues of monitoring and enforcement. For example, every country in the system would be tempted to allow its firms to fraudulently sell their emissions rights into the international market, garner the resulting revenue, and exceed their allowed level of emissions.

Even assuming the most optimistic scenarios for technology and successful implementation of domestic and international trading, it will still not be possible for us to achieve 1990 emissions levels without substantial increases in the price of energy — on the order of 4 to 12 times the amount of the BTU tax.

II. The link between the economy and the environment

There are two key questions concerning the link between the economy and the environment. First, assuming all countries faithfully execute all of the commitments contained in proposals currently on the negotiating table, will the desired environmental benefits necessarily follow? As you know, the answer to this question is "no," because developing countries would not be required to take on binding commitments under any agreement currently under consideration for approval in Kyoto.

The non-participation of developing countries is a fatal flaw for one simple reason: A ton of carbon does the same amount of damage no matter whether it is emitted in Baltimore or in Bangkok. Therefore, from an environmental perspective, it is equally important to control emissions anywhere in the world. But as you are also aware, the politics of enforcing binding commitments on developing countries is extremely difficult.

A second question concerning the link between the economy and the environment is whether the incremental environmental benefits would justify the extra economic costs associated with an accelerated program rather than a more gradual one. The figure at the end of this document suggests that the case for an aggressive program is weak. This figure compares projected increases in global average atmospheric temperature in three different cases: (1) a "*business as usual*" case; (2) an *ambitious* case in which industrialized countries return their emissions to 1990 levels by 2010 and developing countries stabilize their emissions at 2020 levels in 2020 (an extremely optimistic assumption); and (3) a more *gradual* case in which

industrialized countries stabilize their emissions in 2015 and return to 1990 levels by 2040, and developing countries stabilize in 2040 at 2040 levels.

As can be seen in the figure, even by 2100, the difference between the ambitious and gradual strategies is only 0.2 degree Celsius. Virtually all of this difference is attributable to developing countries; the difference in actions taken by developed countries contributes only 0.01 (*one one-hundredth*) of one degree. These amounts are small, not only in absolute terms, but also relative to the 1.7 degree increase in the average temperature that is projected to take place over the next century even under an ambitious policy.

Furthermore, the gradual strategy captures about two-thirds of the environmental benefits generated by the ambitious strategy (in spite of the lesser assumed commitments of developing countries), while imposing overall economic costs that are only *one-tenth to one-third* as great as the costs of the ambitious approach. The lower cost of the gradual strategy reflects two main considerations: (1) retrofitting is extremely expensive compared to replacing capital stock that has lived out its full life; and (2) the longer one delays before investing in new plant and equipment, the better the technology that will be available.

In summary, gradual approaches have nearly the same environmental benefits as ambitious approaches, at only a small fraction of the economic cost.

III. Suggested approaches

The foregoing analysis indicates that the U.S. should promote Kyoto as a "turning point" rather than a "finishing point." The U.S. should take a principled approach to the Kyoto negotiations and insist that the objective of any international agreement should be to stabilize long run concentrations in the least-cost fashion. This has important implications for both the breadth of the Kyoto commitment, in terms of the number of countries covered, and the depth of the commitment, in terms of the targets and timetables adopted by each country. Key features of our ultimate commitment should be:

- The long-term goal of the treaty should be to *stabilize concentrations* of greenhouse gases in the atmosphere at a level that will prevent dangerous anthropogenic interference with the climate system. This goal could be achieved with concentrations at or somewhat above a doubling of pre-industrial levels in the next one hundred years.

- Concentrations should be stabilized through targets and timetables which obtain that goal in a cost-effective fashion. In particular, we suggest that our focus should be on eliminating emissions growth in the developed countries 10-20 years after ratification, and reducing emissions levels gradually thereafter to reach — and then to decline below — 1990 levels in later years to be decided, stabilizing concentrations.

- This approach should also include a periodic review of the underlying science, the data on the path of emissions, and the economic impact, to allow for adjustments in the policy.

- The goal is the least-cost global approach to stabilization of carbon concentrations in the atmosphere. Therefore, we should negotiate and begin a new Kyoto Mandate, requiring developing country participation (in stages), starting with more-advanced (Annex B) developing countries, with graduation as countries develop. Developing countries commit to reduce the rate of growth of emissions consistent with stabilizing carbon concentrations and continued economic growth, with ceilings on costs. The United States should not initial the agreement until the Annex B countries have binding commitments.

- Develop a tradable permits system, with auction of all permits (rather than grandfathering), in the near term. Impose this system early at a level of emissions near the baseline, then increase the number of permits in small, gradual, predetermined steps, based on economic cost and aggressive technological progress, subject to periodic review.

- Use a portion of funds raised for cost-effective technology research and diffusion programs, including basic research. The bulk would be available for a range of domestic priorities (tax relief for individuals; business investment incentives; the solution to the fiscal effects of the demographic imbalance; infrastructure; etc.) chosen to make the program attractive.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Adele C. Morris (CN=Adele C. Morris/OU=CEA/O=EOP [CEA])

CREATION DATE/TIME: 3-OCT-1997 13:27:29.00

SUBJECT: updated paper

TO: Janet L. Yellen (CN=Janet L. Yellen/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

TEXT:
========== ATTACHMENT 1 ==========
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:
Unable to convert ARMS_EXT:[ATTACH.D47]MAIL46469457N.216 to ASCII,
The following is a HEX DUMP:

CLOSE HOLD: PRELIMINARY

September 30, 1997

MEMORANDUM

FROM: Lawrence Summers
Janet Yellen

SUBJECT: Targets and Timetables for Reducing Greenhouse Gas Emissions

Executive Summary

This memo provides a preliminary evaluation of the likely economic consequences for the United States of a program to attain 1990 CO_2 emissions levels by 2010. It concludes that the attainment of such a goal would necessitate at least a doubling in energy prices and impose substantial economic costs. In contrast, a more gradual emissions reduction path that eliminates emissions growth by 2010-2020 and reduces emissions to 1990 levels thereafter captures nearly identical environmental benefits as the more aggressive approach while entailing costs between one tenth and one third as large.

If attained through domestic emissions reductions alone the "1990 by 2010" target requires a reduction in CO_2 emissions of roughly 30% relative to projected 2010 emissions assuming "business as usual". The reduction in energy use needed to meet this goal would substantially exceed that achieved during the decade of the OPEC price hikes, so that energy price increases, at least comparable in magnitude, are likely. Economic analysis and historical precedent suggest energy price increases of this magnitude would have stagflationary consequences. As in the decade of the oil shocks, both unemployment and inflation would undoubtedly rise, at least for a time.

An "idealized" system of international permit trading among Annex I countries could hypothetically halve the change in carbon emissions prices needed to attain a 1990 by 2010 goal. This would mean paying Russia and other Eastern European countries to reduce emissions in place of the United States. However, such an arrangement could prove infeasible for a number of reasons, including difficulties in establishing adequate enforcement and monitoring mechanisms in the near term. Joint implementation with non-Annex I countries is likely to marginally reduce the impact on energy prices in the United States.

The memo argues that a more gradual timetable for emissions reduction can deliver virtually identical environmental benefits at a fraction of the cost. The aggressive "1990 by 2010" path is extremely inefficient because it requires premature scrappage of capital and foregoes the considerable advantages of waiting for the development of carbon-lean technologies before replacing existing plant and equipment. In contrast, a timetable that eliminates emissions growth in the second decade of the program (2010-2020) and reduces emissions to 1990 levels and below in subsequent decades is consistent with a long-term goal of stabilizing atmospheric CO_2 concentrations. *The total cost of this "back-loaded" approach is likely one third to one tenth that of the "front-loaded" 1990 by 2010 program.* Implementation of the gradual timetable requires an early, modest increase in the price of carbon emissions, along with

a credible commitment to further emissions price increases over time.

In comparison with a more gradual emissions reduction timetable, the environmental benefits of an aggressive abatement target are minimal. For example, the expected difference in global average temperature in 2100 along a fast-takeoff abatement path that attains 1990 emissions by 2010 and a slow-takeoff abatement path that peaks in 2015 and attains 1990 emissions by 2040 is less than 0.05 degrees Celsius. Between now and 2100, global average temperature is expected to rise about 2½ degrees Celsius irrespective of the path chosen for stabilization.

The body of this memorandum lays out the rationale for these conclusions.

I. Introduction

The Framework Convention on Climate Change signed at the 1992 earth summit in Rio de Janeiro called for carbon dioxide emissions in 2000 at 1990 levels. Most countries, including the United States, are unlikely to achieve these emissions reductions. But the Rio approach remains historically important, and most quantitative proposals that have been advanced in the run up to Kyoto can be understood as variants of the Rio target and timetable. In particular, a proposal to "stabilize CO_2 emissions at 1990 levels by 2010" (and variants thereof, including a more stringent proposal by several EU countries to stabilize at 10% below 1990 levels by 2010) has received considerable attention.

This memo assesses the consequences for the U.S. economy of a program to attain 1990 CO_2 emissions levels by 2010. It compares the costs and cost effectiveness of this baseline proposal with those of alternative targets and timetables that entail a less rapid initial reduction in CO_2 emissions levels. The conclusions described here rely on the substantial body of economic analysis that has been conducted by researchers worldwide, including the Intergovernmental Panel on Climate Change (IPCC), and Administration economists.

II. 1990 by 2010: The Scope of the Task

To appreciate the ambitiousness of a program to curb U.S. emissions levels to 1990 by 2010 it is necessary to recognize that such a target involves a cutback of about 31 percent in energy use in 2010 relative to baseline.[1] As of 1996, energy related carbon emissions were already 9 percent above 1990 levels. Growth in the economy through the end of the next decade would further raise carbon emissions. Even under an optimistic assumption concerning the pace of improvement of energy efficiency (0.9 percent per year), under constant relative energy prices, there would be further increases in carbon emissions by 2010 of about 22 percent over 1990 levels if we continue with business as usual. The net required reductions to achieve 1990 emissions in 2010 thus amount to about 31 percent.

Comparison with the Oil Shocks. Increases in energy efficiency of this magnitude are considerably greater than those that were achieved during the 1970s and early 1980s. Figure 1 shows aggregate energy use in the United States and the relative price of energy over the period 1960 to 1990. During the oil-shock decade--1972 to 1982--energy use was virtually constant in absolute terms, while GDP grew in real terms at about 2.25 percent per year. Over this period, the relative price of energy more than doubled: it rose about 150 percent. This historical experience, and other empirical analysis, suggests that energy use does respond to changes in the price of energy, but the responsiveness (the price elasticity of demand for energy) over periods as short as a decade is low--no higher than 0.2. In contrast to the oil shock period, the "1990 by

[1] This assumes a 2.4 percent annual GDP growth rate. Even with a more moderate assumption of 2.2 percent annual GDP growth, the cutback in carbon emissions would need to be about 28 percent relative to baseline.

2010" program would entail an even larger emissions cutback. To meet the 1990 by 2010 goal it would not be sufficient just to keep emissions constant between now and 2010: a further, roughly 10 percent rollback in emissions would be needed to offset the expansion that has already occurred since 1990. Thus, we would need to accomplish a reduction in energy use considerably larger than what occurred over a decade in which the relative price of energy more than doubled. This suggests that energy prices would likely have to rise by about 150% to attain 1990 emissions by 2010.

Model results. Numerous economic/energy models have been used to estimate the impact of a 1990 by 2010 program on energy prices. These models arrive at the same conclusion as was generated above using no model whatsoever: a program to achieve 1990 emissions by 2010 would likely entail more than doubling energy prices. A broad range of models place the carbon permit price required to achieve 1990 emissions by 2010 in the range of $80 to $200 per ton. If fully passed through to energy prices, a permit price of $100 per ton, for example, entails a 76 percent increase in energy prices. The impact on the prices of different sources of energy are all large, but the effect on coal is particularly severe. The price of coal would more than triple, while the price of a barrel of petroleum would increase by about fifty percent. Gas at the pump would increase in price by about 26 cents. Relative to the BTU tax proposed by the Administration in 1993 a $100 implicit carbon tax is about 5 times as large. Thus, attaining a goal of 1990 by 2010 would have very large effects on our economy.

Evidence from International Comparisons. A final piece of evidence confirming the conclusion that a strong price signal over a long period of time is necessary to alter energy use comes from comparisons of energy usage between the United States and Europe. It should hardly be surprising that energy use per dollar of GDP is lower in Europe than the United States. Energy prices in Europe have long been substantially higher--roughly double U.S. energy prices. Moreover, major differences in living patterns between the United States and Europe result in higher European energy efficiency. In addition to the geographical "advantage", from an energy efficiency standpoint, of Europe's higher population density, resulting in lower transportation requirements, Europe has locked in place many long-run adaptations to high energy prices. Innovations in the design of housing and transportation systems and the configuration of residential areas have occurred in response to high energy prices. But in spite of its natural advantages and its long history of high energy prices, energy per dollar of GDP is only 44% lower in Europe than in the United States. This means that even if the United States were to become Europe--energywise per dollar of GDP--its energy savings, even in the long run, would be no greater than 44 percent. This U.S.-Europe comparison supports the conclusions drawn from the natural experiment of the oil shock: namely, a return to 1990 emissions will not occur without very major price measures over a long period of time.

The Role of Technology and the Scope for "No Regrets" Policies. According to the preceding assessment, a large price inducement is necessary to meet a 1990 by 2010 target. Your economic advisers agree on this conclusion. However several of your advisers are more optimistic about the chances of achieving a 1990 by 2010 target. They emphasize the current

availability of "no regrets" (cost-saving) technologies that promise substantial opportunities for abatement. A recent report by the Department of Energy research laboratories, for example, catalogues emissions-saving technologies that, by their calculations, are currently "cost effective." If put in place now, such practices could allegedly reduce emissions by between 30 to 50 percent of the amount needed to reach a 1990 by 2010 target. Even so, the report finds that "aggressive" and "invigorated" government policies--including potentially costly and intrusive regulations and standards--as well as a $50 carbon tax would be necessary to reach the 1990 by 2010 target.

Your economic advisers agree that there now exist unused technological opportunities for emissions reduction, but we question by what means, over what time frame, and at what expense government policies could change private behavior if such opportunities are currently underutilized. Engineering studies generally ignore the sometimes subtle disadvantages of available cost-saving technologies or overestimate their hypothetical returns. An example is illustrative: significant energy and cost savings could result if consumers replace incandescent bulbs with compact fluorescents. Over the long lifetime of such bulbs there would also be a substantial monetary gain. However, actual adoption of these light bulbs has been slow to date, possibly due to pure inertia, possibly because consumers dislike their color, or perhaps because they apply a high "discount rate" when valuing energy savings that accrue after the purchaser may have switched residence. Several recent studies have demonstrated that the actual returns to home improvement investments, such as attic insulation, often fall short of those predicted by engineering studies.

Regardless of the reasons, if consumers have not adopted "no regrets" measures at a faster rate, it is likely that additional incentives will be necessary for them to change their minds. Rather than stressing the mere availability of alternative technologies, your economic advisers insist on realistic estimates of likely rates of adoption and diffusion and they stress the need for economic incentives--in the form of a higher implicit price for carbon emissions--to induce the adoption of emissions-saving technology. They point out too that the baseline energy demand estimates used to predict the price increase needed to attain a 1990 by 2010 target already assume substantial ongoing improvements in energy efficiency due to the diffusion of existing technologies and the development of new ones. Significant adoption of such technologies is necessary merely to meet this assumed baseline. Finally, it is important to note that the DOE labs study includes as part of its policy package to reach 1990 emissions by 2010 extensive regulations, including stringent CAFE and appliance standards and national building codes--command and control policies that your economic advisers would oppose--along with a $50 carbon tax.

To summarize, your economic advisers consider it unrealistic to predict a substantial increase in the pace of adoption of new emissions-saving technologies in the absence of a large increase in the price of carbon emissions--and hence of energy. Based in part on the evidence from the energy shocks of the 1970s, in part on international comparisons, and in part on model results, they are optimistic that such an increase in prices would bring forth a reduction in CO_2

emissions--with larger responses to a given price change likelier the longer the time period for response. The evidence is strong that a very large price increase will be necessary to attain emissions reductions of 20 to 30 percent over a period as short as a decade. *Moreover, other approaches that apparently do not involve large price increases (such as performance standards) will impose even higher costs on the American economy.*

III. Why are the costs of early emissions reductions so high?

The previous section argued that a "1990 by 2010" target would entail high carbon emissions prices and significant economic costs. This section shows that the 1990 by 2010 timepath for emissions reductions is so aggressive as to be inefficient--in the sense of raising substantially the total projected economic cost of reaching a given environmental goal. There are three major reasons why an aggressive takeoff in curtailing emissions raises overall costs: (1) it induces premature obsolescence of the capital stock because it does not allow adequate time for the capital stock to turn over naturally; (2) it provides insufficient lead time to develop and implement new technologies; (3) it causes a significant stagflationary short-term macroeconomic shock. Additionally, an aggressive timetable for emissions reductions does not allow time for the resolution of uncertainty and it does not take advantage of the time-value of money (resources not spent on emissions reductions early on can be invested at a positive return which could purchase more emissions reductions later).

The Role of Turnover of the Capital Stock. The most clear-cut and easily quantifiable reason for the high price tag associated with rapid emissions reductions relates to the need for premature replacement of plant and equipment in response to large increases in the price of carbon emissions. It is expensive enough to replace plants that are fully depreciated, but vastly more so if those plants are still in the prime of their productive lives. Within 20 to 40 years, much of our existing plant and equipment will be ready for replacement anyway; therefore building in greater carbon efficiency at that time will be relatively cheap. *It is important to emphasize that the case we are making here is not based on procrastinating for the sake of avoiding the problem; rather, it is based on simple principles of hard-headed business efficiency.*

The advantage of a slower emissions reduction timetable in avoiding the large costs associated with premature obsolescence of the capital stock can be illustrated by considering electrical power generation. The case of electricity generation is important in its own right since this industry is responsible for 88% of coal use and more than one third of all carbon dioxide emissions in the United States. But the principle concerning the costs of premature replacement applies broadly because reduced greenhouse gas emissions may entail the accelerated retrofitting of housing and commercial structures, the premature scrappage of vehicles and appliances, and the premature replacement of plant and equipment in energy intensive industries.

Figure 2 illustrates the effect of an accelerated retirement schedule for today's U.S. electric power generation capacity installed during the last 40 years. Imagine, to take an extreme case, that a timetable is adopted that necessitates replacing all power plants with less-polluting technology within ten years. This would require retiring 630 out of 670 gigawatts of generating capacity before the end of its normal life span, or 94 per cent of the total. If the timetable were extended so that all power plants instead had to be replaced within 20 years, the accelerated replacement of capacity would affect 450 gigawatts of capacity, or 67 per cent of the total. Allowing this additional 10 years for turnover avoids the premature retirement of 27 per cent of existing electric power plant capacity. With a 30 year horizon, complete turnover would mean accelerated retirement of only 21 per cent of the total capacity and, with a 40 year timetable, there would be almost no additional costs due to premature obsolescence.[2, 3]

The Advantage of Waiting for Superior Technologies. The example of electric power generation also illustrates a second important reason why a slow takeoff in curbing greenhouse gas emissions is ultimately less costly: new technologies take a long time to develop. Waiting until these new technologies are available before making expensive emissions-saving investments offers the potential of both lower economic costs and higher environmental payoffs. Under a tight target and timetable with its associated high carbon emissions price, electric utilities will be forced to replace existing capacity in the very near future and to rely on currently available lean-carbon technologies, likely gas-turbine plants. If some delay can be factored in, however, they will be able to install more effective and less costly alternative technologies. A rapid timetable forces long-term investments to be made before superior technologies have been developed and refined.

Implication: The Need for a Credible, Long-Term Price Increase. The example of electricity generation illustrates two general principles. First, the responsiveness of both demand and supply are greater in the long run than in the short run. This means that, with a longer horizon, any given amount of abatement can be accomplished with a smaller increase in carbon emissions prices. Second, and perhaps even more important for policy, any credible emissions reduction strategy must include both a price increase at the outset and also a clear commitment to maintain and likely increase prices further over time. Without such a commitment, the changes in behavior required to meet even a long-run target of emissions

[2]The distribution has been truncated at 40 years, the average lifespan of existing electric power plants. A few plants of yet older vintage are still in use.

[3]The same exercise can be performed for coal-fired power plants. These generators produce the most carbon per kilowatt hour of electricity and thus will have a high incidence of replacement even under a moderate abatement plan. If a complete change-over of coal plants were to be accomplished in 10 years, 96 per cent of total capacity would be retired early. If retirement occurred over 20 years, only 64 per cent would be retired early. Allowing an additional 10 years for turnover would avoid premature retirement of one-third of existing coal-fired plant capacity.

reduction will likely not occur. Consider a utility that today is drawing up its plans for a new power plant. That utility will choose among today's technologies, which vary in their costs and CO_2 emissions. In order to induce the utility to choose a more costly, lean-emissions technology today, it must be clear that CO_2 emissions will be costly enough over the 40 years or more lifetime of the plant to justify a more expensive investment option today. A large cumulative reduction in emissions can be achieved over the long term with only a modest carbon emissions price increase now, but only if the commitment to still higher prices in the future is credible and clear.

Stagflationary Macroeconomic Impact. From a macroeconomic perspective, increases in energy prices constitute an adverse "supply shock." Such developments are stagflationary--even if anticipated--because they raise both inflation and unemployment simultaneously, creating a painful macroeconomic dilemma. As noted above, a plan to attain 1990 emissions levels by 2010 would require a change in energy prices over the first decade of the 21st century at least comparable in magnitude to the two oil shocks of the 1970s. Those shocks are widely acknowledged to have raised both unemployment and inflation. Similarly, the energy price increases required by a 1990 by 2010 program would raise inflation, lower real wages, and raise unemployment. Unemployment in the four years after the first oil shock averaged 7.2 percent in comparison to 5.0 percent in the four years prior; and unemployment rose further, to an average of 8.6 percent, in the four-year aftermath of the second oil shock.[4] Although the increases in energy prices associated with a treaty to reduce greenhouse gases would be anticipated, rather than a surprise, we should nevertheless expect that the efforts of the Federal Reserve to contain inflation, coupled with likely efforts on the part of workers to recoup real wage losses will lead to a period of higher unemployment.

Furthermore, it is important to note that most model-based estimates of the costs of a program to attain 1990 emissions levels by 2010 assume that resources are fully employed, thereby ignoring these potential short-term effects. Such models therefore provide no assessment of the consequent increases in unemployment.

IV. Quantifying the Economic Costs of Slow versus Fast Take-off

[4] There is debate about how much of this was due directly to the oil shocks, because there was a simultaneous decline in productivity growth and transfers of real income to OPEC producers.

The relative costs of slow versus fast takeoff timetables in curbing CO_2 emissions has recently been analyzed by the Stanford Energy Modeling Forum (EMF-14).[5] The Stanford group used six large-scale economic/energy models to compare the total projected cost of two alternative emissions reduction time paths--one "frontloaded", the second more "backloaded". *Importantly, both paths were designed eventually to stabilize atmospheric concentrations of CO_2 at double the pre-industrial level--550 ppmv.*[6] Although a high degree of uncertainty is inherent in particular numerical estimates from individual models, the simulations nevertheless point to some robust qualitative conclusions. *The major conclusion to be drawn from this project is that an emissions reductions path characterized by an aggressive initial phase is substantially more costly--3 to 10 times more costly--than a path with a slower takeoff but larger eventual reductions.*

To enable a comparison of the costs of slow and rapid takeoff strategies, the EMF investigators asked each of six modeling groups to simulate the economic impacts of two alternative strategies to attain stabilization of CO_2 concentrations at 550 ppmv. The first strategy (the WG-1 path) corresponds to an emissions pathway published in 1994 by Working Group 1 (WG-1) of the Intergovernmental Panel on Climate Change (IPCC). The working group computed a set of global CO_2 emissions pathways consistent with stabilization of concentrations at 550 ppmv and several alternative concentration levels. The WG-1 path entails an immediate departure from the baseline or "business as usual" emissions path. Subsequently, Wigley, Richels and Edmonds (WRE) published an alternative set of emissions profiles to achieve the same concentration targets. In contrast to the WG-1 paths, the WRE emissions path was constructed to follow the baseline or "business as usual" scenario in the early years with sharper reductions after this initial phase. Wigley, Richels and Edmonds hypothesized that their slower-takeoff emissions pathways would yield identical environmental objectives with substantially lower economic costs, for the reasons discussed above. The EMF-14 exercise validates this hypothesis.

The EMF-14 comparison project assessed the total costs to the OECD, the EEFSU (Eastern Europe and the former Soviet Union) and the non-Annex I countries of the WG-1 and WRE pathways to stabilization of CO_2 concentrations at 550 ppmv. The appropriate economic measure of total cost is the present discounted value of losses in future consumption

[5] To enable meaningful comparisons of results across models, the EMF has coordinated a series of projects in which a number of large scale energy models are used to estimate the impact of given, specified emissions reduction scenarios under common standardized, benchmark assumptions concerning population and economic activity, discount rates, energy resource availability and prices and technology availability.

[6] All energy models make numerous simplifications and approximations in order to describe the energy sector globally and over the span of a century or more. In particular, all of the models assume full employment, thereby abstracting from the likely short-run macroeconomic costs of an emissions reduction program.

relative to a "Business as Usual" scenario. Estimates of regional costs depend on the extent of burden sharing--namely, the assumed "division of labor"--between Annex-I and non-Annex I countries in controlling emissions as well as the extent of international emissions trading. Recall that, by the end of the next century--by 2100-- assuming "business as usual"--non Annex 1 countries will have more than 90 percent of CO_2 emissions. Thus, developing country participation is absolutely essential to achieving stabilization of concentrations. Consistent with the Berlin Mandate, the simulations assumed that the burden of emissions reduction would fall on Annex I countries exclusively during the early decades; that by 2030, non-Annex I countries would begin to participate; and by 2050, a full transition to targets based on equal per capita emissions rights is assumed.

Figure 3 plots the OECD emissions paths in the WG-1 and WRE scenarios. Under the WG-1 scenario, OECD emissions begin to decline immediately and continue to decline for roughly four decades. For example, OECD emissions fall 10 percent below initial levels ten years after implementation--corresponding closely to the requirement of a "1990 by 2010" timetable, which requires a reduction of 9 percent from current emissions in roughly a decade. In contrast, OECD emissions along the WRE path continue to rise for roughly two decades--corresponding closely to a plan calling for emissions to peak around 2020--return to 1990 levels around 2040 and decline substantially further in subsequent decades.

Table 1 illustrates a robust conclusion that emerges from this exercise: fast takeoff in emissions reductions greatly increases the costs. Table 1 shows the cost for both the aggressive (WG-1) and slow-paced (WRE) paths--both with and without idealized international trading of permits. In 10 out of 12 simulations--for six different models with and without permit trading--the costs on the slow-takeoff WRE path is less than a third of the cost on the corresponding fast take-off path. Taking account of the likely adverse short-run macroeconomic consequences of an aggressive path would further strengthen this conclusion.

Table 2 illustrates a second, robust conclusion from the EMF-14 exercise: a viable system of international permit trading would very much reduce OECD costs. With global permit trading, the sharp, early emissions reductions required of OECD countries under the aggressive (WG-1) approach would be avoided through the purchase of emissions permits from countries with lower abatement costs. The average reduction in cost is 56 percent.[7]

[7] The computations in Table 2 verify that the slow paced (WRE) path, which permits emissions to depart relatively little from business as usual for several decades, is a substantially less costly than the alternative WG-1 path with its sharper immediate reductions. Since both paths are arbitrarily chosen to conform with the 550 ppmv concentration target, a natural question concerns the characteristics of an optimal or least-cost path for achieving this concentration target. An important recent study by Alan Manne and Richard Richels uses their MERGE model (included in the EMF-14 project) to compute the least cost path with 550-stabilization in 2100 and international permit trading. The optimal path, while not identical to the WRE path, is similar in character. This least-cost path peaks approximately three decades

Finally, it is important to note that in most of the EMF models, policy actions to raise carbon emissions prices must be taken at the inception of the slow-paced (WRE) program and a commitment to increasing emissions prices over time is required to achieve additional emissions reductions. Naturally, the required initial carbon emissions price is substantially lower, at the outset, under the slower-paced (WRE) than under the aggressive (WG-1) path. Thus, although the slower-paced emissions path initially approximates the business as usual baseline, credible incentives must be put into place immediately, and strengthened over time, to achieve the needed investments in carbon-efficient technologies.

V. The Environmental Consequences of Slow versus Fast Takeoff.

after the initiation of the program and declines thereafter.

While the excess cost of a fast compared to a gradual emissions reduction path is large, the difference in projected global temperatures over the next century between the fast and the slow paths is quite small, both in absolute amount and relative to temperature changes expected even if an aggressive policy path is adopted. Under "business as usual" assumptions, average global temperatures are expected to rise about 1 degree Celsius by 2050 and about 2½ degrees Celsius by 2100. An aggressive emissions reduction path that stabilizes emissions at 1990 levels by 2010 and maintains emissions at the 1990 level thereafter would mitigate this temperature increase by roughly 0.1 degrees by 2050 and 0.2 degrees by 2100.[8] In contrast, a more gradual emissions path that peaks around 2015, stabilizes emissions at 1990 levels by 2040, and holds emissions constant at 1990 levels thereafter yields virtually identical environmental benefits: the temperature difference between the aggressive and gradual paths diverges by no more than 0.05 degrees at any time over the next century. Similarly, the temperature differences along the aggressive WG-1 and less aggressive WRE paths--both designed ultimately to stabilize concentrations at 550 ppmv--differ by a maximum of 0.2 degrees over the next several centuries.[9]

The limited climatological impact of even an extremely aggressive emissions reduction program measured in terms of temperature impacts during the next century reflects the extremely long lags involved in the underlying physical processes and the dependence of temperature on the total stock of carbon dioxide in the atmosphere, rather than the flow of emissions at a given time. Emissions reductions do matter to temperature, but only over an extremely long horizon. The cumulative nature of the process suggests that there is little effect on global temperature from a slow rather than from a fast abatement takeoff. The addition to the total stock of carbon from a slow rather than a fast start to abatement adds relatively little to the total atmospheric stock of CO_2 between now and 2100 for four separate reasons: the difference in carbon emissions between a slow and a fast start over the initial decades of abatement is only a small fraction of total emissions in that period; the stock of CO_2 in the atmosphere is itself the result of many decades of emissions; some of the CO_2 emissions of the early decades will have been re-absorbed; and the most serious build-up in CO_2 under business as usual occurs late in the next century, as a consequence of burgeoning emissions from non-Annex I countries.

Even the potential for a catastrophic environmental event, such as the melting of the West Antarctic ice sheet, a runaway greenhouse effect (e.g., from release of trapped methane with the

[8] Successful stabilization would require very large cuts from "business as usual" in China, India, and other non-Annex I countries.

[9] If a model assumes that sulfur dioxide emissions decline with the decline in carbon dioxide emissions under climate policy (as predicted, given the extent of sulfur emissions associated with fossil fuel combustion, and incorporated in the IPCC's IS92 emissions projections), the more aggressive WG-1 path will be *warmer* than the WRE path between 2000 and 2040. This result reflects the negative impact of sulfate aerosols on the greenhouse effect. Early and substantial cuts in fossil fuel combustion, while decreasing the carbon emissions that warm the atmosphere, also decrease the sulfate aerosols that cool the atmosphere.

melting of the permafrost), or a structural change in ocean currents such as the Gulf Stream, which the preceding abstracts from, does not fundamentally affect the basic trade-offs between the high costs of fast vs. slow takeoff paths. These factors do, however, add--perhaps greatly--to the urgency of adopting moderate long-term greenhouse gas concentration targets and a program involving an immediate, albeit moderate, increase in the price of CO_2 emissions.

VI. International Trading of Permits

As has already been noted, an effective system of international carbon emissions permit trading among Annex I countries could substantially diminish the cost of a CO_2 abatement program. An Annex I trading system could, potentially, reduce the size of the carbon emissions price to attain a 1990 by 2010 goal by up to 50%. Moreover, joint implementation projects with non-Annex I countries could, hypothetically, reduce this figure by half again.

Although international trading and joint implementation--so-called "where flexibility"--has enormous advantages in theory, your economic advisers are concerned that substantial barriers would stand in the way of implementing any workable analogue of such an idealized system--at least in the near term. Consequently, they stress that Annex I international permit trading and joint implementation between the U.S. and non-Annex I countries realistically can serve only a limited role in reducing the costs associated with meeting a "1990 by 2010" target.

A *hypothetical* example shows how an international trading system would work, and why it would reduce each participant country's abatement costs. Suppose, ideally, that every country adopts a domestic permit system to implement its Kyoto target. Absent international trading, the price of emissions permits would surely differ across countries, reflecting differing marginal costs of abatement internationally. With different permit prices in different national markets, profit- seeking traders would be motivated to buy permits in countries where they are cheap and resell them in countries where they are more expensive. Such arbitrage activities would create an international permit market, bringing permit prices into equality worldwide. This idealized system promotes global efficiency in achieving any worldwide abatement goal. Countries with permit prices below world levels have the incentive to reduce emissions more than they otherwise would in order to profit in the international permit market. Countries with high permit prices would have the incentive to purchase permits, thereby relaxing their Kyoto emissions constraints. The U.S. government could avoid any direct participation in such a system as long as it deems foreign-issued permits presented to the U.S. government by U.S. carbon-emitting entities as valid as those issued by the U.S. government itself.

The preceding description of how an international permit trading system would work provides an idealized picture of its possibilities. But the actual benefits of such a system are apt to fall short of this utopian portrayal in part because countries are not obliged to fulfill their Kyoto commitments via a domestic permit trading scheme; indeed, few Annex I countries have indicated an intention to do so. For example, consider a government that has decided to limit

domestic emissions through regulatory controls. International permit sales that result in tighter domestic constraints could well be politically unpopular so that a government would hesitate before selling its emissions rights to the United States. Similarly, international permit sales by a country that is meeting its Kyoto obligations through domestic carbon or energy taxes would necessitate a hike in those taxes. In either case, international trading would involve government to government negotiations, and difficult political decisions. In contrast, in the idealized system, trades result from profit oriented transactions among individuals, mediated through the market.

Monitoring and enforcement issues are also likely to be paramount in insuring the workability of international trading. If domestic enforcement is effective in all countries, so that, in the aggregate, consumers and firms in each country actually limit their emissions to the national permit levels, international permit sales by private agents in the country actually translate into lower domestic emissions. But consider the difficulties that can occur with imperfect enforcement. If the government of a country--country X--finds it difficult either to measure domestic emissions or to enforce the purchase of permits by domestic emitters, then reductions in X's emissions may be insufficient to reach the Kyoto target. Those firms or individuals in X that are lucky enough to have been assigned the rights to X's permits will be able to sell them, at a quick profit, on the international market. With imperfect enforcement, international sales, without corresponding domestic emissions reductions, could emanate from countries with the weakest systems of enforcement. To prevent such "paper trades", which profit some participants and increase emissions, many countries, including the United States, will want controls to ensure the integrity of international permits. Buyers, too, will want clear concrete guarantees of the validity of permits so as to be sure they are not being passed counterfeit goods. These controls and guarantees will surely inhibit the efficiency of the market and render some--possibly much--of the estimated savings illusory. In fact, most of the benefits projected from the international sale of permits come from inducing emissions reductions from countries in Eastern Europe and the former Soviet Union--countries with particularly weak tax collection and enforcement mechanisms. Without these countries in the scheme the gains from international trading of permits will be very small.

Joint implementation with non-Annex I countries also has the potential to reduce the U.S. burden of attaining any given timetable. Under this type of approach, U.S. businesses could receive credit for the construction of nuclear, oil, or natural gas electricity generation plants in China if it were confidently expected that China would instead have constructed coal-fired plants with much higher CO_2 emissions. Certification of such credits might be overseen by an international agency to ensure that the projects were emissions-replacing. Such a project-by-project system is likely the most that is feasible in the absence of quantitative targets. Your economics advisers have concerns about even this level of endeavor due to the inherent difficulty in establishing that a particular set of projects has actually reduced a country's emissions, absent a reference path enabling a clear quantitative comparison. For example, the construction of a nuclear power plant in place of a coal-powered plant in China could indirectly raise CO_2 emissions elsewhere in the Chinese economy--partially offsetting the direct CO_2 reducing effect of the project--if the reduced demand for coal lowers its domestic price and

encourages greater use elsewhere in the Chinese economy. A project-oriented approach to joint implementation will, in effect, constitute a limited form of international trading with high transaction costs. As a result, it will probably capture only a small fraction of the total benefits of full international trading. In contrast, model results concerning the benefits of joint implementation treat it as equivalent to idealized international trading.

VII. Recycling of Revenues

The ultimate economic cost of an emissions abatement program depends upon how the revenues realized from carbon taxes or auctioned permits are used. It has been estimated that the efficiency loss from collecting an extra dollar of tax revenue amounts to around 30 cents. If the revenues from a carbon tax or auctioned permits are used to reduce inefficient taxes inhibiting work or investment, the resulting gains would partially offset the micro-efficiency losses from energy curtailment. The simple lesson is that the costs of emissions abatement may be greatly reduced if the revenues from the taxes levied can be put to good use.

So far we have approached the recycling of revenues from the standpoint of microeconomic efficiency. There is also the potential for using the revenues to abate the macroeconomic consequences of the emissions program. The oil shocks are believed by many economists to have resulted in increased unemployment because workers resisted the fall in real wages that was associated with the inflationary impact of higher energy prices. Increased wage demands added inflationary pressures to the economy that could only be suppressed by tighter monetary policy. Thus it might be argued that the effects of the real wage shock on inflation and unemployment could be diminished by lowering payroll or other worker taxes to offset the real wage losses from higher energy prices.

But England's experience points to the need for caution in assessing the potential for revenue recycling to allay the macroeconomic consequences of the rising energy costs. In 1979, immediately after her election, Margaret Thatcher increased the VAT tax and simultaneously decreased the income tax. These two policy changes had offsetting effects on real after tax incomes, and therefore might have been expected to have had no effect on wage bargaining. However, the increase in the VAT tax resulted in an immediately noticeable increase in the CPI. A wage-price spiral ensued as workers attempted to maintain their pre-tax real wages.

VIII. Policy Implications

The foregoing arguments point to the attractiveness, from both an economic and environmental standpoint, of a U.S. policy to raise the price of carbon emissions--either through a carbon tax or a system of auctioned permits--by a moderate amount--for example, between $5 and $15 per ton of carbon--in the near term, with further increases scheduled over the longer term. A realistic target and timetable corresponding to such a program would entail continued emissions growth in the first decade of the program, say 200-2010; elimination of emissions growth in the second decade (2010-2020) and reductions in emissions thereafter This program

entails significant, early policy action and is consistent with a strong U.S. commitment to attaining the ultimate objective of the Framework Convention--namely to stabilize atmospheric concentrations of CO_2 and hence global temperatures.

A program involving gradual increases in the relative price of carbon emissions over time would avoid the substantial macroeconomic consequences of a 1990 by 2010 program. The energy price increases associated with the more moderate program would have a modest impact on family income that could be offset by compensating cuts in other taxes.

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Global Climate Change: Which Way Forward?

I. Economic costs

There is no doubt that we must take action to begin to stabilize and eventually reduce our emissions of greenhouse gases. Economic evidence indicates, however, that meeting the targets and timetables for emissions reductions that are currently on the negotiating table would require severe and unpopular actions. Achieving such targets would entail greater restraint on energy consumption than resulted from the OPEC oil price increases of the 1970s. Such restraint could only be accomplished by imposing a tax — or the economic equivalent thereof — on energy that is more than five times larger than our 1993 BTU tax proposal. Advances in technology and mechanisms for international burden-sharing would help cushion this impact somewhat, but even with the most effective possible measures in place on these fronts, an aggressive program would still inflict considerable economic pain. For all these reasons, an ambitious approach would face severe Congressional opposition and have other highly adverse political consequences. Moreover, none of the lead signatories on the recent economists' letter supporting action on climate change believes that returning carbon emissions to 1990 levels by 2010 is warranted.

There is a better alternative available to the Administration: A more gradual program of emissions restraint would capture most of the environmental benefits of an ambitious program, and at only a small fraction of the economic cost.

Broadly speaking, there are three possible ways to satisfy the obligations we might sign onto in Kyoto: We can raise the price of emitting carbon; we can increase the efficiency with which we use carbon; or we can buy our way out of at least part of the obligation by paying other countries to reduce their emissions. The next several subsections consider five possible approaches to advancing one or more of these objectives: a tax on carbon emissions; a system of tradeable permits; command-and-control regulation; investment in technology; and international cost-reduction measures.

A. Carbon taxes

The most straightforward way to reduce carbon emissions is to tax them. Imposing a tax would increase the incentive to become "carbon-efficient."

The magnitude of the required tax would depend on the aggressiveness of the objective. If the objective is to return emissions to 1990 levels by 2010, then the tax would have to be between $80 per ton and $200 per ton of carbon emissions. This tax would have to be introduced within the next few years, and would ramp up to its full level by 2010.

- A tax of this magnitude would be 4-10 times larger than the BTU tax that was proposed in 1993.

- Even an $80-per-ton tax (i.e., a tax at the lower end of the estimated required range) would reduce the standard of living of the average family by about $880; this is roughly

equivalent to 1-½ week's worth of take-home pay. Furthermore, a tax of this type would be highly regressive: the burden on the lowest fifth of the population would be 6 times as great as the burden on the highest fifth.

- The impact of a tax of this magnitude would be evident in macroeconomic data as well. Conservative estimates suggest that this action would inflict the equivalent of one additional mild recession on the economy every 15 years.

Notwithstanding these severe impacts, your economic advisers believe that a tax on carbon emissions compares favorably to other methods of restraining carbon emissions. The costs to consumers and the overall economy under most other methods would exceed the costs under a direct carbon tax. (Some other methods would obscure these costs, but impose them nonetheless.) Importantly, a tax would limit the cost to the economy of the carbon program in a way that no other program is capable of doing: Once the level of the tax was set ("so many dollars per ton of emissions"), the cost could not rise. By contrast, other methods of imposing restraint on carbon emissions leave uncertainty about the eventual cost per ton of emissions.

B. Tradeable permits

Another available tool for restraining emissions is a domestic emissions trading program. At the center of this type of program is a *permit*, which entitles the holder to emit a certain amount of carbon into the atmosphere. Such a program could be implemented either by auctioning permits, or by giving them away. Many designs for the give-away are possible, but one much-discussed option would involve "grandfathering" existng emitters.

Grandfathering is economically ludicrous, in part because it would publically reward polluters; for this and other reasons, we would strongly favor an auction-based approach. Either approach, however, would result in a large increase in the price of energy to consumers, and so would be perceived as essentially equivalent to an increase in taxes.

Some observers have claimed that the sulfur-dioxide program serves as a good model for how a carbon trading program would work, and in particular illustrates that carbon emissions could probably be reduced at surprisingly low cost. In fact, this is not the case. A carbon trading program would be 100 times as large as the sulfur-dioxide program, making any extrapolation extremely speculative. Moreover, a substantial portion of the acknowledged success of the sulfur-dioxide program derives from the fact that it replaced an enormously burdensome set of command-and-control regulations, and the fact that it enjoyed some good luck, notably in the form of a steep decline in freight rail rates. Neither of these factors can be expected to operate in the case of a carbon program.

C. Regulation

Reductions in emissions could be achieved by command-and-control regulation. However, because of the attendant cost to consumers and the resulting political consequences, this approach is not currently under serious consideration.

D. Technology

One alternative to raising the price of carbon is to improve the efficiency with which it is utilized. In the very long run, technology determines what can be achieved in reducing carbon emissions, so provision of major new research funding and perhaps funding for diffusing technology is important.

A recent Energy Department study (the "5 Labs Study) concludes that an ambitious program of investment in technology development and diffusion could move the nation one-third of the way toward meeting the 1990 level of emissions *at no net cost — or possibly even net benefit — to the economy.* John Deutch, your economics advisers, and many other outside reviewers believe that this conclusion is founded on unrealistic assumptions. For example, the report assumes that firms can be induced to invest $50-90 billion per year beyond current levels in energy-efficient technologies and other measures for conservation. But because such additional effort on energy conservation would force firms to redirect 7 percent of their total investment in new equipment, it could only be accomplished by offering costly incentives.

Although the potential for technology to make a positive contribution is real, it is limited. Renewable sources of energy today account for just 8 percent of all energy supplied in the US economy. Experts in energy efficiency currently estimate that these sources could account for 3 percent of total energy supply by 2010.

E. International cost-reduction measures

As you know, the United States has suggested two approaches for reducing what we would have to do domestically to lower greenhouse-gas emissions: international permit trading, and "joint implementation."

- *International emissions trading* has not been accepted by other nations. Even if it were accepted internationally, it is doubtful that Congress would appropriate the $5-10 billion annually that would be required for the US to buy emissions rights from other countries. There is currently no model that would allow corporations to buy emissions rights directly from foreign governments.

- *Joint implementation* poses similar problems. Although it has shown promise in pilot projects, there is no evidence that we can devise a scheme that developing countries will accept and that will reward us properly.

Even assuming the most optimistic scenarios for technology and successful implementation of domestic and international trading, it will still not be possible for us to achieve 1990 emissions levels without substantial increases in the price of energy — on the order of 4 to 10 times the amount of the BTU tax. Regardless of how the restraint on carbon emissions is imposed, energy users and emitters will pass the costs down to consumers. A recent EPI study warning of the loss of 2 million jobs is typical of the reaction that an aggressive proposal would elicit. Other opponents of such a proposal would include most large companies, all energy-intensive small businesses, organized labor, consumer groups, and those fearful about competitiveness. It is likely that moderate sources of analysis (e.g., Brookings, AEI, IIE, and mainstream Democratic economists such as Alan Blinder and William Nordhaus) would oppose ambitious commitments.

II. The link between the economy and the environment

There are two key questions concerning the link between the economy and the environment. First, assuming all countries faithfully executed all of the commitments contained in proposals currently on the negotiating table, would the desired environmental benefits necessarily follow? As you know, the answer to this question is "no," because developing countries would not be required to take on binding commitments under any agreement currently under consideration for approval in Kyoto.

The non-participation of developing countries is a fatal flaw for one simple reason: A ton of carbon does the same amount of damage no matter whether it is emitted in Baltimore or in Bangkok. Therefore, from an environmental perspective, it is equally important to control emissions anywhere in the world. But as you also are aware, the politics of enforcing binding commitments on developing countries is extremely difficult. (The economics is also difficult, given that a sensible policy would have to leave room for the developing countries to improve their average standard of living.)

A second question concerning the link between the economy and the environment is whether it would make more sense, economically and environmentally, to implement an accelerated program or a more gradual one. The figure at the end of this document suggests that the case for an aggressive program is weak. This figure compares projected increases in global average atmospheric temperature in three different cases: (1) a "*business as usual*" case; (2) an *ambitious* case in which industrialized countries return their emissions to 1990 levels by 2010 and developing countries stabilize their emissions at 2020 levels in 2020; and (3) a more *gradual* case in which industrialized countries stabilize their emissions in 2015 and return to 1990 levels by 2040, and developing countries stabilize in 2040 at 2040 levels.

As can be seen in the figure, even by 2100, the difference between the ambitious and gradual strategies is only 0.2 degree Celsius. This amount is small, not only in absolute terms, but also relative to the 1.7 degree increase in the global average temperature that is projected to take place over the next century even under under an ambitious policy. Furthermore, gradual strategy captures about two-thirds of the environmental benefits generated by the ambitious

strategy. Separate results show that the economic costs of the more gradual approach would be only *one-tenth* as great as the costs of the ambitious approach. This difference in cost reflects two main considerations: (1) retrofitting is extremely costly compared to replacing capital stock that has lived out its full life; and (2) the longer one delays before investing in new plant and equipment, the better the technology that will be available; forcing investment on to procede on an accelerated schedule guarantees that inferior capital will be locked in place for a long period of time.

In summary, gradual approaches have nearly the same environmental benefits as ambitious approaches, at only a small fraction of the economic cost.

III. Suggested approaches

The foregoing analysis indicates that the U.S. should promote Kyoto as a "turning point" rather than a "finishing point." A constructive alternative proposal from the United States could include:

A. Domestic steps

Any domestic strategy should include a framework for future policies that maintains maximum flexibility; ambitious rhetoric about the seriousness of the problem and of our response to it; and a position on developing countries that delays a Byrd amendment battle. In addition, it could include:

- Investments in R&D to help minimize the economic costs of reducing emissions;
- Incentives for the purchase and deployment of carbon-efficient technology; and
- Exploration of proposals to shift the basis of taxation away from taxing things that we like, such as income and capital gains, and toward taxing things that we don't like, such as pollution. Such exploration could be undertaken by a National Commission or through a Treasury Department report.

Beyond these initiatives, there are three possible approaches.

Need guidance here.

B. International steps

On the international front, the Administration might take the following constructive steps:

- work for the establishment of a multinational technical study group to determine the best method for obtaining a "global least-cost" approach to stabilizing greenhouse gas emissions. In addition, task this group with studying the practicality of joint implementation and international verification and enforcement. Separately, establish a global research facility to explore the application of renewables, techniques of sequestration, and methods of conservation;

- reiterate our commitment that any solution involve all nations, industrialized and developing, and press for future binding commitments on the part of developing countries that take into account the individual circumstances of each country;

- suggest new targets keyed to the ratification date of Kyoto rather than past dates.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Janet L. Yellen (CN=Janet L. Yellen/OU=CEA/O=EOP [CEA])

CREATION DATE/TIME: 3-OCT-1997 19:23:50.00

SUBJECT: new version

TO: Adele C. Morris (CN=Adele C. Morris/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

TEXT:
========== ATTACHMENT 1 ==========
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:
Unable to convert ARMS_EXT:[ATTACH.D20]MAIL41670757C.216 to ASCII,
The following is a HEX DUMP:

CLOSE HOLD: PRELIMINARY

October 3, 1997

MEMORANDUM

FROM: Lawrence Summers
Janet Yellen

SUBJECT: Targets and Timetables for Reducing Greenhouse Gas Emissions

Executive Summary

This memo provides a preliminary evaluation of the likely economic consequences for the United States of a program to attain 1990 CO_2 emissions levels by 2010. It concludes that the attainment of such a goal would necessitate at least a doubling in energy prices and impose substantial economic costs. In contrast, a more gradual emissions reduction path that eliminates emissions growth by 2010-2020 and reduces emissions to 1990 levels thereafter captures nearly identical environmental benefits as the more aggressive approach while entailing costs between one tenth and one third as large.

If attained through domestic emissions reductions alone the "1990 by 2010" target requires a reduction in CO_2 emissions of roughly 30% relative to projected 2010 emissions assuming "business as usual". The reduction in energy use needed to meet this goal would substantially exceed that achieved during the decade of the OPEC price hikes, so that energy price increases, at least comparable in magnitude, are likely. Economic analysis and historical precedent suggest that energy price increases of this magnitude would have stagflationary consequences. As in the decade of the oil shocks, both unemployment and inflation would undoubtedly rise, at least for a time.

An "idealized" system of international permit trading among Annex I countries could hypothetically halve the change in carbon emissions prices needed to attain a 1990 by 2010 goal. This would mean paying Russia and other Eastern European countries to reduce emissions in place of the United States. However, such an arrangement could prove infeasible for a number of reasons, including difficulties in establishing adequate enforcement and monitoring mechanisms in the near term. Joint implementation with non-Annex I countries is likely to marginally reduce the impact on energy prices in the United States.

The memo argues that a more gradual timetable for emissions reduction can deliver virtually identical environmental benefits at a fraction of the cost. The aggressive "1990 by 2010" path is extremely inefficient because it requires premature scrappage of capital and foregoes the considerable advantages of waiting for the development of carbon-lean technologies before replacing existing plant and equipment. In contrast, a timetable that eliminates emissions growth in the second decade of the program (2010-2020) and reduces emissions to 1990 levels and below in subsequent decades is consistent with a long-term goal of stabilizing atmospheric CO_2 concentrations. *The total cost of this "back-loaded" approach is likely one third to one tenth that of the "front-loaded" 1990 by 2010 program.* Implementation of the gradual timetable requires an early, modest increase in the price of carbon emissions, along with

a credible commitment to further emissions price increases over time.

In comparison with a more gradual emissions reduction timetable, the environmental benefits of an aggressive abatement target are minimal. For example, the expected difference in global average temperature in 2100 along a fast-takeoff abatement path that attains 1990 emissions by 2010 and a slow-takeoff abatement path that peaks in 2015 and attains 1990 emissions by 2040 is less than 0.05 degrees Celsius. Between now and 2100, global average temperature is expected to rise about 2½ degrees Celsius irrespective of the path chosen for stabilization.

The body of this memorandum lays out the rationale for these conclusions.

I. Introduction

The Framework Convention on Climate Change signed at the 1992 earth summit in Rio de Janeiro called for carbon dioxide emissions in 2000 at 1990 levels. Most countries, including the United States, are unlikely to achieve these emissions reductions. But the Rio approach remains historically important, and most quantitative proposals that have been advanced in the run up to Kyoto can be understood as variants of the Rio target and timetable. In particular, a proposal to "stabilize CO_2 emissions at 1990 levels by 2010" (and variants thereof, including a more stringent proposal by several EU countries to stabilize at 10% below 1990 levels by 2010) has received considerable attention.

This memo assesses the consequences for the U.S. economy of a program to attain 1990 CO_2 emissions levels by 2010. It compares the costs and cost effectiveness of this baseline proposal with those of alternative targets and timetables that entail a less rapid initial reduction in CO_2 emissions levels. The conclusions described here rely on the substantial body of economic analysis that has been conducted by researchers worldwide, including the Intergovernmental Panel on Climate Change (IPCC), and Administration economists.

II. 1990 by 2010: The Scope of the Task

To appreciate the ambitiousness of a program to curb U.S. emissions levels to 1990 by 2010 it is necessary to recognize that, by 2010, emissions are likely to exceed their 1990 levels by about 31 percent.[1] As of 1996, energy related carbon emissions were already 9 percent above 1990 levels. Growth in the economy through the end of the next decade would further raise energy use and carbon emissions. Even under an optimistic assumption concerning the pace of improvement of energy efficiency (0.9 percent per year), there would be further increases in carbon emissions of about 22 percent over current levels by 2010 if we continue with business as usual.

Comparison with the Oil Shocks. The reductions in CO_2 emissions necessitated by a 1990 by 2010 target are substantially larger than those achieved during the decade of the OPEC-induced energy price increases. Figure 1 shows aggregate energy use in the United States and the relative price of energy over the period 1960 to 1990. During the oil-shock decade--1972 to 1982--energy use (and carbon emissions) were virtually constant in absolute terms, while GDP grew in real terms at about 2.25 percent per year. But to meet the 1990 by 2010 goal it would not be sufficient just to keep emissions constant between now and 2010: a further, roughly 15 percent rollback in emissions would be needed to offset the expansion that has already occurred since 1990.

[1] This assumes a 2.4 percent annual GDP growth rate. Even with a more moderate assumption of 2.2 percent annual GDP growth, carbon emissions in 2010 would exceed their 1990 level by about 28 percent.

The improvements in energy efficiency that occurred during the OPEC period were induced, in large measure, by increases in the relative price of energy. Indeed, between 1972 and 1982, the relative price of energy more than doubled: it rose about 150 percent. This historical experience, and other empirical analysis, suggests that energy use does respond to changes in the price of energy, but the responsiveness (the price elasticity of demand for energy) over periods as short as a decade is low--no higher than 0.2.

An efficient market-based domestic implementation scheme for meeting a "1990 by 2010" would raise the price of carbon emissions, either through requiring the purchase of an emissions permit or through a carbon tax. An increase in the price of carbon emissions would reduce emissions in two ways: by reducing overall energy use and by inducing switches among fuels, from high carbon fuels like coal to low- and no-carbon fuels, such as natural gas and renewable energy. Even allowing for interfuel substitution, we would need to accomplish a reduction in energy use considerably larger than what occurred over a decade in which the relative price of energy more than doubled. This suggests that energy prices would likely have to at least double to attain 1990 emissions by 2010.

Model results. Numerous economic/energy models have been used to estimate the impact of a 1990 by 2010 program on energy prices. These models arrive at the same conclusion as was generated above using no model whatsoever: a program to achieve 1990 emissions by 2010 would likely entail at least a doubling of energy prices. A broad range of models place the carbon permit price required to achieve 1990 emissions by 2010 in the range of $80 to $200 per ton. If fully passed through to energy prices, a permit price of $100 per ton, for example, entails a 76 percent increase in energy prices. The impact on the prices of different sources of energy are all large, but the effect on coal is particularly severe. The price of coal would more than triple, while the price of a barrel of petroleum would increase by about fifty percent. Gas at the pump would increase in price by about 26 cents. Relative to the BTU tax proposed by the Administration in 1993 a $100 implicit carbon tax is about 5 times as large. Thus, attaining a goal of 1990 by 2010 would have very large effects on our economy.

Evidence from International Comparisons. A final piece of evidence confirming the conclusion that a strong price signal over a long period of time is necessary to alter energy use comes from comparisons of energy usage between the United States and Europe. It should hardly be surprising that energy use per dollar of GDP is lower in Europe than the United States. Energy prices in Europe have long been substantially higher--roughly double U.S. energy prices. Moreover, major differences in living patterns between the United States and Europe result in higher European energy efficiency. In addition to the geographical "advantage", from an energy efficiency standpoint, of Europe's higher population density, resulting in lower transportation requirements, Europe has locked in place many long-run adaptations to high energy prices. Innovations in the design of housing and transportation systems and the configuration of residential areas have occurred in response to high energy prices. But in spite of its natural advantages and its long history of high energy prices, energy per dollar of GDP is only 44% lower in Europe than in the United States. This means that even if the United States were to

become Europe--energywise per dollar of GDP--its energy savings, even in the long run, would be no greater than 44 percent. This U.S.-Europe comparison supports the conclusions drawn from the natural experiment of the oil shock: namely, a return to 1990 emissions will not occur without very major price measures over a long period of time.

The Role of Technology and the Scope for "No Regrets" Policies. According to the preceding assessment, a large price inducement is necessary to meet a 1990 by 2010 target. Your economic advisers agree on this conclusion. However several of your advisers are more optimistic about the chances of achieving a 1990 by 2010 target. They emphasize the current availability of "no regrets" (cost-saving) technologies that promise substantial opportunities for abatement. A recent report by the Department of Energy research laboratories, for example, catalogues emissions-saving technologies that, by their calculations, are currently "cost effective." If put in place now, such practices could allegedly reduce emissions by between 30 to 50 percent of the amount needed to reach a 1990 by 2010 target. Even so, the report finds that "aggressive" and "invigorated" government policies--including potentially costly and intrusive regulations and standards--as well as a $50 carbon tax would be necessary to reach the 1990 by 2010 target.

Your economic advisers agree that there now exist unused technological opportunities for emissions reduction, but we question by what means, over what time frame, and at what expense government policies could change private behavior if such opportunities are currently underutilized. Engineering studies generally ignore the sometimes subtle disadvantages of available cost-saving technologies or overestimate their hypothetical returns. An example is illustrative: significant energy and cost savings could result if consumers replace incandescent bulbs with compact fluorescents. Over the long lifetime of such bulbs there would also be a substantial monetary gain. However, actual adoption of these light bulbs has been slow to date, possibly due to pure inertia, possibly because consumers dislike their color, or perhaps because they apply a high "discount rate" when valuing energy savings that accrue after the purchaser may have switched residence. Several recent studies have demonstrated that the actual returns to home improvement investments, such as attic insulation, often fall short of those predicted by engineering studies.

Regardless of the reasons, if consumers have not adopted "no regrets" measures at a faster rate, it is likely that additional incentives will be necessary for them to change their minds. Rather than stressing the mere availability of alternative technologies, your economic advisers insist on realistic estimates of likely rates of adoption and diffusion and they stress the need for economic incentives--in the form of a higher implicit price for carbon emissions--to induce the adoption of emissions-saving technology. They point out too that the baseline energy demand estimates used to predict the price increase needed to attain a 1990 by 2010 target already assume substantial ongoing improvements in energy efficiency due to the diffusion of existing technologies and the development of new ones. Significant adoption of such technologies is necessary merely to meet this assumed baseline. Finally, it is important to note that the DOE labs study includes as part of its policy package to reach 1990 emissions by 2010 extensive

regulations, including stringent CAFE and appliance standards and national building codes--command and control policies that your economic advisers would oppose--along with a $50 carbon tax.

To summarize, your economic advisers consider it unrealistic to predict a substantial increase in the pace of adoption of new emissions-saving technologies in the absence of a large increase in the price of carbon emissions--and hence of energy. Based in part on the evidence from the energy shocks of the 1970s, in part on international comparisons, and in part on model results, they are optimistic that such an increase in prices would bring forth a reduction in CO_2 emissions--with larger responses to a given price change likelier the longer the time period for response. The evidence is strong that a very large price increase will be necessary to attain emissions reductions of 20 to 30 percent over a period as short as a decade. *Moreover, other approaches that apparently do not involve large price increases (such as performance standards) will impose even higher costs on the American economy.*

III. Why are the costs of early emissions reductions so high?

The previous section argued that a "1990 by 2010" target would entail high carbon emissions prices and significant economic costs. This section shows that the 1990 by 2010 timepath for emissions reductions is so aggressive as to be inefficient--in the sense of raising substantially the total projected economic cost of reaching a given environmental goal. There are three major reasons why an aggressive takeoff in curtailing emissions raises overall costs: (1) it induces premature obsolescence of the capital stock because it does not allow adequate time for the capital stock to turn over naturally; (2) it provides insufficient lead time to develop and implement new technologies; (3) it causes a significant stagflationary short-term macroeconomic shock. Additionally, an aggressive timetable for emissions reductions does not allow time for the resolution of uncertainty and it does not take advantage of the time-value of money (resources not spent on emissions reductions early on can be invested at a positive return which could purchase more emissions reductions later).

The Role of Turnover of the Capital Stock. The most clear-cut and easily quantifiable reason for the high price tag associated with rapid emissions reductions relates to the need for premature replacement of plant and equipment in response to large increases in the price of carbon emissions. It is expensive enough to replace plants that are fully depreciated, but vastly more so if those plants are still in the prime of their productive lives. Within 20 to 40 years, much of our existing plant and equipment will be ready for replacement anyway; therefore building in greater carbon efficiency at that time will be relatively cheap. *It is important to emphasize that the case we are making here is not based on procrastinating for the sake of avoiding the problem; rather, it is based on simple principles of hard-headed business efficiency.*

The advantage of a slower emissions reduction timetable in avoiding the large costs associated with premature obsolescence of the capital stock can be illustrated by considering electrical power generation. The case of electricity generation is important in its own right since this industry is responsible for 88% of coal use and more than one third of all carbon dioxide emissions in the United States. But the principle concerning the costs of premature replacement applies broadly because reduced greenhouse gas emissions may entail the accelerated retrofitting of housing and commercial structures, the premature scrappage of vehicles and appliances, and the premature replacement of plant and equipment in energy intensive industries.

Figure 2 illustrates the effect of an accelerated retirement schedule for today's U.S. electric power generation capacity installed during the last 40 years. Imagine, to take an extreme case, that a timetable is adopted that necessitates replacing all power plants with less-polluting technology within ten years. This would require retiring 630 out of 670 gigawatts of generating capacity before the end of its normal life span, or 94 per cent of the total. If the timetable were extended so that all power plants instead had to be replaced within 20 years, the accelerated replacement of capacity would affect 450 gigawatts of capacity, or 67 per cent of the total. Allowing this additional 10 years for turnover avoids the premature retirement of 27 per cent of existing electric power plant capacity. With a 30 year horizon, complete turnover would mean accelerated retirement of only 21 per cent of the total capacity and, with a 40 year timetable, there would be almost no additional costs due to premature obsolescence.[2, 3]

The Advantage of Waiting for Superior Technologies. The example of electric power generation also illustrates a second important reason why a slow takeoff in curbing greenhouse gas emissions is ultimately less costly: new technologies take a long time to develop. Waiting until these new technologies are available before making expensive emissions-saving investments offers the potential of both lower economic costs and higher environmental payoffs. Under a tight target and timetable with its associated high carbon emissions price, electric utilities will be forced to replace existing capacity in the very near future and to rely on currently available lean-carbon technologies, likely gas-turbine plants. If some delay can be factored in, however, they will be able to install more effective and less costly alternative technologies. A rapid timetable forces long-term investments to be made before superior technologies have been developed and refined.

[2]The distribution has been truncated at 40 years, the average lifespan of existing electric power plants. A few plants of yet older vintage are still in use.

[3]The same exercise can be performed for coal-fired power plants. These generators produce the most carbon per kilowatt hour of electricity and thus will have a high incidence of replacement even under a moderate abatement plan. If a complete change-over of coal plants were to be accomplished in 10 years, 96 per cent of total capacity would be retired early. If retirement occurred over 20 years, only 64 per cent would be retired early. Allowing an additional 10 years for turnover would avoid premature retirement of one-third of existing coal-fired plant capacity.

Implication: The Need for a Credible, Long-Term Price Increase. The example of electricity generation illustrates two general principles. First, the responsiveness of both demand and supply are greater in the long run than in the short run. This means that, with a longer horizon, any given amount of abatement can be accomplished with a smaller increase in carbon emissions prices. Second, and perhaps even more important for policy, any credible emissions reduction strategy must include both a price increase at the outset and also a clear commitment to maintain and likely increase prices further over time. Without such a commitment, the changes in behavior required to meet even a long-run target of emissions reduction will likely not occur. Consider a utility that today is drawing up its plans for a new power plant. That utility will choose among today's technologies, which vary in their costs and CO_2 emissions. In order to induce the utility to choose a more costly, lean-emissions technology today, it must be clear that CO_2 emissions will be costly enough over the 40 years or more lifetime of the plant to justify a more expensive investment option today. A large cumulative reduction in emissions can be achieved over the long term with only a modest carbon emissions price increase now, but only if the commitment to still higher prices in the future is credible and clear.

Stagflationary Macroeconomic Impact. From a macroeconomic perspective, increases in energy prices constitute an adverse "supply shock." Such developments are stagflationary--even if anticipated--because they raise both inflation and unemployment simultaneously, creating a painful macroeconomic dilemma. As noted above, a plan to attain 1990 emissions levels by 2010 would require a change in energy prices over the first decade of the 21st century at least comparable in magnitude to the two oil shocks of the 1970s. Those shocks are widely acknowledged to have raised both unemployment and inflation. Similarly, the energy price increases required by a 1990 by 2010 program would raise inflation, lower real wages, and raise unemployment. Unemployment in the four years after the first oil shock averaged 7.2 percent in comparison to 5.0 percent in the four years prior; and unemployment rose further, to an average of 8.6 percent, in the four-year aftermath of the second oil shock.[4] Although the increases in energy prices associated with a treaty to reduce greenhouse gases would be anticipated, rather than a surprise, we should nevertheless expect that the efforts of the Federal Reserve to contain inflation, coupled with likely efforts on the part of workers to recoup real wage losses will lead to a period of higher unemployment.

Furthermore, it is important to note that most model-based estimates of the costs of a program to attain 1990 emissions levels by 2010 assume that resources are fully employed, thereby ignoring these potential short-term effects. Such models therefore provide no assessment of the consequent increases in unemployment.

[4] There is debate about how much of this was due directly to the oil shocks, because there was a simultaneous decline in productivity growth and transfers of real income to OPEC producers.

IV. Quantifying the Economic Costs of Slow versus Fast Take-off

The relative costs of slow versus fast takeoff timetables in curbing CO_2 emissions has recently been analyzed by the Stanford Energy Modeling Forum (EMF-14).[5] The Stanford group used six large-scale economic/energy models to compare the total projected cost of two alternative emissions reduction time paths--one "frontloaded", the second more "backloaded". *Importantly, both paths were designed eventually to stabilize atmospheric concentrations of CO_2 at double the pre-industrial level--550 ppmv.*[6] Although a high degree of uncertainty is inherent in particular numerical estimates from individual models, the simulations nevertheless point to some robust qualitative conclusions. *The major conclusion to be drawn from this project is that an emissions reductions path characterized by an aggressive initial phase is substantially more costly--3 to 10 times more costly--than a path with a slower takeoff but larger eventual reductions.*

To enable a comparison of the costs of slow and rapid takeoff strategies, the EMF investigators asked each of six modeling groups to simulate the economic impacts of two alternative strategies to attain stabilization of CO_2 concentrations at 550 ppmv. The first strategy (the WG-1 path) corresponds to an emissions pathway published in 1994 by Working Group 1 (WG-1) of the Intergovernmental Panel on Climate Change (IPCC). The working group computed a set of global CO_2 emissions pathways consistent with stabilization of concentrations at 550 ppmv and several alternative concentration levels. The WG-1 path entails an immediate departure from the baseline or "business as usual" emissions path. Subsequently, Wigley, Richels and Edmonds (WRE) published an alternative set of emissions profiles to achieve the same concentration targets. In contrast to the WG-1 paths, the WRE emissions path was constructed to follow the baseline or "business as usual" scenario in the early years with sharper reductions after this initial phase. Wigley, Richels and Edmonds hypothesized that their slower-takeoff emissions pathways would yield identical environmental objectives with substantially lower economic costs, for the reasons discussed above. The EMF-14 exercise validates this hypothesis.

The EMF-14 comparison project assessed the total costs to the OECD, the EEFSU

[5] To enable meaningful comparisons of results across models, the EMF has coordinated a series of projects in which a number of large scale energy models are used to estimate the impact of given, specified emissions reduction scenarios under common standardized, benchmark assumptions concerning population and economic activity, discount rates, energy resource availability and prices and technology availability.

[6] All energy models make numerous simplifications and approximations in order to describe the energy sector globally and over the span of a century or more. In particular, all of the models assume full employment, thereby abstracting from the likely short-run macroeconomic costs of an emissions reduction program.

(Eastern Europe and the former Soviet Union) and the non-Annex I countries of the WG-1 and WRE pathways to stabilization of CO_2 concentrations at 550 ppmv. The appropriate economic measure of total cost is the present discounted value of losses in future consumption relative to a "Business as Usual" scenario. Estimates of regional costs depend on the extent of burden sharing--namely, the assumed "division of labor"--between Annex-I and non-Annex I countries in controlling emissions as well as the extent of international emissions trading. Recall that, by the end of the next century--by 2100-- assuming "business as usual"--non Annex 1 countries will have more than 90 percent of CO_2 emissions. Thus, developing country participation is absolutely essential to achieving stabilization of concentrations. Consistent with the Berlin Mandate, the simulations assumed that the burden of emissions reduction would fall on Annex I countries exclusively during the early decades; that by 2030, non-Annex I countries would begin to participate; and by 2050, a full transition to targets based on equal per capita emissions rights is assumed.

Figure 3 plots the OECD emissions paths in the WG-1 and WRE scenarios. Under the WG-1 scenario, OECD emissions begin to decline immediately and continue to decline for roughly four decades. For example, OECD emissions fall 10 percent below initial levels ten years after implementation--corresponding closely to the requirement of a "1990 by 2010" timetable, which requires a reduction of 9 percent from current emissions in roughly a decade. In contrast, OECD emissions along the WRE path continue to rise for roughly two decades--corresponding closely to a plan calling for emissions to peak around 2020--return to 1990 levels around 2040 and decline substantially further in subsequent decades.

Table 1 illustrates a robust conclusion that emerges from this exercise: fast takeoff in emissions reductions greatly increases the costs. Table 1 shows the cost for both the aggressive (WG-1) and slow-paced (WRE) paths--both with and without idealized international trading of permits. In 10 out of 12 simulations--for six different models with and without permit trading--the costs on the slow-takeoff WRE path is less than a third of the cost on the corresponding fast take-off path. Taking account of the likely adverse short-run macroeconomic consequences of an aggressive path would further strengthen this conclusion.

Table 2 illustrates a second, robust conclusion from the EMF-14 exercise: a viable system of international permit trading would very much reduce OECD costs. With global permit trading, the sharp, early emissions reductions required of OECD countries under the aggressive (WG-1) approach would be avoided through the purchase of emissions permits from countries with lower abatement costs. The average reduction in cost is 56 percent.[7]

[7] The computations in Table 2 verify that the slow paced (WRE) path, which permits emissions to depart relatively little from business as usual for several decades, is a substantially less costly than the alternative WG-1 path with its sharper immediate reductions. Since both paths are arbitrarily chosen to conform with the 550 ppmv concentration target, a natural question concerns the characteristics of an optimal or least-cost path for achieving this concentration target. An important recent study by Alan Manne and Richard Richels uses their MERGE model (included in the EMF-14 project) to compute the least cost path with

Finally, it is important to note that in most of the EMF models, policy actions to raise carbon emissions prices must be taken at the inception of the slow-paced (WRE) program and a commitment to increasing emissions prices over time is required to achieve additional emissions reductions. Naturally, the required initial carbon emissions price is substantially lower, at the outset, under the slower-paced (WRE) than under the aggressive (WG-1) path. Thus, although the slower-paced emissions path initially approximates the business as usual baseline, credible incentives must be put into place immediately, and strengthened over time, to achieve the needed investments in carbon-efficient technologies.

V. The Environmental Consequences of Slow versus Fast Takeoff.

550-stabilization in 2100 and international permit trading. The optimal path, while not identical to the WRE path, is similar in character. This least-cost path peaks approximately three decades after the initiation of the program and declines thereafter.

While the excess cost of a fast, compared to a gradual emissions reduction path is large, the difference in projected global temperatures over the next century between the fast and the slow paths is quite small, both in absolute amount and relative to temperature changes expected even if an aggressive policy path is adopted. Under "business as usual" assumptions, average global temperatures are expected to rise about 1 degree Celsius by 2050 and about 2½ degrees Celsius by 2100. An aggressive emissions reduction path that stabilizes emissions at 1990 levels by 2010 and maintains emissions at the 1990 level thereafter would mitigate this temperature increase by roughly 0.1 degrees by 2050 and 0.2 degrees by 2100.[8] In contrast, a more gradual emissions path that peaks around 2015, stabilizes emissions at 1990 levels by 2040, and holds emissions constant at 1990 levels thereafter yields virtually identical environmental benefits: the temperature difference between the aggressive and gradual paths diverges by no more than 0.05 degrees at any time over the next century. Similarly, the temperature differences along the aggressive WG-1 and less aggressive WRE paths--both designed ultimately to stabilize concentrations at 550 ppmv--differ by a maximum of 0.2 degrees over the next several centuries.[9]

The limited climatological impact of even an extremely aggressive emissions reduction program measured in terms of temperature impacts during the next century reflects the extremely long lags involved in the underlying physical processes and the dependence of temperature on the total stock of carbon dioxide in the atmosphere, rather than the flow of emissions at a given time. Emissions reductions do matter to temperature, but only over an extremely long horizon. The cumulative nature of the process suggests that there is little effect on global temperature from a slow rather than from a fast abatement takeoff. The addition to the total stock of carbon from a slow rather than a fast start to abatement adds relatively little to the total atmospheric stock of CO_2 between now and 2100 for four separate reasons: the difference in carbon emissions between a slow and a fast start over the initial decades of abatement is only a small fraction of total emissions in that period; the stock of CO_2 in the atmosphere is itself the result of many decades of emissions; some of the CO_2 emissions of the early decades will have been re-absorbed; and the most serious build-up in CO_2 under business as usual occurs late in the next century, as a consequence of burgeoning emissions from non-Annex I countries.

Even the potential for a catastrophic environmental event, such as the melting of the West Antarctic ice sheet, a runaway greenhouse effect (e.g., from release of trapped methane with the

[8] Successful stabilization would require very large cuts from "business as usual" in China, India, and other non-Annex I countries.

[9] If a model assumes that sulfur dioxide emissions decline with the decline in carbon dioxide emissions under climate policy (as predicted, given the extent of sulfur emissions associated with fossil fuel combustion, and incorporated in the IPCC's IS92 emissions projections), the more aggressive WG-1 path will be *warmer* than the WRE path between 2000 and 2040. This result reflects the negative impact of sulfate aerosols on the greenhouse effect. Early and substantial cuts in fossil fuel combustion, while decreasing the carbon emissions that warm the atmosphere, also decrease the sulfate aerosols that cool the atmosphere.

melting of the permafrost), or a structural change in ocean currents such as the Gulf Stream, which the preceding abstracts from, does not fundamentally affect the basic trade-offs between the high costs of fast vs. slow takeoff paths. These factors do, however, add--perhaps greatly--to the urgency of adopting moderate long-term greenhouse gas concentration targets and a program involving an immediate, albeit moderate, increase in the price of CO_2 emissions.

VI. International Trading of Permits

As has already been noted, an effective system of international carbon emissions permit trading among Annex I countries could substantially diminish the cost of a CO_2 abatement program. An Annex I trading system could, potentially, reduce the size of the carbon emissions price to attain a 1990 by 2010 goal by up to 50%. Moreover, joint implementation projects with non-Annex I countries could, hypothetically, reduce this figure by half again.

Although international trading and joint implementation--so-called "where flexibility"--has enormous advantages in theory, your economic advisers are concerned that substantial barriers would stand in the way of implementing any workable analogue of such an idealized system--at least in the near term. Consequently, they stress that Annex I international permit trading and joint implementation between the U.S. and non-Annex I countries realistically can serve only a limited role in reducing the costs associated with meeting a "1990 by 2010" target.

A *hypothetical* example shows how an international trading system would work, and why it would reduce each participant country's abatement costs. Suppose, ideally, that every country adopts a domestic permit system to implement its Kyoto target. Absent international trading, the price of emissions permits would surely differ across countries, reflecting differing marginal costs of abatement internationally. With different permit prices in different national markets, profit- seeking traders would be motivated to buy permits in countries where they are cheap and resell them in countries where they are more expensive. Such arbitrage activities would create an international permit market, bringing permit prices into equality worldwide. This idealized system promotes global efficiency in achieving any worldwide abatement goal. Countries with permit prices below world levels have the incentive to reduce emissions more than they otherwise would in order to profit in the international permit market. Countries with high permit prices would have the incentive to purchase permits, thereby relaxing their Kyoto emissions constraints. The U.S. government could avoid any direct participation in such a system as long as it deems foreign-issued permits presented to the U.S. government by U.S. carbon-emitting entities as valid as those issued by the U.S. government itself.

The preceding description of how an international permit trading system would work provides an idealized picture of its possibilities. But the actual benefits of such a system are apt to fall short of this utopian portrayal in part because countries are not obliged to fulfill their Kyoto commitments via a domestic permit trading scheme; indeed, few Annex I countries have indicated an intention to do so. For example, consider a government that has decided to limit

domestic emissions through regulatory controls. International permit sales that result in tighter domestic constraints could well be politically unpopular so that a government would hesitate before selling its emissions rights to the United States. Similarly, international permit sales by a country that is meeting its Kyoto obligations through domestic carbon or energy taxes would necessitate a hike in those taxes. In either case, international trading would involve government to government negotiations, and difficult political decisions. In contrast, in the idealized system, trades result from profit oriented transactions among individuals, mediated through the market.

Monitoring and enforcement issues are also likely to be paramount in insuring the workability of international trading. If domestic enforcement is effective in all countries, so that, in the aggregate, consumers and firms in each country actually limit their emissions to the national permit levels, international permit sales by private agents in the country actually translate into lower domestic emissions. But consider the difficulties that can occur with imperfect enforcement. If the government of a country--country X--finds it difficult either to measure domestic emissions or to enforce the purchase of permits by domestic emitters, then reductions in X's emissions may be insufficient to reach the Kyoto target. Those firms or individuals in X that are lucky enough to have been assigned the rights to X's permits will be able to sell them, at a quick profit, on the international market. With imperfect enforcement, international sales, without corresponding domestic emissions reductions, could emanate from countries with the weakest systems of enforcement. To prevent such "paper trades", which profit some participants and increase emissions, many countries, including the United States, will want controls to ensure the integrity of international permits. Buyers, too, will want clear concrete guarantees of the validity of permits so as to be sure they are not being passed counterfeit goods. These controls and guarantees will surely inhibit the efficiency of the market and render some--possibly much--of the estimated savings illusory. In fact, most of the benefits projected from the international sale of permits come from inducing emissions reductions from countries in Eastern Europe and the former Soviet Union--countries with particularly weak tax collection and enforcement mechanisms. Without these countries in the scheme the gains from international trading of permits will be very small.

Joint implementation with non-Annex I countries also has the potential to reduce the U.S. burden of attaining any given timetable. Under this type of approach, U.S. businesses could receive credit for the construction of nuclear, oil, or natural gas electricity generation plants in China if it were confidently expected that China would instead have constructed coal-fired plants with much higher CO_2 emissions. Certification of such credits might be overseen by an international agency to ensure that the projects were emissions-replacing. Such a project-by-project system is likely the most that is feasible in the absence of quantitative targets. Your economics advisers have concerns about even this level of endeavor due to the inherent difficulty in establishing that a particular set of projects has actually reduced a country's emissions, absent a reference path enabling a clear quantitative comparison. For example, the construction of a nuclear power plant in place of a coal-powered plant in China could indirectly raise CO_2 emissions elsewhere in the Chinese economy--partially offsetting the direct CO_2 reducing effect of the project--if the reduced demand for coal lowers its domestic price and

encourages greater use elsewhere in the Chinese economy. A project-oriented approach to joint implementation will, in effect, constitute a limited form of international trading with high transaction costs. As a result, it will probably capture only a small fraction of the total benefits of full international trading. In contrast, model results concerning the benefits of joint implementation treat it as equivalent to idealized international trading.

VII. Recycling of Revenues

The ultimate economic cost of an emissions abatement program depends upon how the revenues realized from carbon taxes or auctioned permits are used. It has been estimated that the efficiency loss from collecting an extra dollar of tax revenue amounts to around 30 cents. If the revenues from a carbon tax or auctioned permits are used to reduce inefficient taxes inhibiting work or investment, the resulting gains would partially offset the micro-efficiency losses from energy curtailment. The simple lesson is that the costs of emissions abatement may be greatly reduced if the revenues from the taxes levied can be put to good use.

So far we have approached the recycling of revenues from the standpoint of microeconomic efficiency. There is also the potential for using the revenues to abate the macroeconomic consequences of the emissions program. The oil shocks are believed by many economists to have resulted in increased unemployment because workers resisted the fall in real wages that was associated with the inflationary impact of higher energy prices. Increased wage demands added inflationary pressures to the economy that could only be suppressed by tighter monetary policy. Thus it might be argued that the effects of the real wage shock on inflation and unemployment could be diminished by lowering payroll or other worker taxes to offset the real wage losses from higher energy prices.

But England's experience points to the need for caution in assessing the potential for revenue recycling to allay the macroeconomic consequences of the rising energy costs. In 1979, immediately after her election, Margaret Thatcher increased the VAT tax and simultaneously decreased the income tax. These two policy changes had offsetting effects on real after tax incomes, and therefore might have been expected to have had no effect on wage bargaining. However, the increase in the VAT tax resulted in an immediately noticeable increase in the CPI. A wage-price spiral ensued as workers attempted to maintain their pre-tax real wages.

VIII. Policy Implications

The foregoing arguments point to the attractiveness, from both an economic and environmental standpoint, of a U.S. policy to raise the price of carbon emissions--either through a carbon tax or a system of auctioned permits--by a moderate amount--for example, between $5 and $15 per ton of carbon--in the near term, with further increases scheduled over the longer term. A realistic target and timetable corresponding to such a program would entail continued emissions growth in the first decade of the program, say 2000-2010; elimination of emissions growth in the second decade (2010-2020) and reductions in emissions thereafter. This program

entails significant, early policy action and is consistent with a strong U.S. commitment to attaining the ultimate objective of the Framework Convention--namely to stabilize atmospheric concentrations of CO_2 and hence global temperatures.

A program involving gradual increases in the relative price of carbon emissions over time would avoid the substantial macroeconomic consequences of a 1990 by 2010 program. The energy price increases associated with the more moderate program would have a modest impact on family income that could be offset by compensating cuts in other taxes.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Janet L. Yellen (CN=Janet L. Yellen/OU=CEA/O=EOP [CEA])

CREATION DATE/TIME: 3-OCT-1997 15:27:32.00

SUBJECT: Latest revision

TO: Adele C. Morris (CN=Adele C. Morris/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

TEXT:
========== ATTACHMENT 1 ==========
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:
Unable to convert ARMS_EXT:[ATTACH.D35]MAIL448565571.216 to ASCII,
The following is a HEX DUMP:

CLOSE HOLD: PRELIMINARY
September 30, 1997

MEMORANDUM

FROM: Lawrence Summers
Janet Yellen

SUBJECT: Targets and Timetables for Reducing Greenhouse Gas Emissions

This memo assesses the economic consequences for the U.S. economy of a program to attain 1990 CO_2 emissions levels by 2010. In comparison to a more gradual target and timetable, such a program would impose enormous costs on the economy while yielding almost no environmental benefit. Attainment of 1990 emissions levels by 2010 would require a change in energy prices (or the equivalent) considerably in excess of what occurred in the oil shocks of the 1970s. However, the memo also has a positive message: It argues that a more back-loaded approach that delays attainment of 1990 levels of emissions until 2040 would impose much lower economic costs (by a factor of between 3 and 10) while capturing nearly as much environmental benefit as the more aggressive approach. Either path, to be credible, would require an early, increase in the price of carbon emissions.

The economic costs of 1990 by 2010

- In the absence of any scheme for international permit trading, "1990 by 2010" would entail a greater reduction in energy use than was achieved during the decade of the oil shocks, and would impose correspondingly greater damage on the economy. Accomplishing this objective would require a tax (or its economic equivalent) on carbon emissions of at least $100 per ton. This would translate into increases of at least 25 cents per gallon on the price of gasoline, and a tripling of coal prices.

- An *idealized* system of international permit trading among Annex I countries would cut the required price of permits in half. Such a system would entail paying Russia and Eastern European countries to reduce emissions in place of us. Joint implementation with non-Annex I countries could further reduce the required price of permits in the United States.

- However, both international permit trading and joint implementation incur severe difficulties of both enforcement and monitoring. For example, every country in the system would be tempted to allow its firms to fraudulently sell their emissions rights into the international market, garner the resulting revenue, and exceed their allowed level of emissions.

- The high cost of "1990 by 2010" stems from three primary causes. First, the increase in energy prices needed to attain such a goal results in a large stagflationary shock. Second, the program would force a large fraction of the capital stock to be scrapped prematurely -- that is before it had served out its intended lifetime. Third, it would forgo the opportunity to wait for the development of carbon-lean technologies.
- The costs to the domestic economy also depend importantly on the method of domestic implementation. The above estimates are derived under the assumption that an efficient mechanism is used--either a tax on carbon emissions or a system of tradeable permits that are distributed by auction. Any alternative mechanism (such as

performance standards or other forms of "command and control") would multiply the costs to the economy.

The environmental benefits of 1990 by 2010

- The environmental benefits of an aggressive program of emissions abatement are minuscule. *Regardless of whether an aggressive or delayed program of emissions reduction is adopted, a significant amount of global warming will occur over the next century--but there is almost no difference in warming with the adoption of a more aggressive policy.* In comparison to aggressive policies of emissions reduction, a delayed program would result in an increase in global mean temperatures that is uniformly less than .05 degrees Celsius. This difference is only three percent of the change in average temperature that is already fated even with the most aggressive intervention.

Thus, "1990 by 2010" would impose severe economic costs while yielding little environmental benefit.

A more efficient alternative

- There is a better alternative available to the Administration. A program designed to return carbon emissions to 1990 levels by 2040 is both economically and environmentally responsible and realistic. This program would require the United States to initiate meaningful actions now to create effective incentives to reduce carbon emissions over the next century. *Such incentives must entail an early increase in the price of carbon emissions along with a credible commitment to further emissions price increases over time.*

Such a program would attain nearly all of the environmental benefits of its more aggressive cousin, while imposing much lower economic costs.

→Global average atmospheric temperature under the less aggressive approach would *not be noticeably different.*

→Economic costs would be lower under the less aggressive approach, by a factor of between 3 and 10.

I. Introduction

The Framework Convention on Climate Change signed at the 1992 earth summit in Rio de Janeiro called for carbon dioxide emissions in 2000 at 1990 levels. Most countries, including the United States, are unlikely to achieve these emission reductions. But the Rio approach remains historically important, and most quantitative proposals that have been advanced in the run up to Kyoto can be understood as variants of the Rio target and timetable. In particular, a proposal to "stabilize CO_2 emissions at 1990 levels by 2010" (and variants thereof, including a more stringent proposal by several EU countries to stabilize at 10% below 1990 levels by 2010) has received considerable attention.

This memo assesses the consequences for the U.S. economy of a program to attain 1990 CO_2 emissions levels by 2010. It compares the costs and cost effectiveness of this baseline proposal with those of alternative targets and timetables that entail a less rapid initial reduction in CO_2 emission levels. The conclusions described here rely on the substantial body of economic analysis that has been conducted by researchers worldwide, including the Intergovernmental Panel on Climate Change (IPCC), and Administration economists.

II. 1990 by 2010: The Scope of the Task

To appreciate the ambitiousness of a program to curb U.S. emissions levels to 1990 by 2010 it is necessary to recognize that such a target involves a cutback of about 27 percent in energy use in 2010 relative to baseline. As of 1996, energy related carbon emissions were already 9 percent above 1990 levels. Growth in the economy through the end of the next decade would further raise carbon emissions. Even under an optimistic assumption concerning the pace of improvement of energy efficiency (0.9 percent per year), under constant relative energy prices, there would be further increases in carbon emissions by 2010 of about 18 percent if we continue with business as usual. The net required reductions to achieve 1990 emissions in 2010 thus amount to about 27 percent.

Comparison with the Oil Shocks. Increases in energy efficiency of this magnitude are considerably greater than those that were achieved during the 1970s and early 1980s. Figure 1 shows aggregate energy use in the United States and the relative price of energy over the period 1960 to 1990. During the oil-shock decade--1972 to 1982--energy use was virtually constant in absolute terms, while GDP grew in real terms at about 2.25 percent per year. Over this period, the relative price of energy more than doubled: it rose about 150 percent. This historical experience, and other empirical analysis, suggests that energy use does respond to changes in the price of energy, but the responsiveness (the price elasticity of demand for energy) over periods as short as a decade is low--no higher than 0.2. In contrast to the oil shock period, the "1990 by 2010" program would entail an even larger emissions cutback. To meet the 1990 by 2010 goal it would not be sufficient just to keep emissions constant between now and 2010: a further, roughly 10 percent rollback in emissions would be needed to offset the expansion that has already occurred since 1990. Thus, we would need to accomplish a reduction in energy use

considerably larger than what occurred over a decade in which the relative price of energy more than doubled. This suggests that energy prices would likely have to rise by more than 150% to attain 1990 emissions by 2010.

Model results. Numerous economic/energy models have been used to estimate the impact of a 1990 by 2010 program on energy prices. These models arrive at the same conclusion as was generated above using no model whatsoever: a program to achieve 1990 emissions by 2010 would entail at least a doubling of energy prices. A broad range of models place the carbon permit price required to achieve 1990 emissions by 2010 in the range of $80 to $200 per ton. If fully passed through to energy prices, a permit price of $100 per ton, for example, entails nearly a doubling of energy prices. The impact on the prices of different sources of energy are all large, but the effect on coal is particularly severe. The price of coal would more than triple, while the price of a barrel of petroleum would increase by about fifty percent. Gas at the pump would increase in price by about 26 cents. Relative to the BTU tax proposed by the Administration in 1993 a $100 implicit carbon tax is about 9 times as large. Thus, attaining a goal of 1990 by 2010 would have very large effects on our economy.

Evidence from International Comparisons. A final piece of evidence confirming the conclusion that a strong price signal over a long period of time is necessary to alter energy use comes from comparisons of energy usage between the United States and Europe. It should hardly be surprising that energy use per dollar of GDP is lower in Europe than the United States. Energy prices in Europe have long been substantially higher--roughly double U.S. energy prices. Moreover, major differences in living patterns between the United States and Europe result in higher European energy efficiency. In addition to the geographical "advantage", from an energy efficiency standpoint, of Europe's higher population density, resulting in lower transportation requirements, Europe has locked in place many long-run adaptations to high energy prices. Innovations in the design of housing and transportation systems and the configuration of residential areas have occurred in response to high energy prices. But in spite of its natural advantages and its long history of high energy prices, energy per dollar of GDP is only 44% lower in Europe than in the United States. This means that were the United States to become Europe--energywise per dollar of GDP--its energy savings, even in the long run, would be no greater than 44 percent. This U.S.-Europe comparison supports the conclusions drawn from the natural experiment of the oil shock: namely, a return to 1990 emissions will not occur in the absence of very major price measures over a long period of time.

The Role of Technology and the Scope for "No Regrets" Policies. According to the preceding assessment, a large price inducement is necessary to meet a 1990 by 2010 target. Your economic advisers agree on this conclusion. However several of your advisers are more optimistic about the chances of achieving a 1990 by 2010 target. They emphasize the current availability of "no regrets" (cost-saving) technologies that promise substantial opportunities for abatement. A recent report by the Department of Energy research laboratories, for example, catalogues emissions-savings technologies that, by their calculations, are currently "cost effective." If put in place now, such practices could allegedly reduce emissions by between 30

to 50 percent of the amount needed to reach a 1990 by 2010 target. Even so, the report finds that "aggressive" and "invigorated" government policies--including potentially costly and intrusive regulations and standards--as well as a $50 carbon tax would be necessary to reach the 1990 by 2010 target.

Your economic advisers agree that there now exist unused technological opportunities for emissions reduction, but we question by what means, over what time frame, and at what expense government policies could change private behavior if such opportunities are currently underutilized. Engineering studies generally ignore the sometimes subtle disadvantages of available cost-saving technologies or overestimate their hypothetical returns. An example is illustrative: significant energy and cost savings could result if consumers replace incandescent bulbs with compact fluorescents. Over the long lifetime of such bulbs there would also be a substantial monetary gain. However, actual adoption of these light bulbs has been slow to date, possibly due to pure inertia, possibly because consumers dislike their color, or perhaps because they apply a high "discount rate" when valuing energy savings that accrue after the purchaser may have switched residence. Several recent studies have demonstrated that the actual returns to home improvement investments, such as attic insulation, often fall short of those predicted by engineering studies.

Regardless of the reasons, if consumers have not adopted "no regrets" measures at a faster rate, it is likely that additional incentives will be necessary for them to change their minds. Rather than stressing the mere availability of alternative technologies, your economic advisers insist on realistic estimates of likely rates of adoption and diffusion and they stress the need for economic incentives--in the form of a higher implicit price for carbon emissions--to induce the adoption of emissions-savings technology. They point out too that the baseline energy demand estimates used to predict the price increase needed to attain a 1990 by 2010 target already assume substantial ongoing improvements in energy efficiency due to the diffusion of existing technologies and the development of new ones. Significant adoption of such technologies is necessary merely to meet this assumed baseline. Finally, it is important to note that the DOE labs study includes as part of its policy package to reach 1990 emissions by 2010 extensive regulations, including stringent CAFE and appliance standards and national building codes--command and control policies that your economic advisers would oppose--along with a $50 carbon tax.

To summarize, your economic advisers consider it unrealistic to predict a substantial increase in the pace of adoption of new emissions-savings technologies in the absence of a large increase in the price of carbon emissions--and hence of energy. Based in part on the evidence from the energy shocks of the 1970s, in part on international comparisons, and in part on model results, they are optimistic that such an increase in prices would bring forth a reduction in CO_2 emissions--with larger responses to a given price change likelier the longer the time period for response. The evidence is strong that a very large price increase will be necessary to attain emissions reductions of 20 to 30 percent over a period as short as a decade. *Moreover, other approaches that apparently do not involve large price increases (such as performance*

standards) will impose even higher costs on the American economy.

III. Why are the costs of early emissions reductions so high?

The previous section argued that a "1990 by 2010" target would entail high carbon emissions prices and significant economic costs. This section shows that the 1990 by 2010 timepath for emissions reductions is so aggressive as to be inefficient--in the sense of raising substantially the total projected economic cost of reaching a given environmental goal. There are three major reasons why an aggressive takeoff in curtailing emissions raises overall costs: (1) it induces premature obsolescence of the capital stock because it does not allow adequate time for the capital stock to turn over naturally; (2) it provides insufficient lead time to develop and implement new technologies; (3) it causes a significant stagflationary short-term macroeconomic shock. Additionally, an aggressive timetable for emissions reductions does not allow time for the resolution of uncertainty and it does not take advantage of the time-value of money (resources not spent on emission reductions early on can be invested at a positive return which could purchase more emission reductions later).

The Role of Turnover of the Capital Stock. The most clear-cut and easily quantifiable reason for the high price tag associated with rapid emissions reductions relates to the need for premature replacement of plant and equipment in response to large increases in the price of carbon emissions. It is expensive enough to replace plants that are fully depreciated, but vastly more so if those plants are still in the prime of their productive lives. Within 20 to 40 years, much of our existing plant and equipment will be ready for replacement anyway; therefore building in greater carbon efficiency at that time will be relatively cheap. *It is important to emphasize that the case we are making here is not based on procrastinating for the sake of avoiding the problem; rather, it is based on simple principles of hard-headed business efficiency.*

The advantage of a slower emissions reduction timetable in avoiding the large costs associated with premature obsolescence of the capital stock can be illustrated by considering electrical power generation. The case of electricity generation is important in its own right since this industry is responsible for 88% of coal use and more than one third of all carbon dioxide emissions in the United States. But the principle concerning the costs of premature replacement applies broadly because reduced greenhouse gas emissions may entail the accelerated retrofitting of housing and commercial structures, the premature scrappage of vehicles and appliances, and the premature replacement of plant and equipment in energy intensive industries.

Figure 2 illustrates the effect of an accelerated retirement schedule for today's U.S. electric power generation capacity installed during the last 40 years. Imagine, to take an extreme case, that a timetable is adopted that necessitates replacing all power plants with less-polluting technology within ten years. This would require retiring 630 out of 670 gigawatts of generating

capacity before the end of its normal life span, or 94 per cent of the total. If the timetable were extended so that all power plants instead had to be replaced within 20 years, the accelerated replacement of capacity would affect 450 gigawatts of capacity, or 67 per cent of the total. Allowing this additional 10 years for turnover avoids the premature retirement of 27 per cent of existing electric power plant capacity. With a 30 years horizon, complete turnover would mean accelerated retirement of only 21 per cent of the total capacity and, with a 40 year timetable, there would be almost no additional costs due to premature obsolescence.[1, 2]

The Advantage of Waiting for Superior Technologies. The example of electric power generation also illustrates a second important reason why a slow takeoff in curbing greenhouse gas emissions is ultimately less costly: new technologies take a long time to develop. Waiting until these new technologies are available before making expensive emissions-saving investments offers the potential of both lower economic costs and higher environmental payoffs. Under a tight target and timetable with its associated high carbon emissions price, electric utilities will be forced to replace existing capacity in the very near future and to rely on currently available lean-carbon technologies, likely gas-turbine plants. If some delay can be factored in, however, they will be able to install more effective and less costly alternative technologies. A rapid timetable forces long-term investments to be made before superior technologies have been developed and refined.

Implication: The Need for a Credible, Long-Term Price Increase. The example of electricity generation illustrates two general principles. First, the responsiveness of both demand and supply are greater in the long run than in the short run. This means that, with a longer horizon, any given amount of abatement can be accomplished with a smaller increase in carbon emissions prices. Second, and perhaps even more important for policy, any credible emissions reduction strategy must include both a price increase at the outset and also a clear commitment to maintain and likely increase prices further over time. Without such a commitment, the changes in behavior required to meet even a long-run target of emissions reduction will likely not occur. Consider a utility that today is drawing up its plans for a new power plant. That utility will choose among today's technologies, which vary in their costs and CO_2 emissions. In order to induce the utility to choose a more costly, lean-emissions technology today, it must be clear that CO_2 emissions will be costly enough over the 40 years or more

[1]The distribution has been truncated at 40 years, the average lifespan of existing electric power plants. A few plants of yet older vintage are still in use.

[2]The same exercise can be performed for coal-fired power plants. These generators produce the most carbon per kilowatt hour of electricity and thus will have a high incidence of replacement even under a moderate abatement plan. If a complete change-over of coal plants were to be accomplished in 10 years, 96 per cent of total capacity would be retired early. If retirement occurred over 20 years, only 64 per cent would be retired early. Allowing an additional 10 years for turnover would avoid premature retirement of one-third of existing coal-fired plant capacity.

lifetime of the plant to justify a more expensive investment option today. A large cumulative reduction in emissions can be achieved over the long term with only a modest carbon emissions price increase now, but only if the commitment to still higher prices in the future is credible and clear.

Stagflationary Macroeconomic Impact. From a macroeconomic perspective, increases in energy prices constitute an adverse "supply shock." Such developments are stagflationary--even if anticipated--because they raise both inflation and unemployment simultaneously, creating a painful macroeconomic dilemma. As noted above, a plan to attain 1990 emissions levels by 2010 would require a change in energy prices over the first decade of the 21st century at least comparable in magnitude to the two oil shocks of the 1970s. Those shocks are widely acknowledged to have raised both unemployment and inflation. Similarly, the energy price increases required by a 1990 by 2010 program would raise inflation, lower real wages, and raise unemployment. Unemployment in the four years after the first oil shock averaged 7.2 percent in comparison to 5.0 percent in the four years prior; and unemployment rose further, to an average of 8.6 percent, in the four-year aftermath of the second oil shock.[3] Although the increases in energy prices associated with a treaty to reduce greenhouse gases would be anticipated, rather than a surprise, we should nevertheless expect that the efforts of the Federal Reserve to contain inflation, coupled with likely efforts on the part of workers to recoup real wage losses will lead to a period of higher unemployment.

Furthermore, it is important to note that most model-based estimates of the costs of a program to attain 1990 emissions levels by 2010 assume that resources are fully employed, thereby ignoring these potential short-term effects. Such models therefore provide no assessment of the consequent increases in unemployment.

IV. Quantifying the Economic Costs of Slow versus Fast Take-off

[3] There is debate about how much of this was due directly to the oil shocks, because there was a simultaneous decline in productivity growth and transfers of real income to OPEC producers.

The relative costs of slow versus fast takeoff timetables in curbing CO_2 emissions has recently been analyzed by the Stanford Energy Modeling Forum (EMF-14).[4] The Stanford group used six large-scale economic/energy models to compare the total projected cost of two alternative emissions reduction time paths--one "frontloaded", the second more "backloaded". *Importantly, both paths were designed eventually to stabilize atmospheric concentrations of CO_2 at double the pre-industrial level--550 ppmv.*[5] Although a high degree of uncertainty is inherent in particular numerical estimates from individual models, the simulations nevertheless point to some robust qualitative conclusions. *The major conclusion to be drawn from this project is that an emission reductions path characterized by an aggressive initial phase is substantially more costly--3 to 10 times more costly--than a path with a slower takeoff but larger eventual reductions.*

To enable a comparison of the costs of slow and rapid takeoff strategies, the EMF investigators asked each of six modeling groups to simulate the economic impacts of two alternative strategies to attain stabilization of CO_2 concentrations at 550 ppmv. The first strategy (the WG-1 path) corresponds to an emissions pathway published in 1994 by Working Group 1 (WG-1) of the Intergovernmental Panel on Climate Change (IPCC). Using the Wigley model of the carbon cycle, the working group computed a set of global CO_2 emissions pathways consistent with stabilization of concentrations at 550 ppmv and several alternative concentration levels. The WG-1 path entails an immediate departure from the baseline or "business as usual" emission path. Subsequently, Wigley, Richels and Edmonds (WRE) published an alternative set of emission profiles to achieve the same concentration targets. In contrast to the WG-1 paths, the WRE emission path was constructed to follow the baseline or "business as usual" scenario in the early years with sharper reductions after this initial phase. Wigley, Richels and Edmonds hypothesized that their slower-takeoff emissions pathways would yield identical environmental objectives with substantially lower economic costs, for the reasons discussed above. The EMF-14 exercise validates this hypothesis.

The EMF-14 comparison project assessed the total costs to the OECD, the EEFSU (Eastern Europe and the former Soviet Union) and the non-Annex I countries of the WG-1 and WRE pathways to stabilization of CO_2 concentrations at 550 ppmv. The appropriate economic measure of total cost is the present discounted value of losses in future consumption

[4] To enable meaningful comparisons of results across models, the EMF has coordinated a series of projects in which a number of large scale energy models are used to estimate the impact of given, specified emission reduction scenarios under common standardized, benchmark assumptions concerning population and economic activity, discount rates, energy resource availability and prices and technology availability.

[5] All energy models make numerous simplifications and approximations in order to describe the energy sector globally and over the span of a century or more. In particular, all of the models assume full employment, thereby abstracting from the likely short-run macroeconomic costs of an emissions reduction program.

relative to a "Business as Usual" scenario. Estimates of regional costs depend on the extent of burden sharing--namely, the assumed "division of labor"--between Annex-I and non-Annex I countries in controlling emissions as well as the extent of international emissions trading. Recall that, by the end of the next century--by 2100-- assuming "business as usual"--non Annex I countries will have more than 90 percent of CO_2 emissions. Thus, developing country participation is absolutely essential to achieving stabilization of concentrations. Consistent with the Berlin Mandate, the simulations assumed that the burden of emissions reduction would fall on Annex I countries exclusively during the early decades; that by 2030, non-Annex I countries would begin to participate; and by 2050, a full transition to targets based on equal per capita emission rights is assumed.

Figure 3 plots the OECD emission paths in the WG-1 and WRE scenarios. Under the WG-1 scenario, OECD emissions begin to decline immediately and continue to decline for roughly four decades. For example, OECD emissions fall 10 percent below initial levels ten years after implementation--corresponding closely to the requirement of a "1990 by 2010" timetable, which requires a reduction of 9 percent from current emissions in roughly a decade. In contrast, OECD emissions along the WRE path continue to rise for roughly two decades--corresponding closely to a plan calling for emissions to peak around 2020--return to 1990 levels around 2040 and decline substantially further in subsequent decades.

Table 1 illustrates a robust conclusion that emerges from this exercise: fast takeoff in emission reduction greatly increases the costs. Table 1 shows the cost for both the aggressive (WG-1) and slow-paced (WRE) paths--both with and without idealized international trading of permits. In 10 out of 12 simulations--for six different models with and without permit trading--the costs on the slow-takeoff WRE path is less than a third of the cost on the corresponding fast take-off path. Taking account of the likely adverse short-run macroeconomic consequences of an aggressive path would further strengthen this conclusion.

Table 2 illustrates a second, robust conclusion from the EMF-14 exercise: a viable system of international permit trading would very much reduce OECD costs. With global permit trading, the sharp, early emission reductions required of OECD countries under the aggressive (WG-1) approach would be avoided through the purchase of emission permits from countries with lower abatement costs. The average reduction in cost is 56 percent.[6]

[6] The computations in Table 2 verify that the slow paced (WRE) path, which permits emissions to depart relatively little from business as usual for several decades, is a substantially less costly than the alternative WG-1 path with its sharper immediate reductions. Since both paths are arbitrarily chosen to conform with the 550 ppmv concentration target, a natural question concerns the characteristics of an optimal or least-cost path for achieving this concentration target. An important recent study by Alan Manne and Richard Richels uses their MERGE model (included in the EMF-14 project) to compute the least cost path with 550-stabilization in 2100 and international permit trading. The optimal path, while not identical to the WRE path, is similar in character. This least-cost path peaks approximately three decades

Finally, it is important to note that in most of the EMF models, policy actions to raise carbon emissions prices must be taken at the inception of the slow-paced (WRE) program and a commitment to increasing emissions prices over time is required to achieve additional emission reductions. Naturally, the required initial carbon emissions price is substantially lower, at the outset, under the slower-paced (WRE) than under the aggressive (WG-1) path. Thus, although the slower-paced emissions path initially approximates the business as usual baseline, credible incentives must be put into place immediately, and strengthened over time, to achieve the needed investments in carbon-efficient technologies.

V. The Environmental Consequences of Slow versus Fast Takeoff.

after the initiation of the program and declines thereafter.

While the excess cost of a fast, compared to a gradual emissions reduction path is large, the difference in projected global temperatures over the next century between the fast and the slow paths is quite small, both in absolute amount and relative to temperature changes expected even if an aggressive policy path is adopted. Under "business as usual" assumptions, average global temperatures are expected to rise about 1 degree Celsius by 2050 and about 2½ degrees Celsius by 2100. An aggressive emission reduction path that stabilizes emissions at 1990 levels by 2010 and maintains emissions at the 1990 level thereafter would mitigate this temperature increase by roughly 0.1 degrees by 2050 and 0.2 degrees by 2100. In contrast, a more gradual emissions path that peaks around 2015, stabilizes emissions at 1990 levels by 2040, and holds emissions constant at 1990 levels thereafter yields virtually identical environmental benefits: the temperature difference between the aggressive and gradual paths diverges by no more than 0.05 degrees at any time over the next century. Similarly, the temperature differences along the aggressive WG-1 and less aggressive WRE paths--both designed ultimately to stabilize concentrations at 550 ppmv--differ by a maximum of 0.2 degrees over the next several centuries.[7]

The limited climatological impact of even an extremely aggressive emission reduction program measured in terms of temperature impacts during the next century reflects the extremely long lags involved in the underlying physical processes and the dependence of temperature on the total stock of carbon dioxide in the atmosphere, rather than the flow of emissions at a given time. Emissions reductions do matter to temperature, but only over an extremely long horizon. The cumulative nature of the process suggests that there is little effect on global temperature from a slow rather than from a fast abatement takeoff. The addition to the total stock of carbon from a slow rather than a fast start to abatement adds relatively little to the total atmospheric stock of CO_2 between now and 2100 for four separate reasons: the difference in carbon emissions between a slow and a fast start over the initial decades of abatement is only a small fraction of total emissions in that period; the stock of CO_2 in the atmosphere is itself the result of many decades of emissions; some of the CO_2 emissions of the early decades will have been re-absorbed; and the most serious build-up in CO_2 under business as usual occurs late in the next century, as a consequence of burgeoning emissions from non-Annex I countries.

Even the potential for a catastrophic environmental event, such as the melting of the West Antarctic ice sheet, a runaway greenhouse effect (e.g., from release of trapped methane with the melting of the permafrost), or a structural change in ocean currents such as the Gulf Stream, which the preceding abstracts from, does not fundamentally affect the basic trade-offs between the high costs of fast vs. slow takeoff paths. These factors do, however, add--perhaps greatly--to

[7] If a model assumes that sulfur dioxide emissions decline with the decline in carbon dioxide emissions under climate policy (as predicted, given the extent of sulfur emissions associated with fossil fuel combustion, and incorporated in the IPCC's IS92 emissions projections), the WG-1 path will be *warmer* than the WRE path between 2000 and 2040. This result reflects the negative impact of sulfate aerosols on the greenhouse effect. Early and substantial cuts in fossil fuel combustion, while decreasing the carbon emissions that warm the atmosphere, also decrease the sulfate aerosols that cool the atmosphere.

the urgency of adopting moderate long-term greenhouse gas concentration targets and a program involving an immediate, albeit moderate, increase in the price of CO_2 emissions.

VI. International Trading of Permits

As has already been noted, an effective system of international carbon emission permit trading among Annex I countries could substantially diminish the cost of a CO_2 abatement program. An Annex I trading system could, potentially, reduce the size of the carbon emissions price to attain a 1990 by 2010 goal by about 50%. Moreover, joint implementation projects with non-Annex I countries could, hypothetically, reduce this figure by half again.

Although international trading and joint implementation--so-called "where flexibility"--has enormous advantages in theory, your economic advisers are concerned that substantial barriers would stand in the way of implementing any workable analogue of such an idealized system--at least in the near term. Consequently, they stress that Annex I international permit trading and joint implementation between the U.S. and non-Annex I countries realistically can serve only a limited role in reducing the costs associated with meeting a "1990 by 2010" target.

A hypothetical example shows how an international trading system would work, and why it would reduce each participant country's abatement costs. Suppose, ideally, that every country adopts a domestic permit system to implement its Kyoto target. Absent international trading, the price of emissions permits would surely differ across countries, reflecting differing marginal costs of abatement internationally. With different permit prices in different national markets, profit- seeking traders would be motivated to buy permits in countries where they are cheap and resell them in countries where they are more expensive. Such arbitrage activities would create an international permit market, bringing permit prices into equality worldwide. This idealized system promotes global efficiency in achieving any worldwide abatement goal. Countries with permit prices below world levels have the incentive to reduce emissions more than they otherwise would in order to profit in the international permit market. Countries with high permit prices would have the incentive to purchase permits, thereby relaxing their Kyoto emissions constraints. The U.S. government could avoid any direct participation in such a system as long as it deems foreign-issued permits presented to the U.S. government by U.S. carbon-emitting entities as valid as those issued by the U.S. government itself.

The preceding description of how an international permit trading system would work provides an idealized picture of its possibilities. But the actual benefits of such a system are apt to fall short of this utopian portrayal in part because countries are not obliged to fulfill their Kyoto commitments via a domestic permit trading scheme; indeed, few Annex I countries have indicated an intention to do so. For example, consider a government that has decided to limit domestic emissions through regulatory controls. International permit sales that result in tighter domestic constraints could well be politically unpopular so that a government would hesitate before selling its emission rights to the United States. Similarly, international permit sales by a

country that is meeting its Kyoto obligations through domestic carbon or energy taxes would necessitate a hike in those taxes. In either case, international trading would involve government to government negotiations, and difficult political decisions. In contrast, in the idealized system, trades result from profit oriented transactions among individuals, mediated through the market.

Monitoring and enforcement issues are also likely to be paramount in insuring the workability of international trading. If domestic enforcement is effective in all countries, so that, in the aggregate, consumers and firms in each country actually limit their emissions to the national permit levels, international permit sales by private agents in the country actually translate into lower domestic emissions. But consider the difficulties that can occur with imperfect enforcement. If the government of a country--country X--finds it difficult either to measure domestic emissions or to enforce the purchase of permits by domestic emitters, then reductions in X's emissions may be insufficient to reach the Kyoto target. Those firms or individuals in X that are lucky enough to have been assigned the rights to X's permits will be able to sell them, at a quick profit, on the international market. With imperfect enforcement, international sales, without corresponding domestic emissions reductions, could emanate from countries with the weakest systems of enforcement. To prevent such "paper trades", which profit some participants and increase emissions, many countries, including the United States, will want controls to ensure the integrity of international permits. Buyers, too, will want clear concrete guarantees of the validity of permits so as to be sure they are not being passed counterfeit goods. These controls and guarantees will surely inhibit the efficiency of the market and render some--possibly much--of the estimated savings illusory. In fact, most of the benefits projected from the international sale of permits come from inducing emissions reductions from countries in Eastern Europe and the former Soviet Union--countries with particularly weak tax collection and enforcement mechanisms. Without these countries in the scheme the gains from international trading of permits will be very small.

Joint implementation with non-Annex I countries also has the potential to reduce the U.S. burden of attaining any given timetable. Under this type of approach, U.S. businesses could receive credit for the construction of nuclear, oil, or natural gas electricity generation plants in China if it were confidently expected that China would instead have constructed coal-fired plants with much higher CO_2 emissions. Certification of such credits might be overseen by an international agency to ensure that the projects were emissions-replacing. Such a project-by-project system is likely the most that is feasible in the absence of quantitative targets. Your economics advisers have concerns about even this level of endeavor due to the inherent difficulty in establishing that a particular set of projects has actually reduced a country's emissions, absent a reference path enabling a clear quantitative comparison. For example, the construction of a nuclear power plant in place of a coal-powered plant in China could indirectly raise CO_2 emissions elsewhere in the Chinese economy--partially offsetting the direct CO_2 reducing effect of the project--if the reduced demand for coal lowers its domestic price and encourages greater use elsewhere in the Chinese economy. A project-oriented approach to joint implementation will, in effect, constitute a limited form of international trading with high transaction costs. As a result, it will probably capture only a small fraction of the total benefits

of full international trading. In contrast, model results concerning the benefits of joint implementation treat it as equivalent to full international trading.

VII. Recycling of Revenues

The ultimate economic cost of an emission abatement program depends upon how the revenues realized from carbon taxes or auctioned permits are used. It has been estimated that the efficiency loss from collecting an extra dollar of tax revenue amounts to around 30 cents. If the revenues from a carbon tax or auctioned permits are used to reduce inefficient taxes inhibiting work or investment, the resulting gains would partially offset the micro-efficiency losses from energy curtailment. The simple lesson is that the costs of emission abatement may be greatly reduced if the revenues from the taxes levied can be put to good use.

So far we have approached the recycling of revenues from the standpoint of microeconomic efficiency. There is also the potential for using the revenues to abate the macroeconomic consequences of the emissions program. The oil shocks are believed by many economists to have resulted in increased unemployment because workers resisted the fall in real wages that was associated with the inflationary impact of higher energy prices. Increased wage demands added inflationary pressures to the economy that could only be suppressed by tighter monetary policy. Thus it might be argued that the effects of the real wage shock on inflation and unemployment could be diminished by lowering payroll or other worker taxes to offset the real wage losses from higher energy prices.

But England's experience points to the need for caution in assessing the potential for revenue recycling to allay the macroeconomic consequences of the rising energy costs. In 1979, immediately after her election, Margaret Thatcher increased the VAT tax and simultaneously decreased the income tax. These two policy changes had offsetting effects on real after tax incomes, and therefore might have been expected to have had no effect on wage bargaining. However, the increase in the VAT tax resulted in an immediately noticeable increase in the CPI. A wage-price spiral ensued as workers attempted to maintain their pre-tax real wages.

VIII. Policy Implications

The foregoing arguments point to the attractiveness, from both an economic and environmental standpoint, of a U.S. policy to raise the price of carbon emissions--either through a carbon tax or a system of auctioned permits--by a moderate amount--for example, between $5 and $15 per ton of carbon--in the near term, with further increases scheduled over the longer term. A realistic target and timetable corresponding to such a program would entail continued emissions growth in the first decade of the program, say 200-2010; elimination of emissions growth in the second decade (2010-2020) and reductions in emissions thereafter This program entails significant, early policy action and is consistent with a strong U.S. commitment to attaining the ultimate objective of the Framework Convention--namely to stabilize atmospheric concentrations of CO_2 and hence global temperatures.

A program involving gradual increases in the relative price of carbon emissions over time would avoid the substantial macroeconomic consequences of a 1990 by 2010 program. The energy price increases associated with the more moderate program would have a modest impact on family income that could be offset by compensating cuts in other taxes.

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CREATION DATE/TIME: 3-OCT-1997 20:51:52.00

SUBJECT: new version

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READ:UNKNOWN

TEXT:
========== ATTACHMENT 1 ==========
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:
Unable to convert ARMS_EXT:[ATTACH.D85]MAIL47601067G.216 to ASCII,
The following is a HEX DUMP:

CLOSE HOLD: PRELIMINARY

October 3, 1997

MEMORANDUM

FROM: Lawrence Summers
Janet Yellen

SUBJECT: Targets and Timetables for Reducing Greenhouse Gas Emissions

Executive Summary

This memo provides a preliminary evaluation of the likely economic consequences for the United States of a program to attain 1990 CO_2 emissions levels by 2010. It concludes that the attainment of such a goal would necessitate at least a doubling in energy prices and impose substantial economic costs. In contrast, a more gradual emissions reduction path that eliminates emissions growth by 2010-2020 and reduces emissions to 1990 levels thereafter captures nearly identical environmental benefits as the more aggressive approach while entailing costs between one tenth and one third as large.

If attained through domestic emissions reductions alone the "1990 by 2010" target requires a reduction in CO_2 emissions of roughly 30% relative to projected 2010 emissions assuming "business as usual". The reduction in energy use needed to meet this goal would substantially exceed that achieved during the decade of the OPEC price hikes, so that energy price increases, at least comparable in magnitude, are likely. Economic analysis and historical precedent suggest that energy price increases of this magnitude would have stagflationary consequences. As in the decade of the oil shocks, both unemployment and inflation would undoubtedly rise, at least for a time.

An "idealized" system of international permit trading among Annex I countries could hypothetically halve the change in carbon emissions prices needed to attain a 1990 by 2010 goal. This would mean paying Russia and other Eastern European countries to reduce emissions in place of the United States. However, such an arrangement could prove infeasible for a number of reasons, including difficulties in establishing adequate enforcement and monitoring mechanisms in the near term. Joint implementation with non-Annex I countries is likely to marginally reduce the impact on energy prices in the United States.

The memo argues that a more gradual timetable for emissions reduction can deliver virtually identical environmental benefits at a fraction of the cost. The aggressive "1990 by 2010" path is extremely inefficient because it requires premature scrappage of capital and foregoes the considerable advantages of waiting for the development of carbon-lean technologies before replacing existing plant and equipment. In contrast, a timetable that eliminates emissions growth in the second decade of the program (2010-2020) and reduces emissions to 1990 levels and below in subsequent decades is consistent with a long-term goal of stabilizing atmospheric CO_2 concentrations. *The total cost of this "back-loaded" approach is likely one third to one tenth that of the "front-loaded" 1990 by 2010 program.* Implementation of the gradual timetable requires an early, modest increase in the price of carbon emissions, along with

a credible commitment to further emissions price increases over time.

In comparison with a more gradual emissions reduction timetable, the environmental benefits of an aggressive abatement target are minimal. For example, the expected difference in global average temperature in 2100 along a fast-takeoff abatement path that attains 1990 emissions by 2010 and a gradual-takeoff abatement path that peaks in 2015 and attains 1990 emissions by 2040 is less than 0.05 degrees Celsius. Between now and 2100, global average temperature is expected to rise about 2½ degrees Celsius irrespective of the path chosen for Annex I stabilization, assuming developing countries continue with business as usual.

The body of this memorandum lays out the rationale for these conclusions.

I. Introduction

The Framework Convention on Climate Change signed at the 1992 earth summit in Rio de Janeiro called for carbon dioxide emissions in 2000 at 1990 levels. Most countries, including the United States, are unlikely to achieve these emissions reductions. But the Rio approach remains historically important, and most quantitative proposals that have been advanced in the run up to Kyoto can be understood as variants of the Rio target and timetable. In particular, a proposal to "stabilize CO_2 emissions at 1990 levels by 2010" (and variants thereof, including a more stringent proposal by several EU countries to stabilize at 10% below 1990 levels by 2010) has received considerable attention.

This memo assesses the consequences for the U.S. economy of a program to attain 1990 CO_2 emissions levels by 2010. It compares the costs and cost effectiveness of this baseline proposal with those of alternative targets and timetables that entail a less rapid initial reduction in CO_2 emissions levels. The conclusions described here rely on the substantial body of economic analysis that has been conducted by researchers worldwide, including the Intergovernmental Panel on Climate Change (IPCC), and Administration economists.

II. 1990 by 2010: The Scope of the Task

To appreciate the ambitiousness of a program to curb U.S. emissions levels to 1990 by 2010 it is necessary to recognize that, by 2010, emissions are likely to exceed their 1990 levels by about 31 percent.[1] As of 1996, energy related carbon emissions were already 9 percent above 1990 levels. Growth in the economy through the end of the next decade would further raise energy use and carbon emissions. Even under an optimistic assumption concerning the pace of improvement of energy efficiency (0.9 percent per year), there would be further increases in carbon emissions of about 22 percent over current levels by 2010 if we continue with business as usual. **To achieve 1990 emissions in 2010 thus amounts to avoiding about a 31 percent increase in emissions. Models indicate that even allowing for interfuel substitution from more- to less-carbon-intensive fuels, reductions in energy use must account for 20 of the 31 percentage points of avoided emissions growth.**

Comparison with the Oil Shocks. The reductions in CO_2 emissions necessitated by a 1990 by 2010 target are substantially larger than those achieved during the decade of the OPEC-induced energy price increases. Figure 1 shows aggregate energy use in the United States and the relative price of energy over the period 1960 to 1990. During the oil-shock decade--1972 to 1982--energy use (and carbon emissions) were virtually constant in absolute terms, while GDP grew in real terms at about 2.25 percent per year. But to meet the 1990 by 2010 goal it would not be sufficient just to keep emissions constant between now and 2010: a

[1] This assumes a 2.4 percent annual GDP growth rate. Even with a more moderate assumption of 2.2 percent annual GDP growth, carbon emissions in 2010 would exceed their 1990 level by about 28 percent.

further, roughly 15 percent rollback in emissions would be needed to offset the expansion that has already occurred since 1990.

The improvements in energy efficiency that occurred during the OPEC period were induced, in large measure, by increases in the relative price of energy. Indeed, between 1972 and 1982, the relative price of energy more than doubled: it rose about 150 percent. This historical experience, and other empirical analysis, suggests that energy use does respond to changes in the price of energy, but the responsiveness (the price elasticity of demand for energy) over periods as short as a decade is low--no higher than 0.2.

An efficient market-based domestic implementation scheme for meeting a "1990 by 2010" would raise the price of carbon emissions, either through requiring the purchase of an emissions permit or through a carbon tax. An increase in the price of carbon emissions would reduce emissions in two ways: by reducing overall energy use and by inducing switches among fuels, from high-carbon fuels like coal to low- and no-carbon fuels, such as natural gas and renewable energy. Even allowing for interfuel substitution, we would need to accomplish a reduction in energy use considerably larger than what occurred over a decade in which the relative price of energy more than doubled. This suggests that energy prices would likely have to at least double to attain 1990 emissions by 2010.

Model results. Numerous economic/energy models have been used to estimate the impact of a 1990 by 2010 program on energy prices. These models arrive at the same conclusion as was generated above using no model whatsoever: a program to achieve 1990 emissions by 2010 would likely entail at least a doubling of energy prices. A broad range of models place the carbon permit price required to achieve 1990 emissions by 2010 in the range of $80 to $250 per ton. If fully passed through to energy prices, a permit price of $100 per ton, for example, entails a 76 percent increase in energy prices. The impact on the prices of different sources of energy are all large, but the effect on coal is particularly severe. The price of coal would more than triple, while the price of a barrel of petroleum would increase by about fifty percent. Gas at the pump would increase in price by about 26 cents. Relative to the BTU tax proposed by the Administration in 1993 a $100 implicit carbon tax is about 5 times as large. Thus, attaining a goal of 1990 by 2010 would have very large effects on our economy.

Evidence from International Comparisons. A final piece of evidence confirming the conclusion that a strong price signal over a long period of time is necessary to alter energy use comes from comparisons of energy usage between the United States and Europe. It should hardly be surprising that energy use per dollar of GDP is lower in Europe than the United States. Energy prices in Europe have long been substantially higher--roughly double U.S. energy prices. Moreover, major differences in living patterns between the United States and Europe result in higher European energy efficiency. In addition to the geographical "advantage", from an energy efficiency standpoint, of Europe's higher population density, resulting in lower transportation requirements, Europe has locked in place many long-run adaptations to high energy prices.

Innovations in the design of housing and transportation systems and the configuration of residential areas have occurred in response to high energy prices. But in spite of its natural advantages and its long history of high energy prices, energy per dollar of GDP is only 44% lower in Europe than in the United States. This means that even if the United States were to become Europe--energywise per dollar of GDP--its energy savings, even in the long run, would be no greater than 44 percent. This U.S.-Europe comparison supports the conclusions drawn from the natural experiment of the oil shock: namely, a return to 1990 emissions will not occur without very major price measures over a long period of time.

The Role of Technology and the Scope for "No Regrets" Policies. According to the preceding assessment, a large price inducement is necessary to meet a 1990 by 2010 target. Your economic advisers agree on this conclusion. However several of your advisers are more optimistic about the chances of achieving a 1990 by 2010 target. They emphasize the current availability of "no regrets" (cost-saving) technologies that promise substantial opportunities for abatement. A recent report by the Department of Energy research laboratories, for example, catalogues emissions-saving technologies that, by their calculations, are currently "cost effective." If put in place now, such practices could allegedly reduce emissions by between 30 to 50 percent of the amount needed to reach a 1990 by 2010 target. Even so, the report finds that "aggressive" and "invigorated" government policies--including potentially costly and intrusive regulations and standards--as well as a $50 carbon tax would be necessary to reach the 1990 by 2010 target.

Your economic advisers agree that there now exist unused technological opportunities for emissions reduction, but we question by what means, over what time frame, and at what expense government policies could change private behavior if such opportunities are currently underutilized. Engineering studies generally ignore the sometimes subtle disadvantages of available cost-saving technologies or overestimate their hypothetical returns. An example is illustrative: significant energy and cost savings could result if consumers replace incandescent bulbs with compact fluorescents. Over the long lifetime of such bulbs there would also be a substantial monetary gain. However, actual adoption of these light bulbs has been slow to date, possibly due to pure inertia, possibly because consumers dislike their color, or perhaps because they apply a high "discount rate" when valuing energy savings that accrue after the purchaser may have switched residence. Several recent studies have demonstrated that the actual returns to home improvement investments, such as attic insulation, often fall short of those predicted by engineering studies.

Regardless of the reasons, if consumers have not adopted "no regrets" measures at a faster rate, it is likely that additional incentives will be necessary for them to change their minds. Rather than stressing the mere availability of alternative technologies, your economic advisers insist on realistic estimates of likely rates of adoption and diffusion and they stress the need for economic incentives--in the form of a higher implicit price for carbon emissions--to induce the adoption of emissions-saving technology. They point out too that the baseline energy demand estimates used to predict the price increase needed to attain a 1990 by 2010 target already assume

substantial ongoing improvements in energy efficiency due to the diffusion of existing technologies and the development of new ones. Significant adoption of such technologies is necessary merely to meet this assumed baseline. Finally, it is important to note that the DOE labs study includes as part of its policy package to reach 1990 emissions by 2010 extensive regulations, including stringent CAFE and appliance standards and national building codes--command and control policies that your economic advisers would oppose--along with a $50 carbon tax.

To summarize, your economic advisers consider it unrealistic to predict a substantial increase in the pace of adoption of new emissions-saving technologies in the absence of a large increase in the price of carbon emissions--and hence of energy. Based in part on the evidence from the energy shocks of the 1970s, in part on international comparisons, and in part on model results, they are optimistic that such an increase in prices would bring forth a reduction in CO_2 emissions--with larger responses to a given price change likelier the longer the time period for response. The evidence is strong that a very large price increase will be necessary to attain emissions reductions of 20 to 30 percent over a period as short as a decade. *Moreover, other approaches that apparently do not involve large price increases (such as performance standards) will impose even higher costs on the American economy.*

III. Why are the costs of early emissions reductions so high?

The previous section argued that a "1990 by 2010" target would entail high carbon emissions prices and significant economic costs. This section shows that the 1990 by 2010 timepath for emissions reductions is so aggressive as to be inefficient--in the sense of raising substantially the total projected economic cost of reaching a given environmental goal. There are three major reasons why an aggressive takeoff in curtailing emissions raises overall costs: (1) it induces premature obsolescence of the capital stock because it does not allow adequate time for the capital stock to turn over naturally; (2) it provides insufficient lead time to develop and implement new technologies; (3) it causes a significant stagflationary short-term macroeconomic shock. Additionally, an aggressive timetable for emissions reductions does not allow time for the resolution of uncertainty and it does not take advantage of the time-value of money (resources not spent on emissions reductions early on can be invested at a positive return which could purchase more emissions reductions later).

The Role of Turnover of the Capital Stock. The most clear-cut and easily quantifiable reason for the high price tag associated with rapid emissions reductions relates to the need for premature replacement of plant and equipment in response to large increases in the price of carbon emissions. It is expensive enough to replace plants that are fully depreciated, but vastly more so if those plants are still in the prime of their productive lives. Within 20 to 40 years, much of our existing plant and equipment will be ready for replacement anyway; therefore building in greater carbon efficiency at that time will be relatively cheap. *It is important to*

emphasize that the case we are making here is not based on procrastinating for the sake of avoiding the problem; rather, it is based on simple principles of hard-headed business efficiency.

The advantage of a more gradual emissions reduction timetable in avoiding the large costs associated with premature obsolescence of the capital stock can be illustrated by considering electrical power generation. The case of electricity generation is important in its own right since this industry is responsible for 88% of coal use and more than one third of all carbon dioxide emissions in the United States. But the principle concerning the costs of premature replacement applies broadly because reduced greenhouse gas emissions may entail the accelerated retrofitting of housing and commercial structures, the premature scrappage of vehicles and appliances, and the premature replacement of plant and equipment in energy intensive industries.

Figure 2 illustrates the effect of an accelerated retirement schedule for today's U.S. electric power generation capacity installed during the last 40 years. Imagine, to take an extreme case, that a timetable is adopted that necessitates replacing all power plants with less-polluting technology within ten years. This would require retiring 630 out of 670 gigawatts of generating capacity before the end of its normal life span, or 94 percent of the total. If the timetable were extended so that all power plants instead had to be replaced within 20 years, the accelerated replacement of capacity would affect 450 gigawatts of capacity, or 67 percent of the total. Allowing this additional 10 years for turnover avoids the premature retirement of 27 percent of existing electric power plant capacity. With a 30 year horizon, complete turnover would mean accelerated retirement of only 21 percent of the total capacity and, with a 40 year timetable, there would be almost no additional costs due to premature obsolescence.[2, 3]

The Advantage of Waiting for Superior Technologies. The example of electric power generation also illustrates a second important reason why a gradual takeoff in curbing greenhouse gas emissions is ultimately less costly: new technologies take a long time to develop. Waiting until these new technologies are available before making expensive emissions-saving investments offers the potential of both lower economic costs and higher environmental payoffs. Under a tight target and timetable with its associated high carbon emissions price, electric

[2]The distribution has been truncated at 40 years, the average lifespan of existing electric power plants. A few plants of yet older vintage are still in use.

[3]The same exercise can be performed for coal-fired power plants. These generators produce the most carbon per kilowatt hour of electricity and thus will have a high incidence of replacement even under a moderate abatement plan. If a complete change-over of coal plants were to be accomplished in 10 years, 96 percent of total capacity would be retired early. If retirement occurred over 20 years, only 64 percent would be retired early. Allowing an additional 10 years for turnover would avoid premature retirement of one-third of existing coal-fired plant capacity.

utilities will be forced to replace existing capacity in the very near future and to rely on currently available lean-carbon technologies, likely gas-turbine plants. If some delay can be factored in, however, they will be able to install more effective and less costly alternative technologies. A rapid timetable forces long-term investments to be made before superior technologies have been developed and refined.

Implication: The Need for a Credible, Long-Term Price Increase. The example of electricity generation illustrates two general principles. First, the responsiveness of both demand and supply are greater in the long run than in the short run. This means that, with a longer horizon, any given amount of abatement can be accomplished with a smaller increase in carbon emissions prices. Second, and perhaps even more important for policy, any credible emissions reduction strategy must include both a price increase at the outset and also a clear commitment to maintain and likely increase prices further over time. Without such a commitment, the changes in behavior required to meet even a long-run target of emissions reduction will likely not occur. Consider a utility that today is drawing up its plans for a new power plant. That utility will choose among today's technologies, which vary in their costs and CO_2 emissions. In order to induce the utility to choose a more costly, lean-emissions technology today, it must be clear that CO_2 emissions will be costly enough over the 40 years or more lifetime of the plant to justify a more expensive investment option today. A large cumulative reduction in emissions can be achieved over the long term with only a modest carbon emissions price increase now, but only if the commitment to still higher prices in the future is credible and clear.

Stagflationary Macroeconomic Impact. From a macroeconomic perspective, increases in energy prices constitute an adverse "supply shock." Such developments are stagflationary--even if anticipated--because they raise both inflation and unemployment simultaneously, creating a painful macroeconomic dilemma. As noted above, a plan to attain 1990 emissions levels by 2010 would require a change in energy prices over the first decade of the 21st century at least comparable in magnitude to the two oil shocks of the 1970s. Those shocks are widely acknowledged to have raised both unemployment and inflation. Similarly, the energy price increases required by a 1990 by 2010 program would raise inflation, lower real wages, and raise unemployment. Unemployment in the four years after the first oil shock averaged 7.2 percent in comparison to 5.0 percent in the four years prior; and unemployment rose further, to an average of 8.6 percent, in the four-year aftermath of the second oil shock.[4] Although the increases in energy prices associated with a treaty to reduce greenhouse gases would be anticipated, rather than a surprise, we should nevertheless expect that the efforts of the Federal Reserve to contain inflation, coupled with likely efforts on the part of workers to recoup real wage losses will lead to a period of higher unemployment.

[4] There is debate about how much of this was due directly to the oil shocks, because there was a simultaneous decline in productivity growth and transfers of real income to OPEC producers.

Furthermore, it is important to note that most model-based estimates of the costs of a program to attain 1990 emissions levels by 2010 assume that resources are fully employed, thereby ignoring these potential short-term effects. Such models therefore provide no assessment of the consequent increases in unemployment.

IV. Quantifying the Economic Costs of Gradual versus Fast Take-off

The relative costs of gradual versus fast takeoff timetables in curbing CO_2 emissions has recently been analyzed by the Stanford Energy Modeling Forum (EMF-14).[5] The Stanford group used six large-scale economic/energy models to compare the total projected cost of two alternative emissions reduction time paths--one "frontloaded", the second more "backloaded". *Importantly, both paths were designed eventually to stabilize atmospheric concentrations of CO_2 at double the pre-industrial level--550 ppmv.*[6] Although a high degree of uncertainty is inherent in particular numerical estimates from individual models, the simulations nevertheless point to some robust qualitative conclusions. *The major conclusion to be drawn from this project is that an emissions reductions path characterized by an aggressive initial phase is substantially more costly--3 to 10 times more costly--than a path with a slower takeoff but larger eventual reductions.*

To enable a comparison of the costs of gradual and rapid takeoff strategies, the EMF investigators asked each of six modeling groups to simulate the economic impacts of two alternative strategies to attain stabilization of CO_2 concentrations at 550 ppmv. The first strategy (the WG-1 path) corresponds to an emissions pathway published in 1994 by Working Group 1 (WG-1) of the Intergovernmental Panel on Climate Change (IPCC). The working group computed a set of global CO_2 emissions pathways consistent with stabilization of concentrations at 550 ppmv and several alternative concentration levels. The WG-1 path entails an immediate departure from the baseline or "business as usual" emissions path. Subsequently, Wigley, Richels and Edmonds (WRE) published an alternative set of emissions profiles to achieve the same concentration targets. In contrast to the WG-1 paths, the WRE emissions path was constructed to follow the baseline or "business as usual" scenario in the early years with sharper reductions after this initial phase. Wigley, Richels and Edmonds hypothesized that their

[5] To enable meaningful comparisons of results across models, the EMF has coordinated a series of projects in which a number of large scale energy models are used to estimate the impact of given, specified emissions reduction scenarios under common standardized, benchmark assumptions concerning population and economic activity, discount rates, energy resource availability and prices and technology availability.

[6] All energy models make numerous simplifications and approximations in order to describe the energy sector globally and over the span of a century or more. In particular, all of the models assume full employment, thereby abstracting from the likely short-run macroeconomic costs of an emissions reduction program.

more gradual takeoff emissions pathways would yield identical environmental objectives with substantially lower economic costs, for the reasons discussed above. The EMF-14 exercise validates this hypothesis.

The EMF-14 comparison project assessed the total costs to the OECD, the EEFSU (Eastern Europe and the former Soviet Union) and the non-Annex I countries of the WG-1 and WRE pathways to stabilization of CO_2 concentrations at 550 ppmv. The appropriate economic measure of total cost is the present discounted value of losses in future consumption relative to a "Business as Usual" scenario. Estimates of regional costs depend on the extent of burden sharing--namely, the assumed "division of labor"--between Annex I and non-Annex I countries in controlling emissions as well as the extent of international emissions trading. Recall that, by the end of the next century--by 2100-- assuming "business as usual"--non-Annex I countries will have more than 90 percent of CO_2 emissions. Thus, developing country participation is absolutely essential to achieving stabilization of concentrations. Consistent with the Berlin Mandate, the simulations assumed that the burden of emissions reduction would fall on Annex I countries exclusively during the early decades; that by 2030, non-Annex I countries would begin to participate; and by 2050, a full transition to targets based on equal per capita emissions rights is assumed.

Figure 3 plots the OECD emissions paths in the WG-1 and WRE scenarios. Under the WG-1 scenario, OECD emissions begin to decline immediately and continue to decline for roughly four decades. For example, OECD emissions fall 10 percent below initial levels ten years after implementation--corresponding closely to the requirement of a "1990 by 2010" timetable, which requires a reduction of 9 percent from current emissions in roughly a decade. In contrast, OECD emissions along the WRE path continue to rise for roughly two decades--corresponding closely to a plan calling for emissions to peak around 2020--return to 1990 levels around 2040 and decline substantially further in subsequent decades.

Table 1 illustrates a robust conclusion that emerges from this exercise: fast takeoff in emissions reductions greatly increases the costs. Table 1 shows the cost for both the aggressive (WG-1) and gradual (WRE) paths--both with and without idealized international trading of permits. In 10 out of 12 simulations--for six different models with and without permit trading--the costs on the gradual WRE path is less than a third of the cost on the corresponding fast take-off path. Taking account of the likely adverse short-run macroeconomic consequences of an aggressive path would further strengthen this conclusion.

Table 2 illustrates a second, robust conclusion from the EMF-14 exercise: a viable system of international permit trading would very much reduce OECD costs. With global permit trading, the sharp, early emissions reductions required of OECD countries under the aggressive (WG-1) approach would be avoided through the purchase of emissions permits from countries with lower abatement costs. The average reduction in cost is 56 percent.[7]

[7] The computations in Table 2 verify that the gradual (WRE) path, which permits

Finally, it is important to note that in most of the EMF models, policy actions to raise carbon emissions prices must be taken at the inception of the gradual (WRE) program and a commitment to increasing emissions prices over time is required to achieve additional emissions reductions. Naturally, the required initial carbon emissions price is substantially lower, at the outset, under the gradual (WRE) than under the aggressive (WG-1) path. Thus, although the gradual emissions path initially approximates the business as usual baseline, credible incentives must be put into place immediately, and strengthened over time, to achieve the needed investments in carbon-efficient technologies.

V. The Environmental Consequences of Gradual versus Fast Takeoff.

emissions to depart relatively little from business as usual for several decades, is a substantially less costly than the alternative WG-1 path with its sharper immediate reductions. Since both paths are arbitrarily chosen to conform with the 550 ppmv concentration target, a natural question concerns the characteristics of an optimal or least-cost path for achieving this concentration target. An important recent study by Alan Manne and Richard Richels uses their MERGE model (included in the EMF-14 project) to compute the least-cost path with 550 ppmv stabilization and international permit trading. The optimal path, while not identical to the WRE path, is similar in character. This least-cost path peaks approximately three decades after the initiation of the program and declines thereafter.

While the excess cost of a fast, compared to a gradual emissions reduction path is large, the difference in projected global temperatures over the next century between the fast and the gradual paths is quite small, both in absolute amount and relative to temperature changes expected even if an aggressive policy path is adopted. Under "business as usual" assumptions, average global temperatures are expected to rise about 1 degree Celsius by 2050 and about 2½ degrees Celsius by 2100. An aggressive Annex I emissions reduction path that stabilizes emissions at 1990 levels by 2010 and maintains emissions at the 1990 level thereafter would mitigate this temperature increase by roughly 0.1 degrees by 2050 and 0.2 degrees by 2100.[8] In contrast, a more gradual Annex I emissions path that peaks around 2015, stabilizes emissions at 1990 levels by 2040, and holds emissions constant at 1990 levels thereafter yields virtually identical environmental benefits: the temperature difference between the aggressive and gradual paths diverges by no more than 0.05 degrees at any time over the next century. Similarly, the temperature differences along the aggressive WG-1 and less aggressive WRE paths--both designed ultimately to stabilize concentrations at 550 ppmv--differ by a maximum of 0.2 degrees over the next several centuries.[9]

The limited climatological impact of even an extremely aggressive emissions reduction program measured in terms of temperature impacts during the next century reflects the extremely long lags involved in the underlying physical processes and the dependence of temperature on the total stock of carbon dioxide in the atmosphere, rather than the flow of emissions at a given time. Emissions reductions do matter to temperature, but only over an extremely long horizon. The cumulative nature of the process suggests that there is little effect on global temperature from a gradual rather than from a fast abatement takeoff. The addition to the total stock of carbon from a gradual rather than a fast start to abatement adds relatively little to the total atmospheric stock of CO_2 between now and 2100 for four separate reasons: the difference in carbon emissions between a gradual and a fast start over the initial decades of abatement is only a small fraction of total emissions in that period; the stock of CO_2 in the atmosphere is itself the result of many decades of emissions; some of the CO_2 emissions of the early decades will have been re-absorbed; and the most serious build-up in CO_2 under business as usual occurs late in the next century, as a consequence of burgeoning emissions from non-Annex I countries.

Even the potential for a catastrophic environmental event, such as the melting of the West

[8] Successful stabilization would require very large cuts from "business as usual" in China, India, and other non-Annex I countries.

[9] If a model assumes that sulfur dioxide emissions decline with the decline in carbon dioxide emissions under climate policy (as predicted, given the extent of sulfur emissions associated with fossil fuel combustion, and incorporated in the IPCC's IS92 emissions projections), the more aggressive WG-1 path will be *warmer* than the WRE path between 2000 and 2040. This result reflects the negative impact of sulfate aerosols on the greenhouse effect. Early and substantial cuts in fossil fuel combustion, while decreasing the carbon emissions that warm the atmosphere, also decrease the sulfate aerosols that cool the atmosphere.

Antarctic ice sheet, a runaway greenhouse effect (e.g., from release of trapped methane with the melting of the permafrost), or a structural change in ocean currents such as the Gulf Stream, which the preceding abstracts from, does not fundamentally affect the basic trade-offs between the high costs of fast vs. gradual takeoff paths. These factors do, however, add--perhaps greatly--to the urgency of adopting moderate long-term greenhouse gas concentration targets and a program involving an immediate, albeit moderate, increase in the price of CO_2 emissions.

VI. International Trading of Permits

As has already been noted, an effective system of international carbon emissions permit trading among Annex I countries could substantially diminish the cost of a CO_2 abatement program. An Annex I trading system could, potentially, reduce the size of the carbon emissions price to attain a 1990 by 2010 goal by up to 50%. Moreover, joint implementation projects with non-Annex I countries could, hypothetically, reduce this figure by half again.

Although international trading and joint implementation--so-called "where flexibility"--has enormous advantages in theory, your economic advisers are concerned that substantial barriers would stand in the way of implementing any workable analogue of such an idealized system--at least in the near term. Consequently, they stress that Annex I international permit trading and joint implementation between the U.S. and non-Annex I countries realistically can serve only a limited role in reducing the costs associated with meeting a "1990 by 2010" target.

A *hypothetical* example shows how an international trading system would work, and why it would reduce each participant country's abatement costs. Suppose, ideally, that every country adopts a domestic permit system to implement its Kyoto target. Absent international trading, the price of emissions permits would surely differ across countries, reflecting differing marginal costs of abatement internationally. With different permit prices in different national markets, profit-seeking traders would be motivated to buy permits in countries where they are cheap and resell them in countries where they are more expensive. Such arbitrage activities would create an international permit market, bringing permit prices into equality worldwide. This idealized system promotes global efficiency in achieving any worldwide abatement goal. Countries with permit prices below world levels have the incentive to reduce emissions more than they otherwise would in order to profit in the international permit market. Countries with high permit prices would have the incentive to purchase permits, thereby relaxing their Kyoto emissions constraints. The U.S. government could avoid any direct participation in such a system as long as it deems foreign-issued permits presented to the U.S. government by U.S. carbon-emitting entities as valid as those issued by the U.S. government itself.

The preceding description of how an international permit trading system would work provides an idealized picture of its possibilities. But the actual benefits of such a system are apt to fall short of this utopian portrayal in part because countries are not obliged to fulfill their Kyoto commitments via a domestic permit trading scheme; indeed, few Annex I countries have

indicated an intention to do so. For example, consider a government that has decided to limit domestic emissions through regulatory controls. International permit sales that result in tighter domestic constraints could well be politically unpopular so that a government would hesitate before selling its emissions rights to the United States. Similarly, international permit sales by a country that is meeting its Kyoto obligations through domestic carbon or energy taxes would necessitate a hike in those taxes. In either case, international trading would involve government to government negotiations, and difficult political decisions. In contrast, in the idealized system, trades result from profit-oriented transactions among individuals, mediated through the market.

Monitoring and enforcement issues are also likely to be paramount in insuring the workability of international trading. If domestic enforcement is effective in all countries, so that, in the aggregate, consumers and firms in each country actually limit their emissions to the national permit levels, international permit sales by private agents in the country actually translate into lower domestic emissions. But consider the difficulties that can occur with imperfect enforcement. If the government of a country--country X--finds it difficult either to measure domestic emissions or to enforce the purchase of permits by domestic emitters, then reductions in X's emissions may be insufficient to reach the Kyoto target. Those firms or individuals in X that are lucky enough to have been assigned the rights to X's permits will be able to sell them, at a quick profit, on the international market. With imperfect enforcement, international sales, without corresponding domestic emissions reductions, could emanate from countries with the weakest systems of enforcement. To prevent such "paper trades", which profit some participants and increase emissions, many countries, including the United States, will want controls to ensure the integrity of international permits. Buyers, too, will want clear concrete guarantees of the validity of permits so as to be sure they are not being passed counterfeit goods. These controls and guarantees will surely inhibit the efficiency of the market and render some--possibly much--of the estimated savings illusory. In fact, most of the benefits projected from the international sale of permits come from inducing emissions reductions from countries in Eastern Europe and the former Soviet Union--countries with particularly weak tax collection and enforcement mechanisms. Without these countries in the scheme the gains from international trading of permits will be very small.

Joint implementation with non-Annex I countries also has the potential to reduce the U.S. burden of attaining any given timetable. Under this type of approach, U.S. businesses could receive credit for the construction of nuclear, oil, or natural gas electricity generation plants in China if it were confidently expected that China would instead have constructed coal-fired plants with much higher CO_2 emissions. Certification of such credits might be overseen by an international agency to ensure that the projects were emissions-replacing. Such a project-by-project system is likely the most that is feasible in the absence of quantitative targets. Your economics advisers have concerns about even this level of endeavor due to the inherent difficulty in establishing that a particular set of projects has actually reduced a country's emissions, absent a reference path enabling a clear quantitative comparison. For example, the construction of a nuclear power plant in place of a coal-powered plant in China could indirectly raise CO_2 emissions elsewhere in the Chinese economy--partially offsetting the direct CO_2

reducing effect of the project--if the reduced demand for coal lowers its domestic price and encourages greater use elsewhere in the Chinese economy. A project-oriented approach to joint implementation will, in effect, constitute a limited form of international trading with high transaction costs. As a result, it will probably capture only a small fraction of the total benefits of full international trading. In contrast, model results concerning the benefits of joint implementation treat it as equivalent to idealized international trading.

VII. Recycling of Revenues

The ultimate economic cost of an emissions abatement program depends upon how the revenues realized from carbon taxes or auctioned permits are used. It has been estimated that the efficiency loss from collecting an extra dollar of tax revenue amounts to around 30 cents. If the revenues from a carbon tax or auctioned permits are used to reduce inefficient taxes inhibiting work or investment, the resulting gains would partially offset the micro-efficiency losses from energy curtailment. The simple lesson is that the costs of emissions abatement may be greatly reduced if the revenues from the taxes levied can be put to good use.

So far we have approached the recycling of revenues from the standpoint of microeconomic efficiency. There is also the potential for using the revenues to abate the macroeconomic consequences of the emissions program. The oil shocks are believed by many economists to have resulted in increased unemployment because workers resisted the fall in real wages that was associated with the inflationary impact of higher energy prices. Increased wage demands added inflationary pressures to the economy that could only be suppressed by tighter monetary policy. Thus it might be argued that the effects of the real wage shock on inflation and unemployment could be diminished by lowering payroll or other worker taxes to offset the real wage losses from higher energy prices.

But England's experience points to the need for caution in assessing the potential for revenue recycling to allay the macroeconomic consequences of the rising energy costs. In 1979, immediately after her election, Margaret Thatcher increased the VAT tax and simultaneously decreased the income tax. These two policy changes had offsetting effects on real after tax incomes, and therefore might have been expected to have had no effect on wage bargaining. However, the increase in the VAT tax resulted in an immediately noticeable increase in the CPI. A wage-price spiral ensued as workers attempted to maintain their pre-tax real wages.

VIII. Policy Implications

The foregoing arguments point to the attractiveness, from both an economic and environmental standpoint, of a U.S. policy to raise the price of carbon emissions--either through a carbon tax or a system of auctioned permits--by a moderate amount--for example, between $5 and $15 per ton of carbon--in the near term, with further increases scheduled over the longer term. A realistic target and timetable corresponding to such a program would entail continued emissions growth in the first decade of the program, say 2000-2010; elimination of emissions

growth in the second decade (2010-2020) and reductions in emissions thereafter. This program entails significant, early policy action and is consistent with a strong U.S. commitment to attaining the ultimate objective of the Framework Convention--namely to stabilize atmospheric concentrations of CO_2 and hence global temperatures.

A program involving gradual increases in the relative price of carbon emissions over time would avoid the substantial macroeconomic consequences of a 1990 by 2010 program. The energy price increases associated with the more moderate program would have a modest impact on family income that could be offset by compensating cuts in other taxes.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: DAVID.WILCOX@MS01.DO.treas.sprint.com@INET@LNGTWY (
DAVID.WILCOX@MS01.DO.treas.sprint.com@INET@LNGTWY [UNKNOWN])

CREATION DATE/TIME: 3-OCT-1997 19:14:54.00

SUBJECT: attached paper

TO: Peter R. Orszag@eop (Peter R. Orszag@eop [OPD])
READ:UNKNOWN

TO: Janet L. Yellen@eop (Janet L. Yellen@eop [CEA])
READ:UNKNOWN

TO: Jeffrey A. Frankel@EOP (Jeffrey A. Frankel@EOP [CEA])
READ:UNKNOWN

TEXT:
Date: 10/03/1997 06:50 pm (Friday)
From: David Wilcox
To: peter, jon, janet, jeff, ray
Subject: attached paper

<WP Attachment enclosed>

Attached is the final version of the joint Treasury/CEA paper.

The respective staff members have now reached closure on fact
checking.========== ATTACHMENT 1 ==========
ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:
Unable to convert ARMS_EXT:[ATTACH.D30]MAIL468107578.216 to ASCII,
The following is a HEX DUMP:

Global Climate Change: Which Way Forward?

I. Economic costs

There is no doubt that we must take action to begin to stabilize and eventually reduce our emissions of greenhouse gases. Economic evidence indicates, however, that meeting the targets and timetables for emissions reductions that are currently on the negotiating table would require severe and unpopular actions. None of the lead signatories on the recent economists' letter supporting action on climate change believes that returning carbon emissions to 1990 levels by 2010 is warranted.

Achieving the 1990 level of emissions by 2010 would require imposing about as much restraint on energy consumption as resulted from the OPEC oil price increases of the 1970s. Moreover, it could only be accomplished by introducing an energy tax — or the economic equivalent thereof — more than four times larger than our 1993 BTU tax proposal. Advances in technology and mechanisms for international burden-sharing would help cushion this impact somewhat, but even with the most effective possible measures in place on these fronts, an aggressive program would still inflict considerable economic pain. For all these reasons, an ambitious approach would face severe Congressional opposition and have other highly adverse political consequences.

Regardless of how the restraint on carbon emissions is imposed, the costs will be passed down to consumers. A recent EPI study warning of the loss of 2 million jobs is typical of the reaction that an aggressive proposal would elicit. Other opponents of such a proposal would include most large companies, all energy-intensive small businesses, organized labor, consumer groups, and those fearful about competitiveness. It is likely that moderate sources of analysis (e.g., Brookings, AEI, IIE, and mainstream Democratic economists such as Alan Blinder, Richard Cooper, and William Nordhaus) would oppose ambitious commitments.

There is a better alternative available to the Administration: A more gradual program of emissions restraint would capture most of the environmental benefits of an ambitious program, and at only a small fraction of the economic cost.

Broadly speaking, there are two possible ways to satisfy the obligations we might sign onto in Kyoto: We can reduce our domestic use of carbon, or we can buy our way out of at least part of the obligation by paying other countries to reduce their emissions. The next several subsections consider five possible approaches to advancing these objectives: a tax on carbon emissions; a system of tradeable permits; command-and-control regulation; investment in technology; and international cost-reduction measures.

A. Carbon taxes

The most straightforward way to reduce carbon emissions is to tax them. Imposing a tax would increase the incentive to become "carbon-efficient."

The magnitude of the required tax would depend on the aggressiveness of the objective. If the objective is to return emissions to 1990 levels by 2010, then the tax would have to be between $80 per ton and $250 per ton of carbon emissions. This tax would have to be introduced within the next few years, ramp up to this level by 2010, and continue to rise thereafter.

- A tax of this magnitude would be 4-12 times larger than the BTU tax that was proposed in 1993.

- Even an $80-per-ton tax (i.e., a tax at the lower end of the estimated required range) would reduce the standard of living of the average family by about $880; this is roughly equivalent to 1-½ week's worth of take-home pay. Furthermore, a tax of this type would be highly regressive: the relative burden on the lowest fifth of the population would be 6 times as great as the burden on the highest fifth.

- A tax of this magnitude would damage the performance of the macroeconomy as well. It would produce stagflation — a period with higher inflation and more unemployment.

Notwithstanding these severe impacts, your economic advisers believe that a tax on carbon emissions compares favorably to other methods of restraining carbon emissions. With the exception of an auction-based permit approach — discussed below — other methods would impose greater costs on consumers and the overall economy.

B. Tradeable permits

Another approach to restraining emissions would involve creating a domestic emissions trading program. At the center of this type of program is a *permit*, which would entitle the holder to emit a certain amount of carbon into the atmosphere. Such a program could be implemented either by auctioning permits, or by giving them away. Many designs for the give-away are possible, but one much-discussed option would involve "grandfathering" existing emitters.

Grandfathering would probably be unworkable and would surely be unfair. It would publicly reward polluters. It would give as much as $200 billion per year to corporations. And it could be administratively extremely complex, depending on the details of implementation. Therefore, if a permit-based approach is selected rather than a tax-based approach, we would strongly prefer auctioning the permits rather than grandfathering them. Either permit-based approach (auctioning or grandfathering) would cause a large increase in the price of energy to consumers, and so would be perceived as equivalent to a tax.

Some observers have claimed that the sulfur-dioxide program serves as a good model for how a carbon trading program would work, and in particular illustrates that carbon emissions could probably be reduced at surprisingly low cost. This is not the case. A carbon trading

program would be 100 times as large as the sulfur-dioxide program, so extrapolation from one program to the other is extremely speculative. Moreover, a substantial portion of the acknowledged success of the sulfur-dioxide program derives from the fact that it replaced an enormously burdensome set of command-and-control regulations, and the fact that it enjoyed some good luck, notably in the form of a steep decline in freight rail rates. Neither of these factors can be expected to operate in the case of a carbon program.

C. Regulation

Reductions in emissions could be achieved by command-and-control regulation. But this approach would be tremendously inefficient, and could easily be circumvented.

The inefficiency of this approach is illustrated by the U.S. experience with CAFE standards, which: apply only to new vehicles, and therefore perversely increase the incentive to hold onto cheaper, dirtier used vehicles; reduce the cost of driving additional miles, and therefore perversely reduce the incentive to drive fewer miles; and apply more heavily to cars than "light trucks", and so perversely have induced some consumers to purchase low-mileage sport-utility vehicles, which are classified as light trucks and now account for half of new vehicle sales.

These standards impose high costs on the U.S. economy. One study estimated these costs at $11 for every gallon of gasoline saved and more than $100 for every ton of carbon saved. Moreover, new standards would involve very unpopular restrictions on the purchase of the type of vehicles preferred by new car consumers.

D. Technology

In the very long run, technology determines what can be achieved in reducing carbon emissions, so provision of major new research funding and perhaps funding for diffusing technology is important.

A recent Energy Department study (the "5 Labs Study) concludes that an ambitious program of investment in technology development and diffusion could move the nation one-third of the way toward meeting the 1990 level of emissions *at no net cost — or possibly even net benefit — to the economy.* Your economics advisers, John Deutch, and many other outside reviewers believe that this conclusion is founded on unrealistic assumptions. For example, the report assumes that firms can be induced to invest $50-90 billion per year beyond current levels in energy-efficient technologies and other measures for conservation. This is a large amount of investment (roughly 7 percent of total investment in new equipment), and it could only be called forth by offering costly incentives.

E. International cost-reduction measures

As you know, the United States has suggested two approaches for reducing what we

would have to do domestically to lower greenhouse-gas emissions: international permit trading, and "joint implementation." But the practical difficulties of establishing these mechanisms imply that they will only be able to make marginal contributions, at most, in the near future.

- International emissions trading has not been accepted by other nations. Even if such trading were to be accepted, other governments choosing to implement their own domestic emissions reductions through regulatory approaches or through energy taxes probably would not be willing to tighten those domestic restrictions in order to profit from permit sales to the United States.

- Both international permit trading and joint implementation raise difficult issues of monitoring and enforcement. For example, every country in the system would be tempted to allow its firms to fraudulently sell their emissions rights into the international market, garner the resulting revenue, and exceed their allowed level of emissions.

Even assuming the most optimistic scenarios for technology and successful implementation of domestic and international trading, it will still not be possible for us to achieve 1990 emissions levels without substantial increases in the price of energy — on the order of 4 to 12 times the amount of the BTU tax.

II. The link between the economy and the environment

There are two key questions concerning the link between the economy and the environment. First, assuming all countries faithfully execute all of the commitments contained in proposals currently on the negotiating table, will the desired environmental benefits necessarily follow? As you know, the answer to this question is "no," because developing countries would not be required to take on binding commitments under any agreement currently under consideration for approval in Kyoto.

The non-participation of developing countries is a fatal flaw for one simple reason: A ton of carbon does the same amount of damage no matter whether it is emitted in Baltimore or in Bangkok. Therefore, from an environmental perspective, it is equally important to control emissions anywhere in the world. But as you are also aware, the politics of enforcing binding commitments on developing countries is extremely difficult.

A second question concerning the link between the economy and the environment is whether the incremental environmental benefits would justify the extra economic costs associated with an accelerated program rather than a more gradual one. The figure at the end of this document suggests that the case for an aggressive program is weak. This figure compares projected increases in global average atmospheric temperature in three different cases: (1) a "*business as usual*" case; (2) an *ambitious* case in which industrialized countries return their emissions to 1990 levels by 2010 and developing countries stabilize their emissions at 2020 levels in 2020 (an extremely optimistic assumption); and (3) a more *gradual* case in which

industrialized countries stabilize their emissions in 2015 and return to 1990 levels by 2040, and developing countries stabilize in 2040 at 2040 levels.

As can be seen in the figure, even by 2100, the difference between the ambitious and gradual strategies is only 0.2 degree Celsius. Virtually all of this difference is attributable to developing countries; the difference in actions taken by developed countries contributes only 0.01 (*one one-hundredth*) of one degree. These amounts are small, not only in absolute terms, but also relative to the 1.7 degree increase in the average temperature that is projected to take place over the next century even under an ambitious policy.

Furthermore, the gradual strategy captures about two-thirds of the environmental benefits generated by the ambitious strategy (in spite of the lesser assumed commitments of developing countries), while imposing overall economic costs that are only *one-tenth to one-third* as great as the costs of the ambitious approach. The lower cost of the gradual strategy reflects two main considerations: (1) retrofitting is extremely expensive compared to replacing capital stock that has lived out its full life; and (2) the longer one delays before investing in new plant and equipment, the better the technology that will be available.

In summary, gradual approaches have nearly the same environmental benefits as ambitious approaches, at only a small fraction of the economic cost.

III. Suggested approaches

The foregoing analysis indicates that the U.S. should promote Kyoto as a "turning point" rather than a "finishing point." The U.S. should take a principled approach to the Kyoto negotiations and insist that the objective of any international agreement should be to stabilize long run concentrations in the least-cost fashion. This has important implications for both the breadth of the Kyoto commitment, in terms of the number of countries covered, and the depth of the commitment, in terms of the targets and timetables adopted by each country. Key features of our ultimate commitment should be:

- The long-term goal of the treaty should be to *stabilize concentrations* of greenhouse gases in the atmosphere at a level that will prevent dangerous anthropogenic interference with the climate system. This goal could be achieved with concentrations at or somewhat above a doubling of pre-industrial levels in the next one hundred years.

- Concentrations should be stabilized through targets and timetables which obtain that goal in a cost-effective fashion. In particular, we suggest that our focus should be on eliminating emissions growth in the developed countries 10-20 years after ratification, and reducing emissions levels gradually thereafter to reach — and then to decline below — 1990 levels in later years to be decided, stabilizing concentrations.

- This approach should also include a periodic review of the underlying science, the data on the path of emissions, and the economic impact, to allow for adjustments in the policy.

- The goal is the least-cost global approach to stabilization of carbon concentrations in the atmosphere. Therefore, we should negotiate and begin a new Kyoto Mandate, requiring developing country participation (in stages), starting with more-advanced (Annex B) developing countries, with graduation as countries develop. Developing countries commit to reduce the rate of growth of emissions consistent with stabilizing carbon concentrations and continued economic growth, with ceilings on costs. The United States should not initial the agreement until the Annex B countries have binding commitments.

- Develop a tradable permits system, with auction of all permits (rather than grandfathering), in the near term. Impose this system early at a level of emissions near the baseline, then increase the number of permits in small, gradual, predetermined steps, based on economic cost and aggressive technological progress, subject to periodic review.

- Use a portion of funds raised for cost-effective technology research and diffusion programs, including basic research. The bulk would be available for a range of domestic priorities (tax relief for individuals; business investment incentives; the solution to the fiscal effects of the demographic imbalance; infrastructure; etc.) chosen to make the program attractive.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

CREATOR: Jeffrey A. Frankel (CN=Jeffrey A. Frankel/OU=CEA/O=EOP [CEA])

CREATION DATE/TIME: 3-OCT-1997 14:18:16.00

SUBJECT: GCC Package 3

TO: Janet L. Yellen (CN=Janet L. Yellen/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

CC: Joseph E. Aldy (CN=Joseph E. Aldy/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

CC: Randall W. Lutter (CN=Randall W. Lutter/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

CC: Adele C. Morris (CN=Adele C. Morris/OU=CEA/O=EOP @ EOP [CEA])
READ:UNKNOWN

TEXT:
The final form of the "Economic Team's Option" is certainly better than
the earlier versions, as you can see.
JF
---------- Forwarded by Jeffrey A. Frankel/CEA/EOP on 10/03/97
02:15 PM ----------

Joseph J. Minarik

10/03/97 09:55:14 AM
Record Type: Record

To: Peter R. Orszag/OPD/EOP
cc: See the distribution list at the bottom of this message
Subject: GCC Package 3

As I just mentioned in a voice-mail message to you, this revised version
of Package 3 includes a couple of language edits just transmitted by
Treasury. They are not life-and-death, so if it is possible to substitute
this version, great, if not, we will survive.

Also, as I mentioned in the voice mail, the Department of Labor would like
to be identified as supporting Package 3.

Thanks.

Message Copied
To:_____

Franklin D. Raines/OMB/EOP
T J. Glauthier/OMB/EOP
Jeffrey A. Frankel/CEA/EOP
Jill M. Blickstein/OMB/EOP
Alecia Ward/OMB/EOP
========== ATTACHMENT 1 ==========
ATT CREATION TIME/DATE: 0 00:00:00.00

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The following is a HEX DUMP:

PACKAGE 3

TARGET AND TIMETABLE

- The long-term goal of the treaty is to *stabilize concentrations* of greenhouse gases in the atmosphere at a level that will prevent dangerous anthropogenic interference with the climate system. This goal could be achieved with concentrations at or somewhat above a doubling of pre-industrial levels in the next one hundred years.

- Concentrations can be stabilized through the following targets and timetables:

  Reduce emissions growth in the United States in the near term (for example, growth from 2000-2010 less than growth over 1990-2000); then

  Eliminate emissions growth in developed countries 10 to 20 years after treaty is signed (e.g., 2010-2020); then

  Reduce emissions levels in developed countries gradually to reach — and then to decline below — 1990 levels in later years to be decided, stabilizing concentrations.

- This timetable begins effective action soon to establish Presidential leadership.

- The schedule of reducing emissions and emissions growth is determined by the environmental benefits and the degree of economic cost that is acceptable, coupled with a resulting assumed robust rate of improvement in emissions-reduction technologies.

- There would be periodic review of the underlying science, the data on the path of emissions, and the economic impact, to allow for adjustments in the policy.

- Insist on the current U.S. flexibility positions of international trading, multiple multi-year targets, joint implementation (subsidies of non-carbon energy sources in developing countries), banking, and borrowing.

DEVELOPING COUNTRIES

- The goal is the least-cost global approach to stabilization of carbon concentrations in the atmosphere.

- Negotiate and begin a new Kyoto Mandate, requiring developing country participation (in stages), starting with more-advanced (Annex B) developing countries, with graduation as countries develop. Developing countries commit to reduce the rate of growth of emissions consistent with stabilizing carbon concentrations and continued economic growth, with ceilings on costs.

- In a one-step process, the United States will not initial the agreement until the Annex B countries have binding commitments.

DOMESTIC IMPLEMENTATION

- Develop a tradable permits system, with auction of all permits (rather than grandfathering), in the near term; impose the system early at a level of emissions near the baseline (for example, with an implied permit price of perhaps $10 per ton), with enactment as soon as possible, to show U.S. leadership. (A carbon tax, if feasible, would be an alternative method of implementation.)

- Change the number of permits in small, gradual, predetermined steps, based on economic cost and aggressive technological progress (with the implied permit price rising to perhaps $22 per ton by 2015), subject to periodic review.

- A portion of funds raised would be used for cost-effective technology research and diffusion programs, including basic research. The bulk would be available for a range of domestic priorities (tax relief for individuals; business investment incentives; the solution to the fiscal effects of the demographic imbalance; infrastructure; etc.) chosen to make the program attractive.

- Begin a series of voluntary industry programs (perhaps modeled after PNGV) to develop plans to meet the targets.

- The United States would lead toward a global ban on fossil fuel subsidies.

- Provide for banking and borrowing to deal with short-term fluctuations. Borrowed permits would be issued at a premium cost, and banked permits could be resold later at higher prices.

- Provide economic growth insurance or a cost cap on permits that would allow the sale of additional permits. The price would be set consistent with our estimate of the acceptable economic cost, and would be high enough to encourage emissions-efficient investment choices in the near term. (If the cost cap were in effect over an extended period, the target would not be met.)

- These policies are market-oriented. There would be no inefficient, command-and-control regulations used to reduce emissions.

Include common components listed elsewhere.

RECORD TYPE: PRESIDENTIAL (NOTES MAIL)

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CREATION DATE/TIME: 3-OCT-1997 07:43:20.00

SUBJECT: here is the boorstin version

TO: Janet L. Yellen@eop (Janet L. Yellen@eop [CEA])
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TEXT:
Date: 10/02/1997 07:19 pm (Thursday)
From: David Wilcox
To: janet, jeff
Subject: here is the boorstin version

I can be reached at home tonight at 703-549-3865========== ATTACHMENT 1
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ATT CREATION TIME/DATE: 0 00:00:00.00

TEXT:
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The following is a HEX DUMP:

Global Climate Change: Which Way Forward?

I. Economic costs

There is no doubt that we must take action to begin to stabilize and eventually reduce our emissions of greenhouse gases. Economic evidence indicates, however, that meeting the targets and timetables for emissions reductions that are currently on the negotiating table would require severe and unpopular actions. Achieving such targets would entail greater restraint on energy consumption than resulted from the OPEC oil price increases of the 1970s. Such restraint could only be accomplished by imposing a tax — or the economic equivalent thereof — on energy that is more than five times larger than our 1993 BTU tax proposal. Advances in technology and mechanisms for international burden-sharing would help cushion this impact somewhat, but even with the most effective possible measures in place on these fronts, an aggressive program would still inflict considerable economic pain. For all these reasons, an ambitious approach would face severe Congressional opposition and have other highly adverse political consequences. Moreover, none of the lead signatories on the recent economists' letter supporting action on climate change believes that returning carbon emissions to 1990 levels by 2010 is warranted.

There is a better alternative available to the Administration: A more gradual program of emissions restraint would capture most of the environmental benefits of an ambitious program, and at only a small fraction of the economic cost.

Broadly speaking, there are three possible ways to satisfy the obligations we might sign onto in Kyoto: We can raise the price of emitting carbon; we can increase the efficiency with which we use carbon; or we can buy our way out of at least part of the obligation by paying other countries to reduce their emissions. The next several subsections consider five possible approaches to advancing one or more of these objectives: a tax on carbon emissions; a system of tradeable permits; command-and-control regulation; investment in technology; and international cost-reduction measures.

A. Carbon taxes

The most straightforward way to reduce carbon emissions is to tax them. Imposing a tax would increase the incentive to become "carbon-efficient."

The magnitude of the required tax would depend on the aggressiveness of the objective. If the objective is to return emissions to 1990 levels by 2010, then the tax would have to be between $80 per ton and $200 per ton of carbon emissions. This tax would have to be introduced within the next few years, and would ramp up to its full level by 2010.

- A tax of this magnitude would be 4-10 times larger than the BTU tax that was proposed in 1993.

- Even an $80-per-ton tax (i.e., a tax at the lower end of the estimated required range) would reduce the standard of living of the average family by about $880; this is roughly

equivalent to 1-½ week's worth of take-home pay. Furthermore, a tax of this type would be highly regressive: the burden on the lowest fifth of the population would be 6 times as great as the burden on the highest fifth.

- The impact of a tax of this magnitude would be evident in macroeconomic data as well. Conservative estimates suggest that this action would inflict the equivalent of one additional mild recession on the economy every 15 years.

Notwithstanding these severe impacts, your economic advisers believe that a tax on carbon emissions compares favorably to other methods of restraining carbon emissions. The costs to consumers and the overall economy under most other methods would exceed the costs under a direct carbon tax. (Some other methods would obscure these costs, but impose them nonetheless.) Importantly, a tax would limit the cost to the economy of the carbon program in a way that no other program is capable of doing: Once the level of the tax was set ("so many dollars per ton of emissions"), the cost could not rise. By contrast, other methods of imposing restraint on carbon emissions leave uncertainty about the eventual cost per ton of emissions.

B. Tradeable permits

Another available tool for restraining emissions is a domestic emissions trading program. At the center of this type of program is a *permit*, which entitles the holder to emit a certain amount of carbon into the atmosphere. Such a program could be implemented either by auctioning permits, or by giving them away. Many designs for the give-away are possible, but one much-discussed option would involve "grandfathering" existng emitters.

Grandfathering is economically ludicrous, in part because it would publically reward polluters; for this and other reasons, we would strongly favor an auction-based approach. Either approach, however, would result in a large increase in the price of energy to consumers, and so would be perceived as essentially equivalent to an increase in taxes.

Some observers have claimed that the sulfur-dioxide program serves as a good model for how a carbon trading program would work, and in particular illustrates that carbon emissions could probably be reduced at surprisingly low cost. In fact, this is not the case. A carbon trading program would be 100 times as large as the sulfur-dioxide program, making any extrapolation extremely speculative. Moreover, a substantial portion of the acknowledged success of the sulfur-dioxide program derives from the fact that it replaced an enormously burdensome set of command-and-control regulations, and the fact that it enjoyed some good luck, notably in the form of a steep decline in freight rail rates. Neither of these factors can be expected to operate in the case of a carbon program.

C. Regulation

Reductions in emissions could be achieved by command-and-control regulation. However, because of the attendant cost to consumers and the resulting political consequences, this approach is not currently under serious consideration.

D. Technology

One alternative to raising the price of carbon is to improve the efficiency with which it is utilized. In the very long run, technology determines what can be achieved in reducing carbon emissions, so provision of major new research funding and perhaps funding for diffusing technology is important.

A recent Energy Department study (the "5 Labs Study) concludes that an ambitious program of investment in technology development and diffusion could move the nation one-third of the way toward meeting the 1990 level of emissions *at no net cost — or possibly even net benefit — to the economy*. John Deutch, your economics advisers, and many other outside reviewers believe that this conclusion is founded on unrealistic assumptions. For example, the report assumes that firms can be induced to invest $50-90 billion per year beyond current levels in energy-efficient technologies and other measures for conservation. But because such additional effort on energy conservation would force firms to redirect 7 percent of their total investment in new equipment, it could only be accomplished by offering costly incentives.

Although the potential for technology to make a positive contribution is real, it is limited. Renewable sources of energy today account for just 8 percent of all energy supplied in the US economy. Experts in energy efficiency currently estimate that these sources could account for 3 percent of total energy supply by 2010.

E. International cost-reduction measures

As you know, the United States has suggested two approaches for reducing what we would have to do domestically to lower greenhouse-gas emissions: international permit trading, and "joint implementation."

- *International emissions trading* has not been accepted by other nations. Even if it were accepted internationally, it is doubtful that Congress would appropriate the $5-10 billion annually that would be required for the US to buy emissions rights from other countries. There is currently no model that would allow corporations to buy emissions rights directly from foreign governments.

- *Joint implementation* poses similar problems. Although it has shown promise in pilot projects, there is no evidence that we can devise a scheme that developing countries will accept and that will reward us properly.

Even assuming the most optimistic scenarios for technology and successful implementation of domestic and international trading, it will still not be possible for us to achieve 1990 emissions levels without substantial increases in the price of energy — on the order of 4 to 10 times the amount of the BTU tax. Regardless of how the restraint on carbon emissions is imposed, energy users and emitters will pass the costs down to consumers. A recent EPI study warning of the loss of 2 million jobs is typical of the reaction that an aggressive proposal would elicit. Other opponents of such a proposal would include most large companies, all energy-intensive small businesses, organized labor, consumer groups, and those fearful about competitiveness. It is likely that moderate sources of analysis (e.g., Brookings, AEI, IIE, and mainstream Democratic economists such as Alan Blinder and William Nordhaus) would oppose ambitious commitments.

II. The link between the economy and the environment

There are two key questions concerning the link between the economy and the environment. First, assuming all countries faithfully executed all of the commitments contained in proposals currently on the negotiating table, would the desired environmental benefits necessarily follow? As you know, the answer to this question is "no," because developing countries would not be required to take on binding commitments under any agreement currently under consideration for approval in Kyoto.

The non-participation of developing countries is a fatal flaw for one simple reason: A ton of carbon does the same amount of damage no matter whether it is emitted in Baltimore or in Bangkok. Therefore, from an environmental perspective, it is equally important to control emissions anywhere in the world. But as you also are aware, the politics of enforcing binding commitments on developing countries is extremely difficult. (The economics is also difficult, given that a sensible policy would have to leave room for the developing countries to improve their average standard of living.)

A second question concerning the link between the economy and the environment is whether it would make more sense, economically and environmentally, to implement an accelerated program or a more gradual one. The figure at the end of this document suggests that the case for an aggressive program is weak. This figure compares projected increases in global average atmospheric temperature in three different cases: (1) a "*business as usual*" case; (2) an *ambitious* case in which industrialized countries return their emissions to 1990 levels by 2010 and developing countries stabilize their emissions at 2020 levels in 2020; and (3) a more *gradual* case in which industrialized countries stabilize their emissions in 2015 and return to 1990 levels by 2040, and developing countries stabilize in 2040 at 2040 levels.

As can be seen in the figure, even by 2100, the difference between the ambitious and gradual strategies is only 0.2 degree Celsius. This amount is small, not only in absolute terms, but also relative to the 1.7 degree increase in the global average temperature that is projected to take place over the next century even under under an ambitious policy. Furthermore, gradual strategy captures about two-thirds of the environmental benefits generated by the ambitious

strategy. Separate results show that the economic costs of the more gradual approach would be only *one-tenth* as great as the costs of the ambitious approach. This difference in cost reflects two main considerations: (1) retrofitting is extremely costly compared to replacing capital stock that has lived out its full life; and (2) the longer one delays before investing in new plant and equipment, the better the technology that will be available; forcing investment on to procede on an accelerated schedule guarantees that inferior capital will be locked in place for a long period of time.

In summary, gradual approaches have nearly the same environmental benefits as ambitious approaches, at only a small fraction of the economic cost.

III. Suggested approaches

The foregoing analysis indicates that the U.S. should promote Kyoto as a "turning point" rather than a "finishing point." A constructive alternative proposal from the United States could include:

A. Domestic steps

Any domestic strategy should include a framework for future policies that maintains maximum flexibility; ambitious rhetoric about the seriousness of the problem and of our response to it; and a position on developing countries that delays a Byrd amendment battle. In addition, it could include:

- Investments in R&D to help minimize the economic costs of reducing emissions;
- Incentives for the purchase and deployment of carbon-efficient technology; and
- Exploration of proposals to shift the basis of taxation away from taxing things that we like, such as income and capital gains, and toward taxing things that we don't like, such as pollution. Such exploration could be undertaken by a National Commission or through a Treasury Department report.

Beyond these initiatives, there are three possible approaches.

Need guidance here.

B. International steps

On the international front, the Administration might take the following constructive steps:

- work for the establishment of a multinational technical study group to determine the best method for obtaining a "global least-cost" approach to stabilizing greenhouse gas emissions. In addition, task this group with studying the practicality of joint implementation and international verification and enforcement. Separately, establish a global research facility to explore the application of renewables, techniques of sequestration, and methods of conservation;

- reiterate our commitment that any solution involve all nations, industrialized and developing, and press for future binding commitments on the part of developing countries that take into account the individual circumstances of each country;

- suggest new targets keyed to the ratification date of Kyoto rather than past dates.