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THE WHITE HOUSE

WASHINGTON

February 20, 1997

cc: JAF
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MEMORANDUM FOR DISTRIBUTION

FROM: Kristen Panerali
National Economic Council

SUBJECT: Climate Change Deputies Meeting

The Climate Change Deputies meeting scheduled for Monday, February 24 at 2:00 pm in 231 OEOB is rescheduled for Thursday, February 27, at 4 pm in 472 OEOB. Deputies plus one are invited to attend.

An agenda will be sent to you before the meeting. Please call Kristen Panerali at 456-5353 with your clearance information (date of birth and social security number) by COB February 26.

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Tim Wirth, State

GL CC

Deputies meeting.

Bonin announced all.

Strong statement on need for LDCs to participate
(no requests, data submission...)

Japanese becoming more engaged & more positive, as host.
G77 priv. mtg. decided Asian Y. oppose JI

Apr. 15 sub-lapp. So ~ Apr. 1 deadline, for proposals to be placed
on table in June Conference of Parties.

MEMORANDUM

COUNCIL OF ECONOMIC ADVISERS

Date: 6 February 97

To: David Gardiner
Alex Cristofaro
EPA
260-0780 (fax)

From: Jeffrey Frankel
Alicia Munnell

RE: Climate Change Overview paper: Additional Language and questions

Page 1—final paragraph

...National Academy of Sciences and the Office of Technology Assessment suggest that the *"optimistic upper-bounds" are as high as...* of diffusion of existing technologies...

Page 1—final paragraph

How does "net economic benefit" differ from the phrase "potentially painless" used in earlier versions of the technology diffusion paper?

Page 2—first paragraph

....some of the barriers to the deployment of existing technologies. *Given the transaction costs associated with collecting and processing information, for example, potential users may not fully appreciate the potential long-term net benefits of more energy-efficient technologies. (End of paragraph)*

A number of *technology diffusion* programs are....

Page 6—4th and 5th bullet

The net impact of a trading scheme on the value of a firm is an empirical question. We ask that the Market Impacts and Wealth Transfer bullets be integrated into one bullet called Net Sectoral Impacts.

Net Sectoral Impacts. Any program that limits emissions will affect the bottom line of firms. The costs of a permit program will depend on program design. For example, ...energy market. In addition, allocating permits redistributes wealth within the economy. The magnitude of this redistribution depends on the permit price, which is determined by the emissions target and the cost of fossil fuel substitutes. Permits could be auctioned with revenues accruing to the government, or awarded based on historical rates of emissions with wealth accruing to the firms, or both.

Page 8—3rd bullet

Do the Zero CO2 Renewable technology cost estimates include the additional costs associated with the transportation of fuel? If not, we think it would be helpful to point this out.

6
CMM
JES
DAF
MM

THE WHITE HOUSE

WASHINGTON

February 6, 1997

MEMORANDUM FOR DISTRIBUTION

FROM: Kristen Panerali
National Economic Council

SUBJECT: Climate Change Deputies Meeting

The Climate Change Deputies meeting scheduled for Tuesday, February 11 is canceled.

There will still be a Climate Change Deputies meeting on Monday, February 24 at 2:00 pm in 231 OEOb. Deputies plus one are invited to attend. An agenda will be sent to you before the meeting. Please call Kristen Panerali at 456-5353 with your clearance information (date of birth and social security number) by COB February 21.

Distribution:

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DRAFT

Climate Change Deputies Meeting
February 11, 1997
OEOD Room 231

1. Schedule/Key Dates (McGinty/Tarullo)
2. Update on Economic Analysis (Ehrlich)
3. Domestic Policy Development (McGinty/Tarullo)

Issues for Discussion:

1. The papers describe four types of policies - an emissions trading program, more specific regulatory approaches, short-term technology diffusion programs and long-term r&d. Which appear to offer the best potential for controlling US greenhouse gas emissions? *what combination*
2. Where would more work be most useful?
3. The Assistant Secretaries have discussed publishing a condensed version of the attached Overview Paper in the Federal Register for comment. Would this be a useful outreach tool?
4. Should we pursue work on a long-term concentration goal? What role should that work have in developing domestic policies?

February 26, 1997

MEMORANDUM FOR DISTRIBUTION

FROM: ROBERT S. KAPLA
COUNCIL ON ENVIRONMENTAL QUALITY

SUBJECT: CLIMATE CHANGE DEPUTIES MEETING

Attached is the agenda for the climate change deputies meeting scheduled for this **Thursday, February 27th at 4:00pm in room 472 OEOb**. Also attached is a paper on domestic policy options prepared by the Assistant Secretaries.

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CLIMATE CHANGE DEPUTIES MEETING

Thursday, February 27

4:00-6:00pm

OEOB Room 472

AGENDA

- I. International Negotiations
 - current status
 - key upcoming decisions/dates
- II. Economic Modeling Analysis
 - initial output from benchmark runs
 - next steps
- III. Domestic Policy Options
 - Overview Paper
 - next steps
- IV. Outreach Strategy
- V. Relationship of Emissions, Concentrations and Impacts

Overview of Greenhouse Gas Mitigation Options

Introduction

Over the next century, important shifts in the global economy would be required to address climate change. (See attachments 1 and 2). While many mitigation options exist, these policies entail costs (e.g. increases in energy prices or additional federal spending). Taking no action also involves costs, since global warming can adversely affect both humans and ecosystems.

This paper lays out the broad policy options available for limiting emissions, but does not analyze the costs and benefits of particular options. The options fall into three general categories:

- Those that seek to increase the rate at which existing energy efficient technologies are deployed in the marketplace by overcoming information and other barriers to their use. The Administration's efforts in the Climate Change Action Plan were designed to use technology diffusion to reduce emissions to 1990 levels and may reduce as much as one-fourth of the amount of projected growth to the year 2010.
- Those that create new government requirements to internalize the costs of greenhouse gas emissions in the marketplace. These could take the form of additional standards and regulations, changes in other government policies that indirectly affect energy use, and/or an emissions trading program. Such programs typically involve government imposed limits on emissions that increase the costs of energy or restrict consumer choice.
- Research and Development (R&D). R&D can reduce costs in all periods. However, it is particularly important in the long term, since controlling warming ultimately requires adopting an energy system that does not rely primarily on fossil fuels. This would involve stepping up and refocusing the federal government's R&D program and reversing the long-term trend of declining government and private R&D expenditures.

Technology Diffusion Programs

As noted by the National Academy of Sciences (NAS) and the Office of Technology Assessment, many energy saving technologies already exist, but are not being implemented. The NAS, for example, stated that the total diffusion of existing energy efficiency technologies in "reasonable applications" could reduce current carbon emissions by almost one-fourth.

For an energy efficient technology to be more fully employed, however, potential buyers of products need to know of the technology, as well as its performance and

economic benefits. Service providers must have the expertise to appropriately design, install and operate the technology. Yet, given the transaction costs associated with obtaining reliable information, potential users may not fully appreciate the potential long-term net benefits of more energy-efficient technologies.

A number of technology diffusion programs to address these problems are currently underway. The Administration's CCAP launched over 40 initiatives in 1993. Their goal was to return U.S. greenhouse gas emissions to 1990 levels by the year 2000. The Administration currently projects that if funding at current annual levels (\$183 million) continues, these programs will eliminate as much as one-fourth of the total growth in emissions through the year 2010 and save over \$35 billion in energy expenses in that year. The Administration proposed higher spending levels years (\$305 million) for each of the past two years. However, Congress cut the requests by 40%.

The following illustrate the kinds of programs underway or that could be pursued in this category:

- Fully funding existing CCAP programs, adding initiatives to further reduce emissions beyond the year 2000.
- Establishing additional information and energy labeling programs for buildings (e.g., to redress the asymmetry of information between builders and occupants). This sector consumes one-third of the nation's energy.
- Should a domestic emissions trading system be created, setting aside a reserve of allowances or a portion of auction revenues to reward new R&D investment and the production of efficient and renewable technologies. Alternatively, a voluntary early banking program could be designed to encourage early action.
- Creating a secondary market for energy efficiency financing.
- Expanding sector-wide compacts in which entire industries could pledge improvements in emissions and benefit from shared information or R&D on technologies.
- Extending government procurement efforts for energy efficient technologies to state and local levels.
- Mandating through Executive Order the purchase of "green" power by federal facilities where available.

Standards and Regulations

Limitations on greenhouse gas emissions could also take the form of standards and regulations. These would have to be imposed on a wide array of consumer goods and energy consuming equipment, involving many government actions in which the tradeoffs among costs, emission reductions, and other product attributes would be contested. The resulting level of emissions would have to be consistent with the targets established by international agreement. Since total national greenhouse gas emissions would not be capped, such compliance would have to be projected based on an analysis of the impacts of the standards program. Such standards could include:

- *Direct limits on greenhouse gases:* Standards could specify allowable greenhouse gas emission levels per unit of output (or some other factor). For example, methane from some landfills is already controlled due to limits on emissions of volatile organic compounds.
- *Minimum energy efficiency standards for energy consuming equipment:* Historically, these have targeted appliances and other residential and commercial equipment, as well as personal transportation (i.e., the Corporate Average Fuel Economy (CAFE) program). DOE estimates that the federal appliance standards implemented to date will reduce carbon emissions by 14 million tons in the year 2000. Further development of standards could result in additional reductions, although recent bipartisan attacks on implementing new standards under the 1992 Energy Policy Act have stalled recent efforts to make progress in the appliance standards area.

Emissions of greenhouse gases from the transportation sector account for about one-third of total U.S. GHG emissions and are expected to grow by about 25% by 2010. The overall in-use fuel economy of the combined new light vehicle fleet (i.e., cars and light trucks such as minivans, sport utility vehicles, and pickup trucks) has begun to *decline*. In 1994, President Clinton convened a Federal Advisory Committee Policy Dialogue to assist in the development of measures to significantly reduce greenhouse gas emissions from personal motor vehicles ("CarTalk"). Although CarTalk ended without consensus among members of the Committee, the process did result in a number of proposed policies that could be pursued.

Other Policies Relevant to Emissions

In addition to the standards it sets, government indirectly affects the levels of greenhouse gas emissions through its policies towards transportation and energy market regulation. These also offer opportunities to generate reductions in greenhouse gas emissions. Most prominent among these are:

Electricity Restructuring: States are currently adopting retail competition for the electricity industry. This trend could be accelerated with federal legislation. Retail

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

- A “portfolio standard” for renewable energy or greenhouse gas emissions: This would require that all generators meet a specified level of renewable generation or greenhouse gas emission reduction either by undertaking such projects themselves or purchasing “credits” from others who have.
- A social benefit fund: Revenues from a charge on transmission service are used to subsidize energy efficiency projects, renewables, R&D, or low income consumers. California has adopted this approach.
- Information disclosure requirements: Generators could be required to disclose the emission profiles of their generation, facilitating the marketing of “green” electricity.
- Additional air pollutant requirements: Many states are hesitant to adopt retail competition because they perceive that differing regional environmental requirements put their electric industry at a competitive disadvantage and will result in more pollution being transported into their states. Thus, additional environmental provisions to “level the playing field” – which could include greenhouse gas emission reductions – are currently being debated.

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

- Congestion Mitigation and Air Quality Improvement Program: Additional funds could be targeted to transportation projects that reduce air emissions and energy consumption on a long-term sustainable basis.
- Brownfields Restoration: Successful redevelopment of brownfields can help revive inner city areas and reduce sprawl, thereby reducing vehicle miles traveled. More funds could be made available for these projects.
- Incentive Funds: A new \$500 million Fuel Efficiency Incentive Fund could be established to reward the ten states that are able to reduce fuel consumption, on a per capita basis, by the greatest amount over the next five years.

Emissions Trading

Emissions trading is a tool for meeting a total quantity limit on emissions. It involves allocating or auctioning emissions allowances, and allowing the trading of allowances in a market with sufficient mechanisms to ensure compliance with targeted levels. Since emission trading involves the creation of new, marketable assets that can have substantial value, addressing distributional issues will be an important component of program design. Allocation rules or auction revenues can be used to address these distributional issues.

Emission trading systems can offer both static and dynamic efficiency advantages over more traditional forms of regulation. The potential for static efficiency gains exists because emitters face different abatement costs. Emissions trading allows those with high abatement costs to purchase allowances from those whose costs are lower. Total costs would therefore be lower than through traditional regulations, which require all polluters to comply with a specific standard. However, it should be noted that such a program involves people and firms adjusting to higher energy prices.

Under traditional regulation, firms have little incentive to investigate ways of abating pollution by more than the minimum required to comply with regulatory requirements. Firms under-invest in pollution control R&D since they can capture neither the full market benefits from such spending (since others benefit from learning of their successes), nor the full value of any resulting environmental improvements. Here, trading offers efficiency gains because of the incentive to continuously improve pollution abatement technologies in order to create “surplus” allowances for sale.

Experience in the United States has shown that final compliance costs for the programs that have incorporated emissions trading have, in general, been lower than predicted – often dramatically lower. While emissions trading is not the sole cause of this phenomenon, it has contributed to lower abatement costs in the acid rain program, the phase-out of Chlorofluorocarbons (CFCs), the “criteria” air pollution program, and the phase-out of lead in gasoline.

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

A program would have to establish permit lifetimes, monitoring and enforcement provisions, as well as rules for permit banking, borrowing, and trading. Consideration should also be given to transaction costs, which should be kept as low as possible.

However, particularly difficult issues involve determining what types of activities require a permit and how permits should be allocated. The decision for the former should consider the following:

- *Coverage:* While it may not be necessary to ensure that every ton of greenhouse gas is accounted for within an emission trading regime, the scope of coverage of the trading program should be sufficient to ensure compliance with targets set in accordance with an international agreement.
- *Administrative and compliance feasibility:* The number of sources involved in the trading program should be small enough to be administratively feasible and large enough to ensure market competition. In addition, monitoring and verification of permit compliance must be possible for those included in the program.
- *Potential to Diffuse Low Greenhouse Gas Technologies:* Alternative points of intervention should be evaluated for their ability to provide incentives for research, development, adoption and diffusion of low greenhouse gas technologies.
- *Market Impacts:* Any program that limits emissions will affect the bottom line of firms. The permit program will have economic impacts that vary depending on program design. For example, exempting certain sizes or categories of sources from permit requirements because of administrative or equity concerns (e.g., small boilers or home heating oil) has competitive implications within the energy market.

Since virtually all of the carbon contained in fossil fuel extracted from the ground (with the possible exception of certain feedstocks) is eventually released to the atmosphere, a trading program need not focus uniquely on direct emitters, but can be implemented through other points in the energy market. These include fuel imports, fuel extraction, processing, refining, distribution, and secondary conversion (e.g., coal to electricity). In addition, these points could vary by sector. For example, an emission trading program could focus on the point of final combustion for coal, but on refining for oil, or distribution for natural gas.

In an emission trading system, some mechanism must be provided for allocating permits to sources. This could be done on the basis of baseline/historical emissions (where permits are given to those currently emitting) or through an auction (where revenues accrue to the government). These two mechanisms might also be combined: some portion of permits could be allocated on the basis of historical emissions while the rest are auctioned. In any case, the value of these assets could be large depending on the permit price, which is determined by the emissions target and the costs of substitutes. Given that an auction could produce substantial revenues, some decision would have to be made with respect to what to do with the proceeds.

Research and Development (R&D)

One of the key issues in developing a domestic climate change policy will be the emphasis placed on potentially expanding the Federal R&D effort into technologies that reduce future greenhouse gas emissions and/or lower the cost of achieving a given greenhouse gas reduction target. Achieving greenhouse gas emission reductions that would stabilize atmospheric concentrations at “safe” levels will require major advances in technology in virtually every sector of the economy. These goals will be difficult to achieve during a time of constrained federal spending and sharp reductions in long-term private sector R&D. Since 1978, federal investment in energy R&D has declined 75%. Investment by industry fell 33% from 1983 to 1993.

The President’s Fiscal Year 1998 budget requests an increase of \$200 to \$300 million in relevant R&D over the current level of approximately \$1.3 billion. Such an increase was rejected by Congress last year, and achieving it may require raising the issue to a higher level in budget negotiations. In the Fiscal Year 1999 budget and beyond, further increases will be needed, as will a more coordinated effort to target the R&D on the biggest opportunities for CO₂ mitigation.

Achieving greenhouse gas levels that are not harmful to humans or the environment will require major advances in technology as can be seen from the following equation:

$$\text{Emissions} = \text{Population} \times \text{Affluence (GDP/capita)} \times \text{Technology (Emissions/GDP)}$$

From 1990 to 2060, we may well see global population double and affluence increase by a factor of four. At the same time, the world may ultimately need to *lower* emissions from 1990 levels, requiring the average emissions-related technology to improve by more than a factor of ten during the next few decades and be rapidly deployed throughout the world. The benefits could be enormous, in part because of these technologies serve a number of other national goals, including reducing the emission of the criteria air pollutants and decreasing dependence on foreign oil.

Because of the high risk nature of R&D, a number of pathways could be pursued simultaneously:

Clean Power

- The next generation of natural gas technologies, including gas turbines and fuel cells, could achieve energy conversion efficiencies of 70% or more by 2005.
- The next generation of high efficiency coal-fueled power plants, such as integrated gasification combined cycle perhaps combined with a fuel cell, could achieve efficiency exceeding 55%, with half the CO₂ emission of current plants.

- Renewable technologies—wind power, photovoltaics, biomass power, solar thermal, and geothermal—have seen sharp cost reductions in the past two decades, some by a factor of ten. Further R&D, coupled with expanded deployment to achieve economies of scale and improvements in manufacturing, would likely make one of more these technologies competitive with fossil fuels in a large number of areas in the next two decades.
- Nuclear fission and fusion remain options that could benefit from further R&D, though these raise significant environmental issues regarding waste handling and disposal.

Energy Efficiency

Transportation

The Partnership for a New Generation of Vehicles (PNGV) is a public-private partnership to design and build a triple-efficiency clean car by 2004. Multiple technology paths are being pursued to build a hybrid vehicle that has both an advanced engine (such as a clean diesel, Stirling or gas turbine) and an energy storage device (such as a battery, fly-wheel or ultracapacitor). Supporting R&D includes lightweight, super-strong materials such as composites; high-temperature ceramics; regenerative braking; and advanced power electronics. Proton-exchange membrane (PEM) fuel cells have perhaps the greatest long-term potential for reducing transportation CO₂.

Biofuels also lower transportation CO₂. Continued R&D in bio-engineered organisms and fast-growing crops is expected to produce ethanol from waste paper, crop waste, and dedicated crops for under 70 cents a gallon by 2005, competitive with oil at \$25 a barrel.

Industry

The seven most energy-intensive industries—steel, aluminum, petroleum refining, chemicals, pulp and paper products, glass, and metal casting—account for about 80% of the energy consumed in U.S. manufacturing and more than 90% of the hazardous waste. They represent the largest opportunity for reducing industrial CO₂ emissions, and the Energy Department is partnering with them because they significantly underinvest in R&D compared to the industry average. Key areas that would benefit from expanded R&D include advanced materials development; separation technology; catalysis; bioprocessing, biocatalysis, and renewable feedstocks; sensors and controls; and industrial cogeneration of electricity and heat, which can achieve overall efficiencies of more than 80% and ultimately utilize biomass.

Buildings

The buildings sector consumes one-third of the nation's energy and two-thirds of its electricity. Key near-term R&D opportunities include improvements in lighting, windows, design software, high-efficiency appliances, gas heat pumps, insulation and duct systems,

cooling including gas cooling, solar heating and cooling, daylighting, and urban heat island mitigation (reflective roofing and road materials). Longer term R&D needs include electrochromic glazings for windows, building-integrated PV systems, and PEM fuel cells.

Capture and Sequestration

If major reductions in CO₂ emissions are necessary, and global reliance on fossil fuels continues beyond the middle of the next century, then some form of CO₂ sequestration (i.e. capture and disposal) will be needed. A long-term R&D strategy would include demonstration of a number of sequestration options and research into their possible environmental impacts; converting CO₂ into industrial chemical feedstocks; selectively permeable membranes for CO₂ capture; processes for converting fossil fuels and biomass into CO₂ and hydrogen; development of hydrogen infrastructure technology, including transportation and storage; and PEM fuel cells. Capture and sequestration has received only limited funding to date.

Advanced Research

A number of areas of advanced research could prove crucial to responding to climate change, including photosynthetic mechanisms, biotechnology, fermentation microbiology, combustion research, polymer and ceramic science, process engineering, supercritical CO₂, new materials synthesis, and nanotechnology. One essential area for expanded basic and applied R&D is superconductivity, which offers the possibility of nearly loss-less energy storage and transmission and of highly efficient superconducting motors.

Conclusion

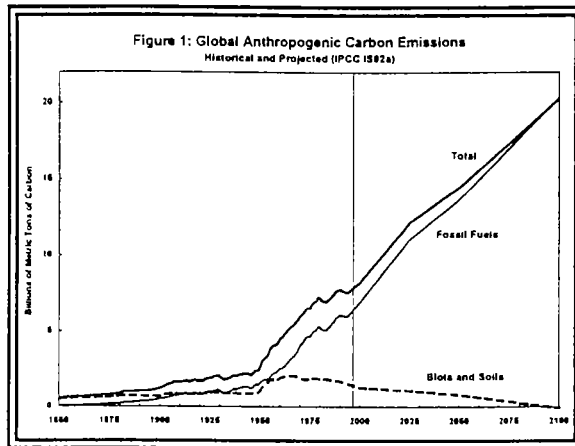
A number of mitigation options exist for controlling greenhouse gas emissions. These can be organized in three general categories. First, greater efforts could be made to diffuse underutilized energy efficiency technologies. This could be accomplished through programs, such as those in the Climate Change Action Plan, to address lack of information and other market barriers. Second, new government interventions, either in the form of emissions trading and/or expanded regulatory programs, could be used to limit greenhouse gas emissions. Finally, additional incentives could be provided for (both government and private) research and development, since stabilization of atmospheric concentrations of greenhouse gases can only be accomplished if new non-fossil technologies are available and adopted.

Attachment 1: Global Trends in Emissions and Concentrations

Growing emissions of greenhouse gases (GHGs) from industrial activity and land-use changes are rapidly raising the concentrations of these gases in the atmosphere, making some degree of climate change virtually certain. Although greenhouse gases come from many sources, carbon dioxide (CO₂) from fossil fuel use is the source of

greatest concern because of its rapid historical and projected growth.¹

Atmospheric carbon concentrations are already over 30% higher than their pre-industrial levels and rising at about 4% per decade. The further potential for human activities to disrupt the natural balance is enormous because hundreds of years' worth of carbon (at current rates of use) are currently available in proved fossil fuel reserves that could be exploited under current economic and technological conditions – and even

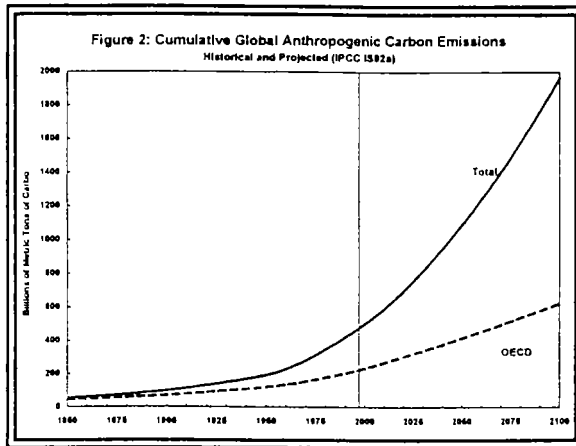


larger “ultimately recoverable” reserves. In the absence of controls, emissions are projected to grow quickly as the developing countries experience rapid population growth and industrial development. These trends are expected to lead to ongoing atmospheric accumulation and climate change into the indefinite future, with a doubling of atmospheric carbon concentrations sometime during the second half of the next century and a resulting long-run increase in average global temperatures by an estimated 1.5° to 4.5°C. Even stabilizing global emissions at 1990 levels *permanently* will lead to a near doubling of atmospheric carbon concentrations by the end of the next century.

Climate change is truly a global problem in the sense that emissions from anywhere will affect everyone everywhere. As a consequence, concerted international action will be needed to induce all countries to cooperate in reducing emissions. Nevertheless, cooperation will be hampered by the uneven distribution of past and future emissions. Simply put, the developed industrial nations have relatively high levels of per capita emissions and are largely responsible for past emissions, while the developing nations, whose per capita emissions are currently very low, will be responsible for the

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

bulk of emissions in the future.² Since the developed countries have enjoyed high levels of emissions now and bear the greatest responsibility for current atmospheric concentrations, the developing countries have been reluctant to undertake any emissions reductions at all in the absence of significant emission controls on the part of the developed countries.



Yet, actions taken by the developed countries alone are likely to have little effect on cumulative global emissions or on atmospheric concentrations. Based on the projections shown in Figures 1 and 2, stabilization of Annex I country³ emissions at 1990 levels from 2000 through 2100 would reduce cumulative carbon emissions by around 8%, and would reduce atmospheric CO₂ concentrations in 2100 by less than 5%. In other words, Annex I emissions stabilization will still lead to

well more than a doubling of atmospheric CO₂ concentrations by 2100. Even stabilizing total global emissions – which, given anticipated population growth, would require dramatic reductions in global per capita emissions – will not lead to stabilized concentrations. *Stabilization of concentrations requires global emissions to fall well below current levels, and ultimately to decline to near zero.*

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

Researchers have examined in some detail the annual emissions paths required to meet atmospheric carbon concentration targets of 450 to 750 ppm.⁴ As shown in Table 1, all of these targets require significant reductions in cumulative

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

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

³ The OECD nations plus the former Soviet Bloc.

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

projected global carbon emissions; and as shown in Figures 3 and 4, all of them require dramatic reductions in annual emissions rates sometime during the next century. To achieve a 450 ppm target – which still represents a two-thirds increase in atmospheric

Figure 3: Alternative Atmospheric Concentration Pathways

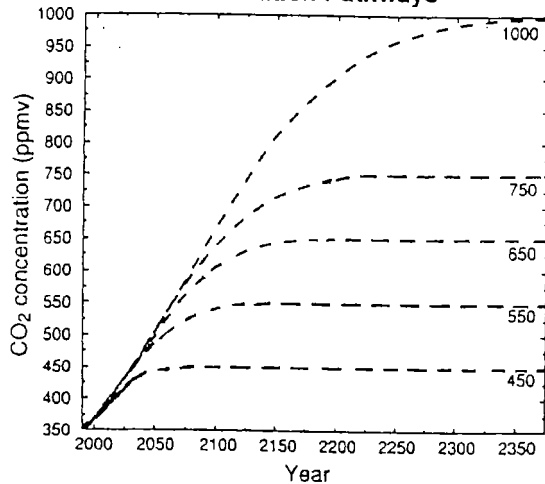
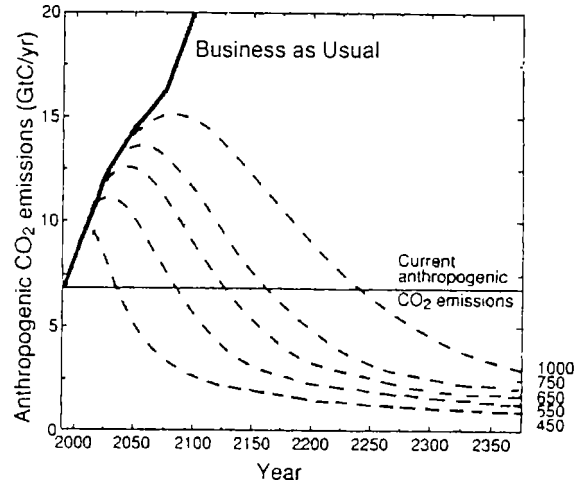


Figure 4: Emission Scenarios to Meet Alternative Atmospheric Concentrations



concentrations over preindustrial levels – annual emissions must begin declining steeply within the next quarter-century and must fall to less than half the current rate by 2100. To achieve a 550 ppm concentration target – which represents more than a doubling in atmospheric concentrations – annual emissions must begin declining steeply during the second quarter of the century. Furthermore, these budgets must be distributed both across countries and across time. And while emissions can increase in the near term, higher growth in emissions in the near term must be offset by increasingly dramatic reductions later on.

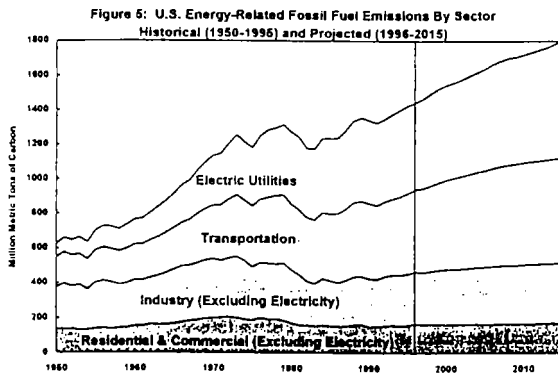
Attachment 2: U.S. Emission Trends

In 1995, gross greenhouse gas emissions in the U.S. were about 1,674 MMTCe (million metric tons of carbon equivalent), of which more than 85% were carbon emissions from fossil fuel combustion. Methane emissions (mainly from landfills and agricultural activities) accounted for 11%, nitrous oxides 2% and various halocarbons 2%. These emissions were offset by roughly 100 MMTCe of carbon sequestered by the nation's forests. U.S. greenhouse gas emissions have risen nearly 7% in the past five years.

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

The electric utility sector's share has grown from 12% in 1950 to 35% in 1996 (500 MMTC), as the American economy has steadily increased its use of electricity. Over 85% of electric utility sector carbon emissions come from burning coal. Similarly, the transportation sector's share of fossil-related carbon emissions has grown from 28% in 1950 to 33% in 1996 (470 MMTC),

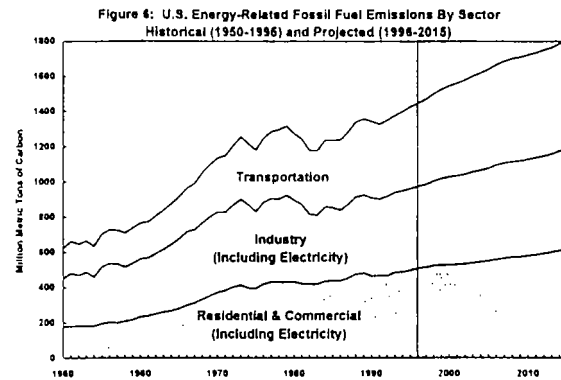
with oil accounting for practically all of the fuel use in the transportation sector. Thus, the transportation and utility sectors together currently account for 68% of U.S. fossil-related carbon emissions.



In contrast, carbon emissions from the residential and commercial sectors' direct energy use have fallen from 22% of the total in 1950 to 12% in 1996; while emissions from industrial direct energy use

have fallen from 38% to 20%. However, if electricity-related carbon emissions are attributed to the sectors that consume the electricity (rather than to the utility sector which produces it), the residential and commercial sectors' share has risen from 28% in 1950 to 35% in 1996. In contrast, the industrial sector's share has fallen from 44% in 1950 to 32% in 1996, as industry's share of economic activity has declined and services' share has risen.

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



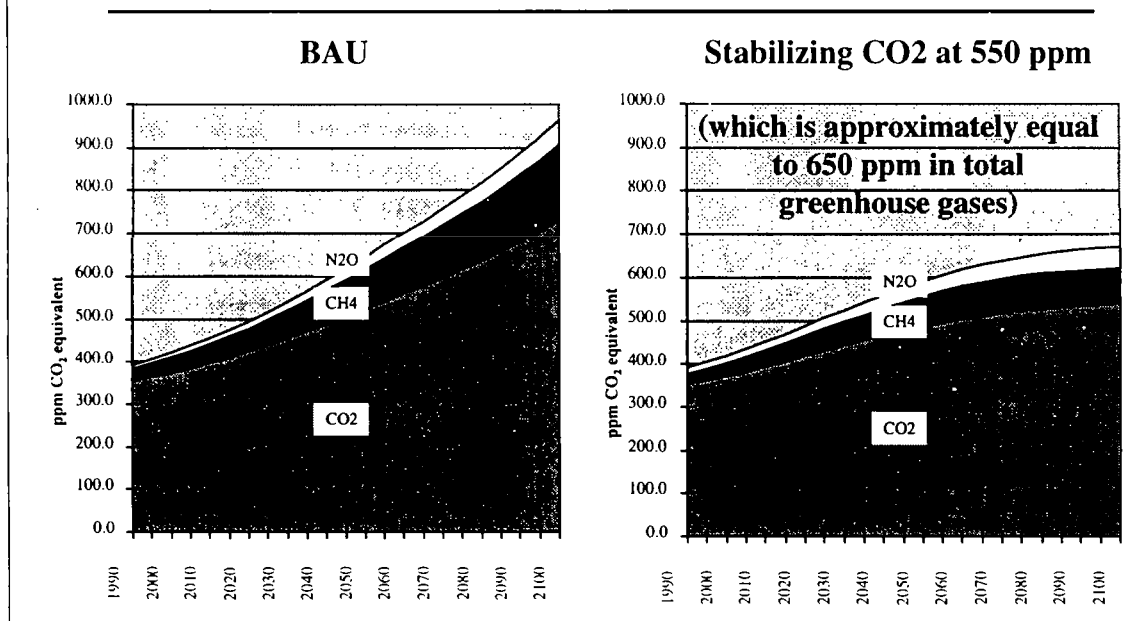
KEY POINT #1:

Impacts expected in a doubled-CO₂ world:

- There will be significant changes in water resources including runoff and frequency and intensity of floods and droughts. In the United States, the Great Basin, California, Missouri, Arkansas, Texas Gulf, Rio Grande, and Lower Colorado are likely to be most vulnerable.
- One-third of the Earth's forests could undergo a major change in vegetation: the Northeast United States will likely lose beech trees and sugar maples. Western conifer forests will decrease in area.
- A sea level rise of 20 inches is expected over the next century. In the United States, this could inundate more than 5000 square miles of dry land and an additional 4000 square miles of wetlands. The Atlantic and Gulf Coasts are particularly vulnerable.
- There will be significant shifts in the ideal range for many agricultural crops. Food scarcity may increase, especially in the tropics and sub-tropics.
- Heat-related mortality and illness will increase. Reduced air quality will exacerbate respiratory disease, asthma, and allergic disorders.
- Geographic ranges for disease will expand, leading to an increase in diseases such as malaria, dengue and yellow fever. 50-80 million additional cases of malaria per year are projected worldwide.

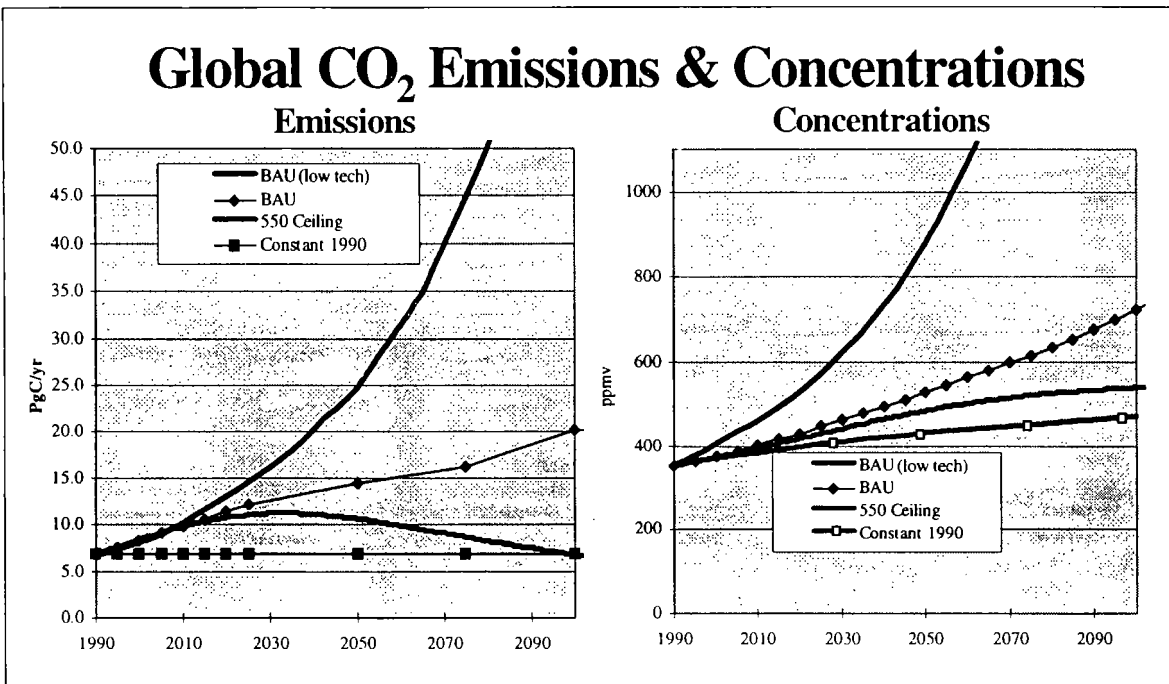
KEY POINT #2:

Non-CO₂ Greenhouse Gases Make the “Effective” Atmospheric Concentration Higher.



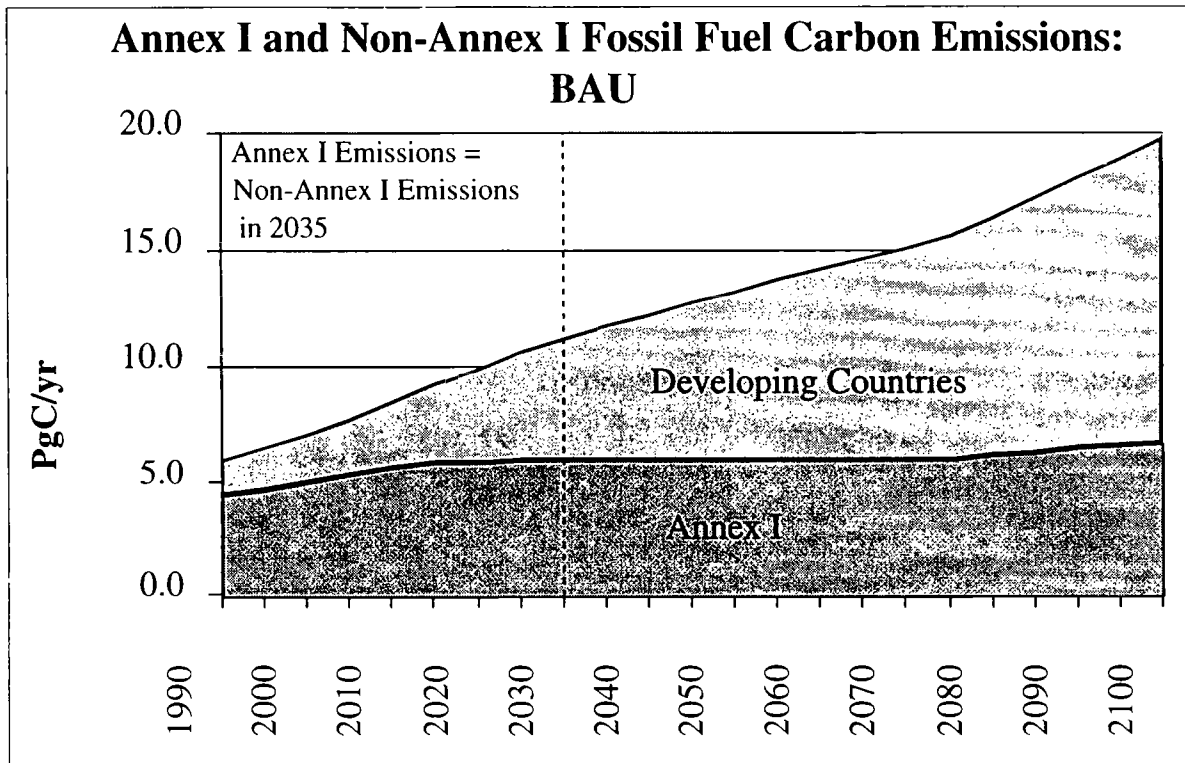
- Other greenhouse gases, principally methane and nitrous oxides, make the “effective” atmospheric concentrations about 20% higher than carbon dioxide alone.
- 550 ppm is about two times pre-industrial carbon dioxide (CO₂)

KEY POINT #3:



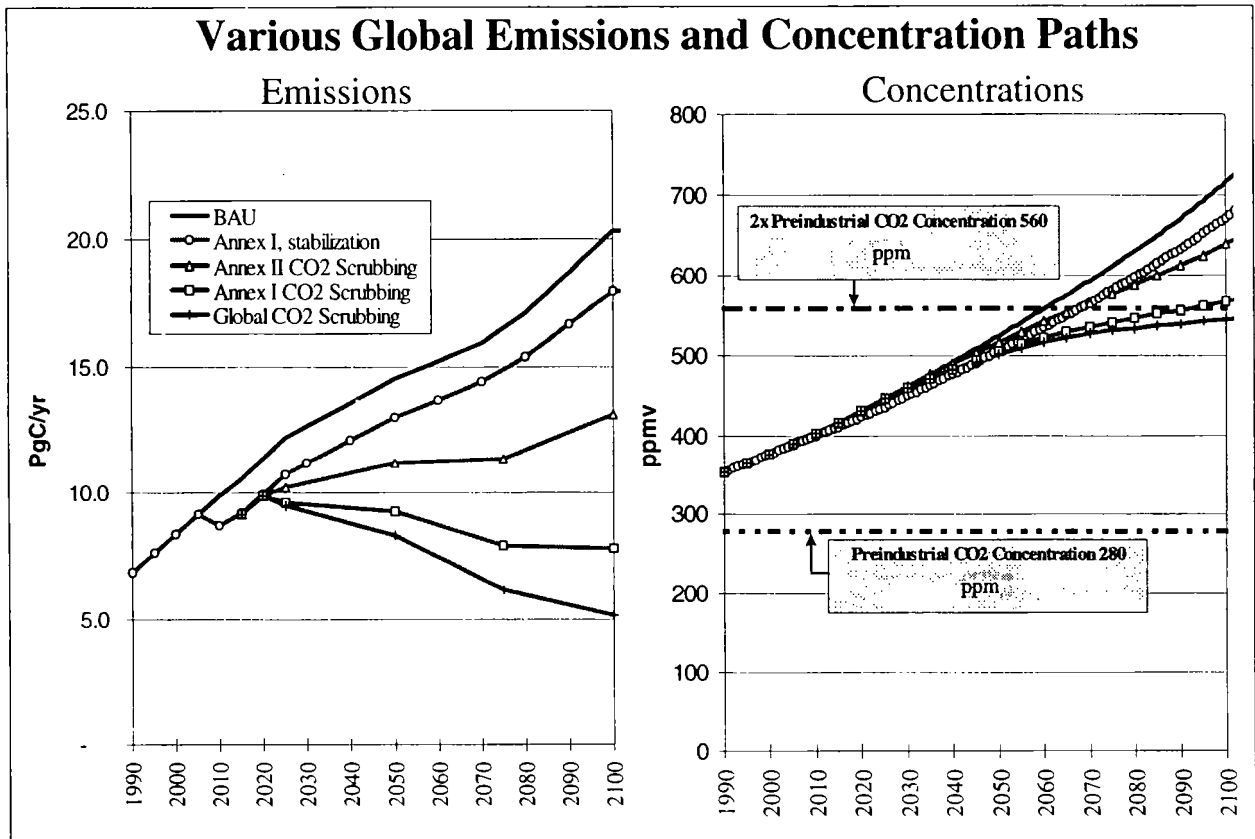
- If we continue on a Business-As-Usual (BAU) path (top 2 lines in above figures), concentrations will double over the next few decades, never achieving stabilization.
- Stabilizing emissions will not stabilize concentrations.

KEY POINT #4:



- A Business-As-Usual path implies that over time the majority of emissions will shift from developed to developing nations.

KEY POINT #5:



- Actions by Annex I alone are insufficient to achieve stabilization
- In order to cap emissions at just under a doubling of pre-industrial CO₂ levels, actions by Annex I countries need to be coupled with actions by non-Annex I countries in the next few decades.

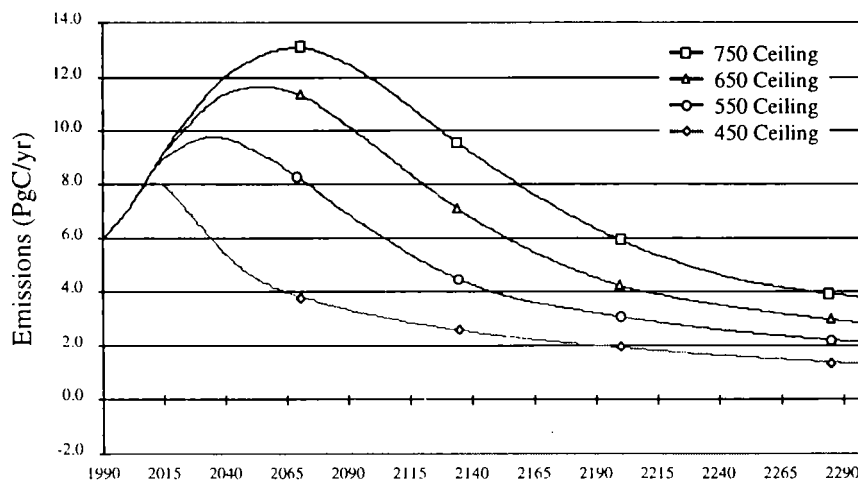
KEY POINT #6:

Energy emission pathways and stabilization concentrations

Steady-State Concentration →	450 ppm	550 ppm	650 ppm	750 ppm
Deflection Date BAU ^a	2007	2013	2018	2023
Maximum Emission Date	2011	2033	2049	2062
Maximum Emission ^b	8.0	9.7	11.4	12.5

^a The deflection date is the year in which emissions in the emissions stabilization trajectory first fall below BAU emissions by more than 0.1 PgC/yr.

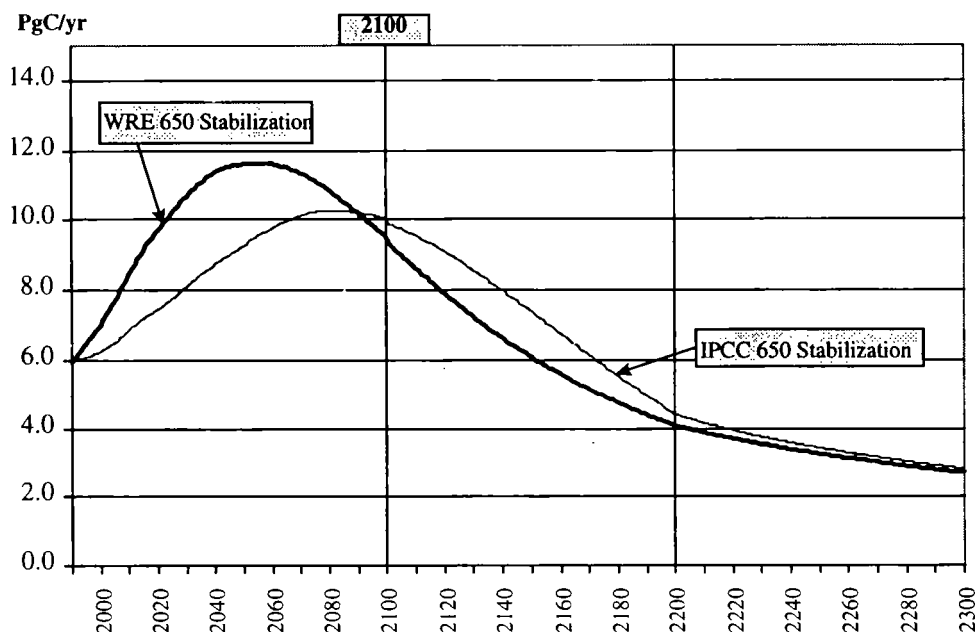
^b Maximum PgC/yr fossil fuel carbon emissions. If other greenhouse gases are included, emissions would be effectively 20% higher; thus, reductions would have to occur sooner than the deflection date noted to achieve a given concentration.



- To meet atmospheric concentrations of 450-750 ppm CO₂ requires a significant reduction in annual emissions during the next century.
- For example, to meet a target of 550 ppm CO₂, the table shows that global CO₂ emissions due to fossil fuel burning must begin to deflect from the business-as-usual curve by 2013. In that scenario, energy-related emissions would peak at 9.7 PgC/yr in 2033 and drop rapidly thereafter. (Because of the other greenhouse gases, the effective concentration would be about 650 ppm.)

KEY POINT #7:

Fossil Fuel CO₂ Emissions for Two 650 ppm Stabilization Cases--



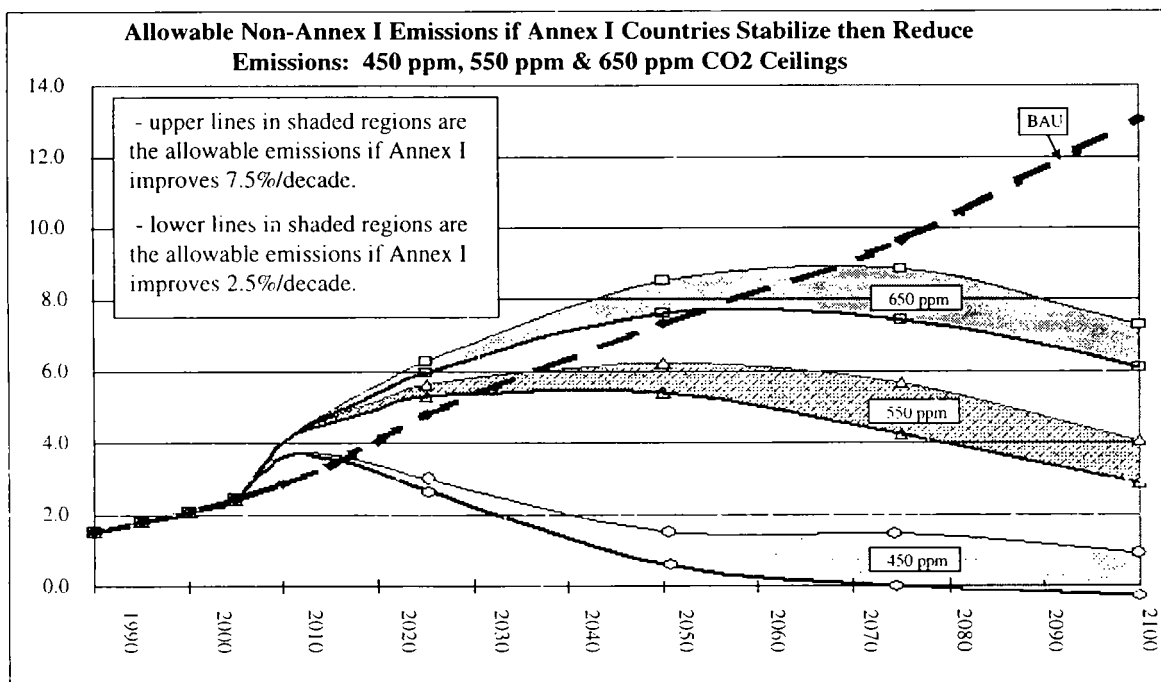
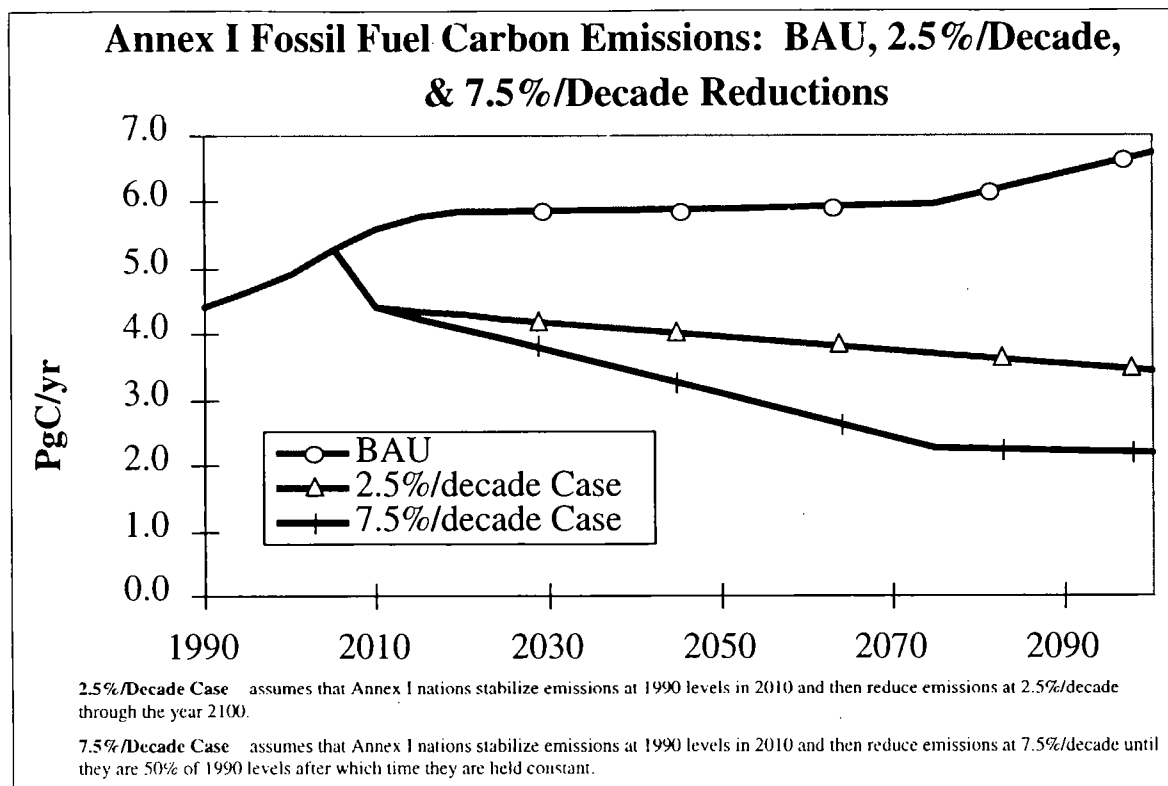
WRE-TRAJECTORY	
Global Deflection Date BAU (Tech+) *	2018
Non-Annex I Deflection Date BAU (Tech+) *	2055
Maximum Global Fossil Fuel Emission Date	2049
Maximum Global Fossil Fuel Emission ^b	11.4
Maximum Non-Annex I Fossil Fuel Emission Date	2060
Maximum Non-Annex I Fossil Fuel Emission ^b	7.7
S SERIES TRAJECTORY	
Global Deflection Date BAU (Tech+) *	1991
Non-Annex I Deflection Date BAU (Tech+) *	1991
Maximum Global Fossil Fuel Emission Date	2081
Maximum Global Fossil Fuel Emission ^b	10.3
Maximum Non-Annex I Fossil Fuel Emission Date	2090
Maximum Non-Annex I Fossil Fuel Emission ^b	6.7

* The deflection date is the year in which emissions in the stabilization trajectory first fall below BAU emissions by more than 0.1 PgC/yr.

^b PgC/yr fossil fuel carbon emissions on the date of maximum total anthropogenic carbon emissions.

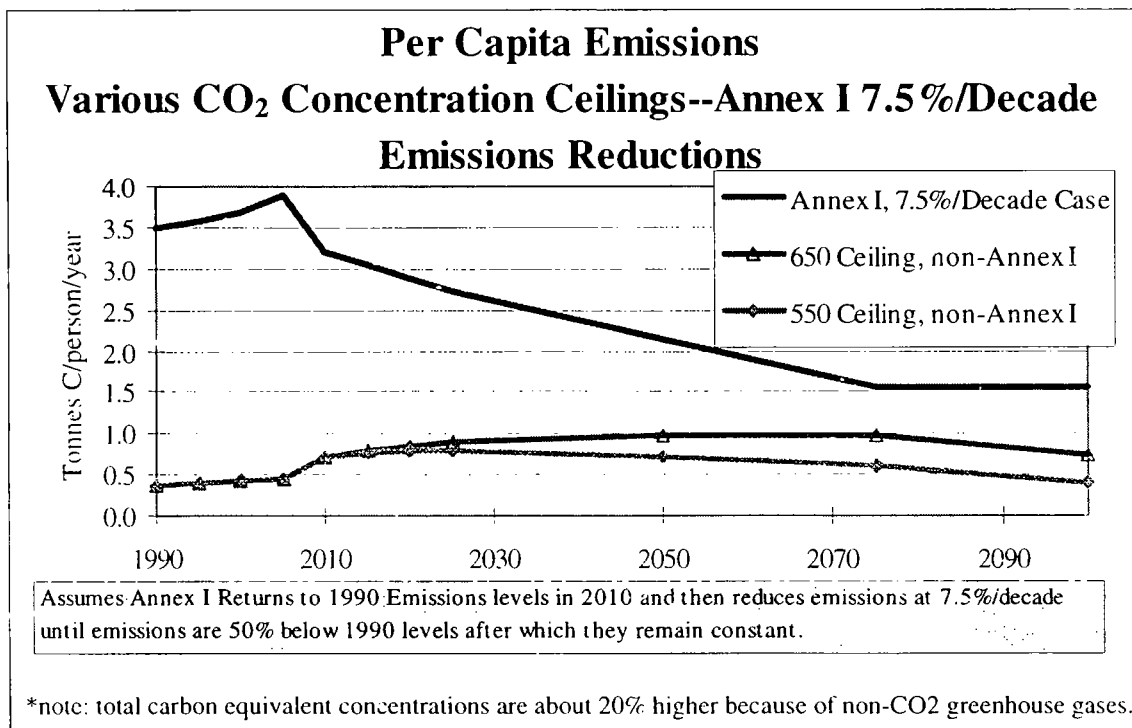
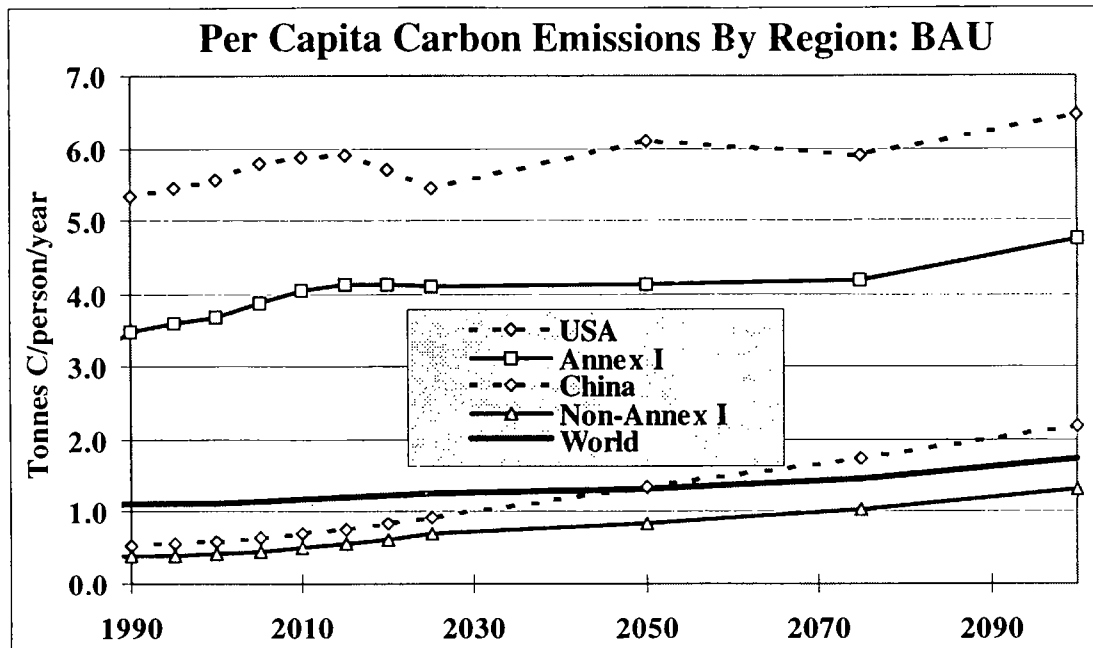
- These 2 curves show two different paths to achieve stabilization at CO₂ emissions of 650 ppm. The WRE line – estimated to be less expensive – allows emissions to initially grow and then drop more steeply as new technologies come online. For example, the developing countries could emit 150 billion tons more carbon under the WRE scenario.

KEY POINT #8:



- If Annex I countries freeze emissions in 2010 and then reduce steadily (upper chart), developing countries can continue on business-as-usual paths for some time before reducing emissions (lower chart).

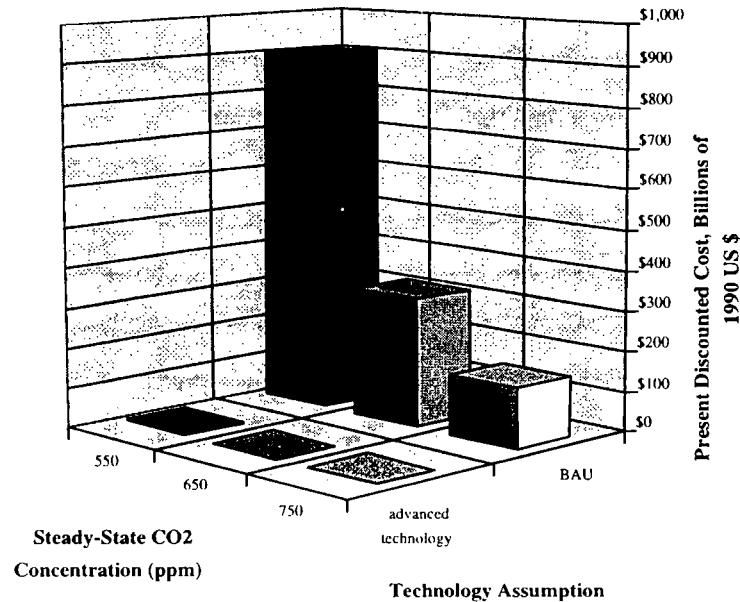
KEY POINT #9:



- Although they remain widely disparate, per capita emissions of Annex I and non-Annex I countries begin to converge over time. The top figure shows Business As Usual per capita emissions. The lower figure shows per capita emissions under one policy scenario.

KEY POINT #10:

The Relationship Between Technology and Minimum Cost of Stabilizing the Atmosphere Below Various Ceilings



- If a functional, cost-effective cap and trade system is in place, investments in technology can greatly reduce global costs.

THE WHITE HOUSE
WASHINGTON

February 20, 1997

MEMORANDUM FOR DISTRIBUTION

FROM: ELGIE HOLSTEIN
DAVID SANDALOW

SUBJECT: Climate Change

There will be a meeting tomorrow, Friday, February 21 from 1:00-2:30 in OEOD Room 231. We will start promptly at 1:00.

The agenda is:

1. Next Steps on Economic Analysis
2. Next Steps on Domestic Policy Development
3. Hill Modeling Briefing
4. Concentrations/Emissions Paper

Everyone on the attached list has been cleared into the building. If you have questions concerning clearance, please call Wendy Philleo (456-6224).

From

Jay S

*

Attached is the paper for #4
(ROBINA's paper). ~~the~~ ROSINA, Steve Siedel,
and I had a meeting where I asked
for and wrote up points that summarized
the key ideas in the paper. The idea
was to put the key points on page 1 for
the deputies. I thought we understood each
other but that is not how it turned out.

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

Most discussions have focused on what steps might be taken in the medium term (2010-2020) to reduce emissions of greenhouse gases. Such actions represent only an initial step and, by themselves, would fall far short of significantly reducing the risks of climate change. Much more long-term planning will be necessary to achieve the goal of the Framework Convention on Climate Change:

“stabilization of greenhouse gas concentrations . . . at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should . . . allow ecosystems to adapt naturally to climate change; ensure that food production is not threatened; and enable economic development to proceed in a sustainable matter.”

This paper describes emissions paths that would be necessary to achieve various longer-term goals of stabilizing atmospheric concentrations of greenhouse gases. It also explores the implications that a longer term goal has for shaping near-term policy decisions.

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

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

I. GLOBAL EMISSIONS AND ATMOSPHERIC CONCENTRATIONS

In the absence of any actions specifically to limit carbon dioxide emissions, the Intergovernmental Panel on Climate Change (IPCC), as shown in Figure 1, estimated that current emissions (as shown by the 2 upper lines labeled Business as Usual [BAU]) of 6 billion tons of carbon per year could grow to between 15-25 billion tons of carbon by 2050 and continue to

increase through the end of the next century.

Global CO₂ Emissions & Concentrations

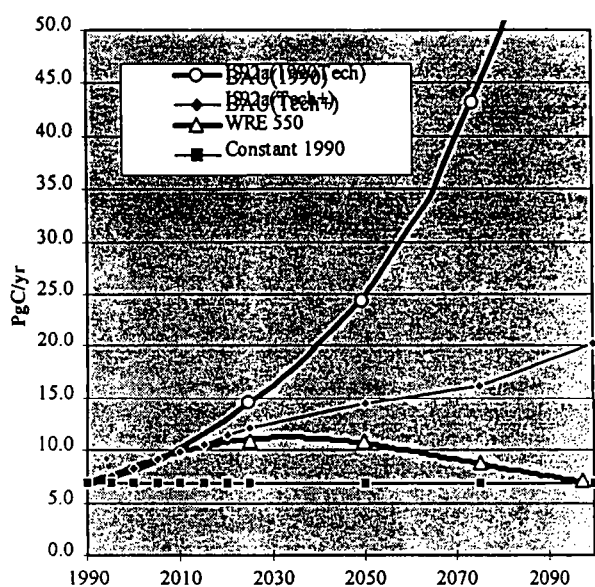


Figure 1

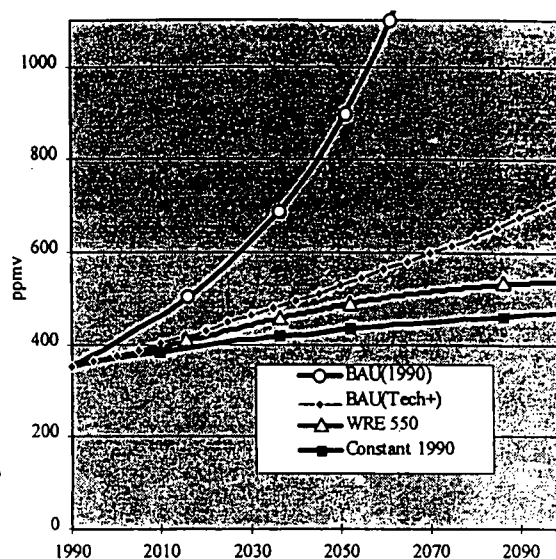


Figure 2

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

If it were possible to cap global emissions in both developed and developing countries at 1990 levels, figure 2 (line labeled "constant 1990") shows that concentrations would nonetheless continue to rise throughout the next century and beyond, eventually exceeding a doubling of preindustrial levels. (Note that the other greenhouse gases make the effective concentration about 20% higher than indicated by CO₂ alone.)

Figure 3 shows the projected long-term atmospheric concentrations if emissions were stabilized at different levels. The figure shows that if emissions were stabilized at current levels (6 PgC/yr), atmospheric concentrations would grow to almost 500 ppm by 2100 and continue increasing thereafter. It also shows that if worldwide emissions are frozen at 10 PgC/yr, roughly 33 percent higher than today's level, then atmospheric concentrations would more than double from pre-industrial levels by 2100, and continue to increase thereafter.

CO2 Concentrations Associated with BAU(Tech+) and Alternative Energy Related Emissions Stabilization Levels

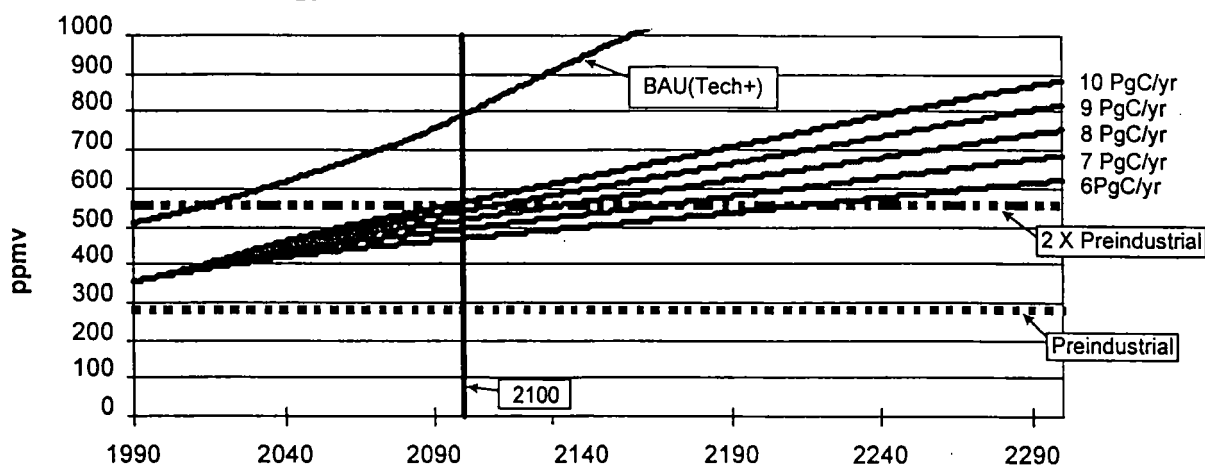


Figure 3

Table 1 shows how various concentration targets relate to emissions pathways. For example, to meet a 550 ppmv concentration goal, global emissions must begin to deflect from the business-as-usual curve by 2013. In this scenario, emissions would peak at 9.7 PgC/yr in 2033 and drop rapidly thereafter.

Researchers have examined in some detail the annual emissions paths required to meet atmospheric carbon concentration targets of 450 to 750 ppm. These targets require significant reductions in cumulative projected global carbon emissions; and as shown in Figure 3, all of them require dramatic reductions in annual emissions rates sometime during the next century. To achieve 450 ppm target – which still represents a two-thirds increase in atmospheric concentrations over preindustrial levels – annual emissions must begin declining steeply within the next quarter-century and must fall to less than half the current rate by 2100. To achieve a 550 ppm concentration target – which represents about a doubling in atmospheric concentrations – annual emissions must begin declining steeply during the second quarter of the century. Furthermore, these budgets must be distributed both across countries and across time.

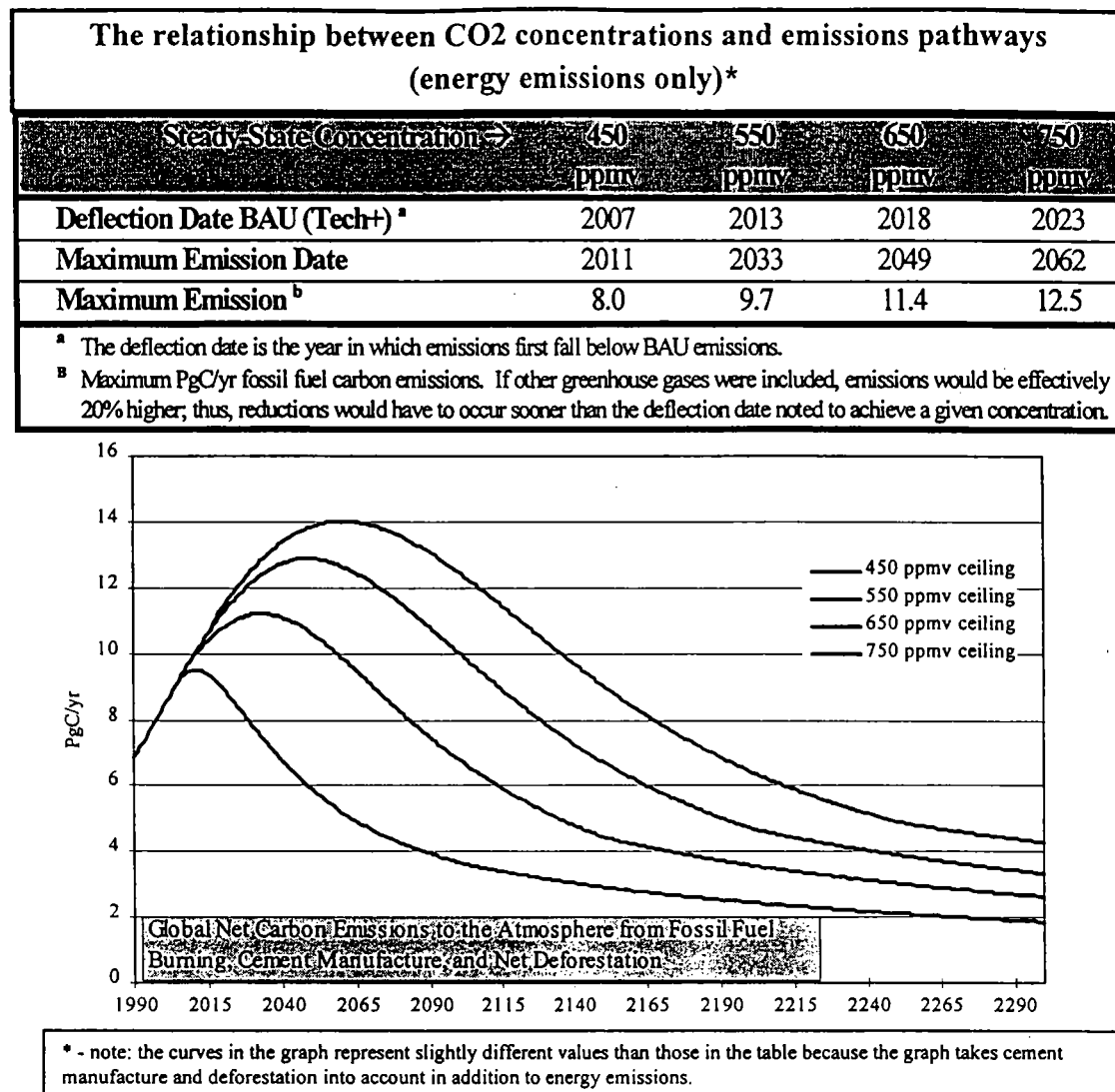


Figure 4

II. DEVELOPED AND DEVELOPING COUNTRY EMISSION TRENDS

Figure 5 presents current and projected emissions of carbon dioxide for developed and developing countries. Of the current emissions of roughly 6 billion tons, approximately two-thirds are from developed and one-third from developing countries. The U.S. is currently the largest emitter of carbon dioxide, with China the second largest source. However, on a per capita basis, the U.S. emits about 5 tons of carbon per capita, compared to an average of approximately 4 tons per capita in Japan and Western Europe, and 0.4 tons per capita for developing countries. Figure 6 shows per capita emissions for the BAU case out to 2100. While per capita differences remain large over time, by the middle of the next century, developing countries would become a source for more than half of total global emissions.

Annex I and Non-Annex I Fossil Fuel Carbon Emissions: BAU(Tech+)

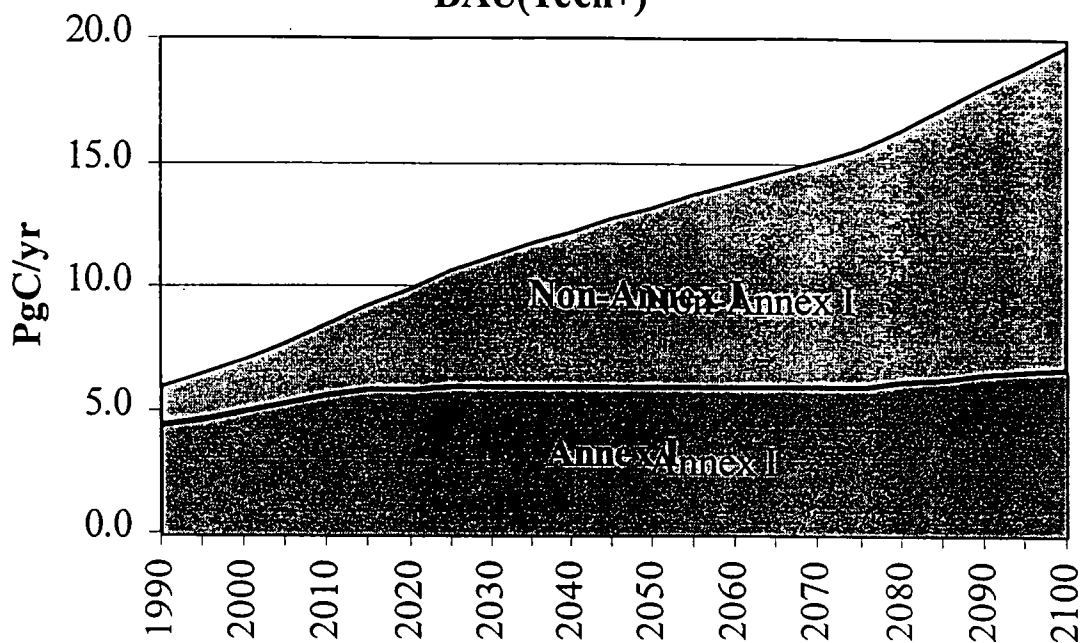


Figure 5

Per Capita Carbon Emissions By Region: BAU(Tech+)

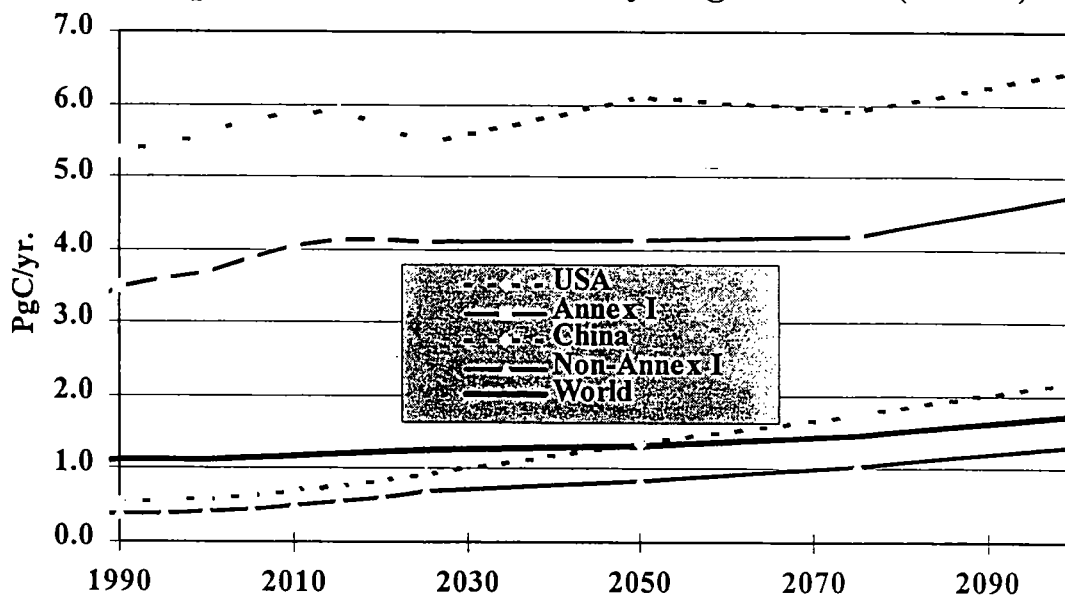


Figure 6

III. ILLUSTRATIVE EMISSION REDUCTION SCENARIOS

Limited mid-term actions to reduce emissions by developed countries alone have little impact on shifting the atmospheric concentrations curve. The top line in Figure 7 shows the small change

in concentrations if Annex I (developed countries) freeze emissions at 1990 levels in the year 2010. Successive lines show what a coal ban in various parts of the world (beginning in 2020) might do to emissions and concentrations. Without the participation of developing countries, concentrations will not stabilize.

Global Paths for BAU(Tech+), Annex I Emissions Stabilization, Coal Bans

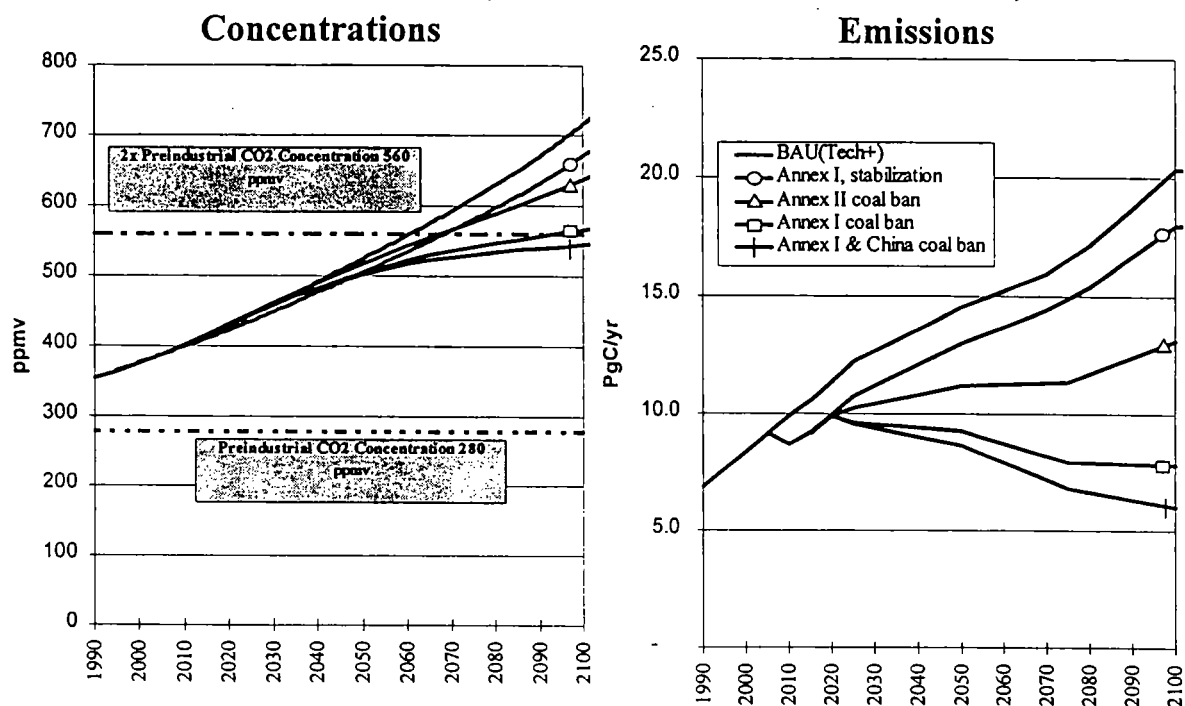
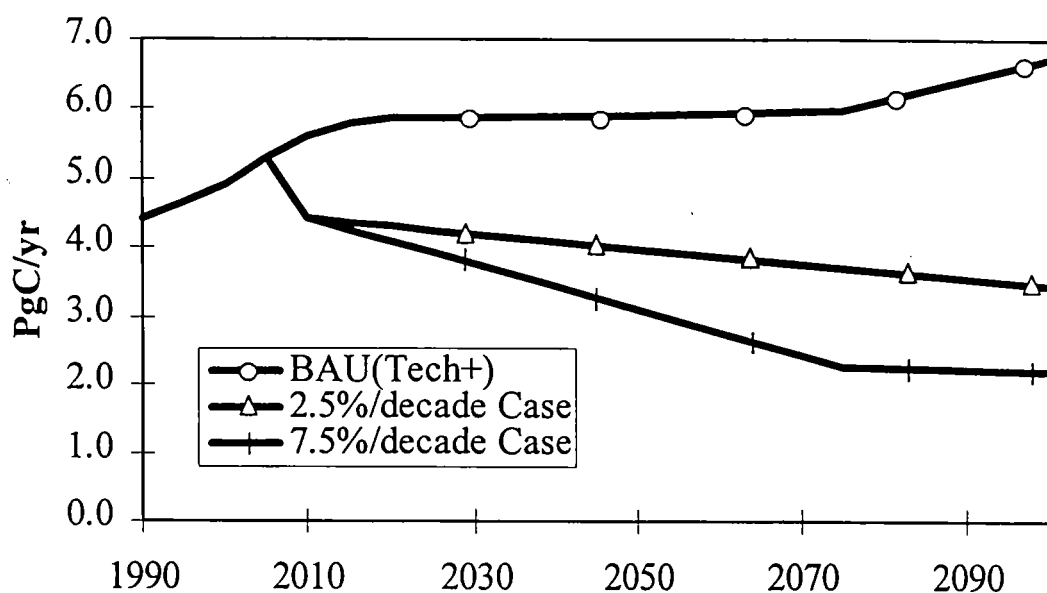


Figure 7

Annex I Fossil Fuel Carbon Emissions: BAU(Tech+), and 2.5%/Decade, & 7.5%/Decade Reductions



2.5%/Decade Case assumes that Annex I nations stabilize emissions at 1990 levels in 2010 and then reduce emissions at 2.5%/decade through the year 2100.

7.5%/Decade Case assumes that Annex I nations stabilize emissions at 1990 levels in 2010 and then reduce emissions at 7.5%/decade until they are 50% of 1990 levels after which time they are held constant.

Figure 8

Figure 8 illustrates two possible emissions profiles for developed (Annex I) countries. Both scenarios assume a freeze in emissions at 1990 levels in 2010. On the hatched line, emissions are then reduced by 2.5% per decade and in the lower line they are reduced at 7.5% per decade. The highest line is the business-as-usual (TECH+) scenario from the IPCC.

Figure 9 is based on the Annex I pathways described in Figure 6. They show the pathway developing countries would need to follow to stabilize concentrations at 450 ppm, 550 ppm and 650 ppm. These figures show that to achieve stabilization at 550, developing countries would be able to emit on their currently projected path until about 2020 before significant reductions would be required.

Figures 10 and 11 show the **per capita** emissions for both developed and developing countries that result from the scenarios described in the previous two figures. They show that under these scenarios, developed country emissions stay substantially greater than those in developing countries (which rise to 1 TC/person only in the 650 ppm case).

Allowable Non-Annex I Emissions if Annex I Countries Stabilize then Reduce Emissions: 450 ppmv, 550 ppmv & 650 ppmv CO₂ Ceilings

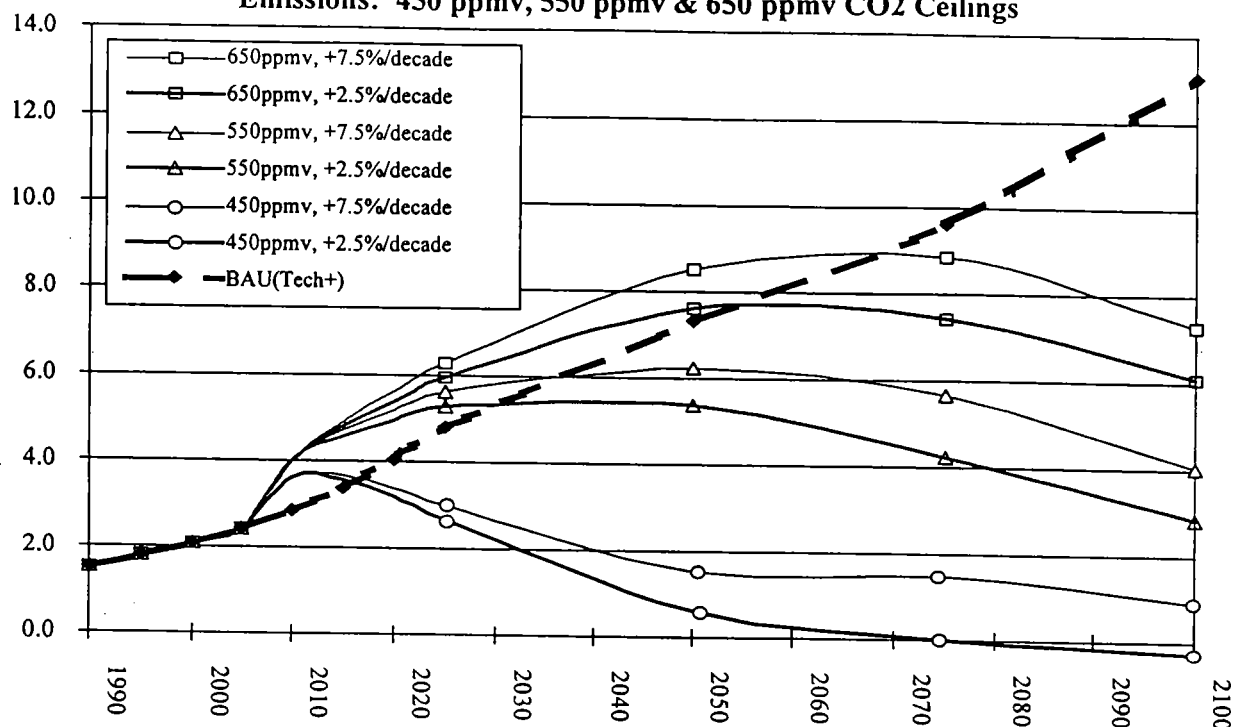


Figure 9

Per Capita Emissions Various CO₂ Concentration Ceilings--Annex I 2.5%/Decade Emissions Reductions

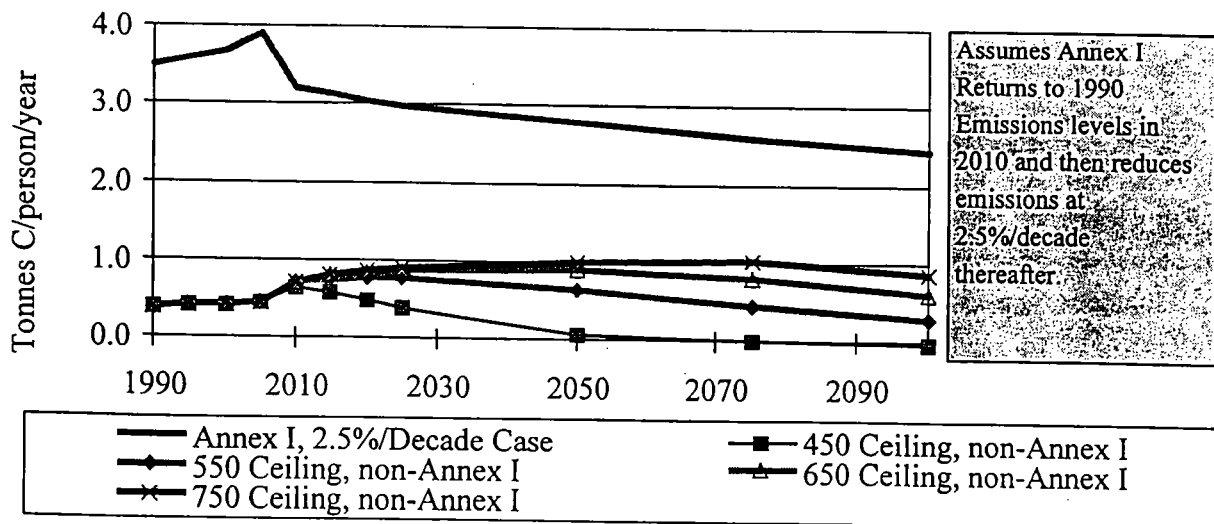


Figure 10

Per Capita Emissions Various CO2 Concentration Ceilings--Annex I 7.5%/Decade Emissions Reductions

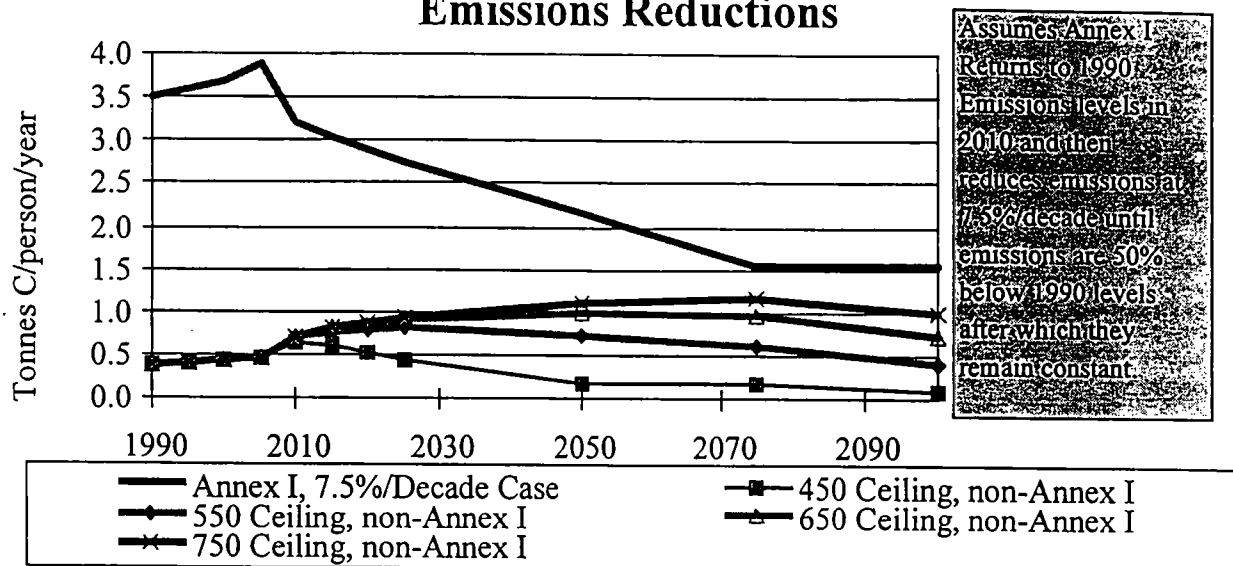


Figure 11

IV. THE ROLE OF TECHNOLOGY AND IMPACTS ON COSTS

As suggested in Figure 1, the rate of technological change can play a very important role in determining the level at which atmospheric concentrations can be stabilized. Figure 11 looks specifically at the costs associated with different technology cases. It looks at three specific cases:

- 1990 tech: assumes no technological change from 1990
- 1990 tech +: assumes significant improvements in reducing the costs of alternative fuels and in improving efficiency;
- Advanced tech: assumes even further advances and cost savings.

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

Figure 11 shows for each of these technology cases, the total costs associated with achieving three different levels of atmospheric concentrations: 550, 650 and 750 ppm. The estimated costs under the assumption that no technological progress is possible were found to be about \$12 trillion or 1.2% of total world GDP, compared to \$1 trillion or 0.12% of GDP assuming substantial progress in reduction technologies. In the advanced technology case, which assumes very substantial non-fossil alternatives will be available by 2020, the costs are greatly reduced. However, the assumed cost and performance of the alternative technologies would only

become achievable with significant increases in research and development investments. For example, funding in conservation and renewables is about half of what it was 15 years ago, despite substantial proposed increases each year of the Clinton Administration.

The Relationship Between Technology and Minimum Cost of Stabilizing the Atmosphere Below Various Ceilings

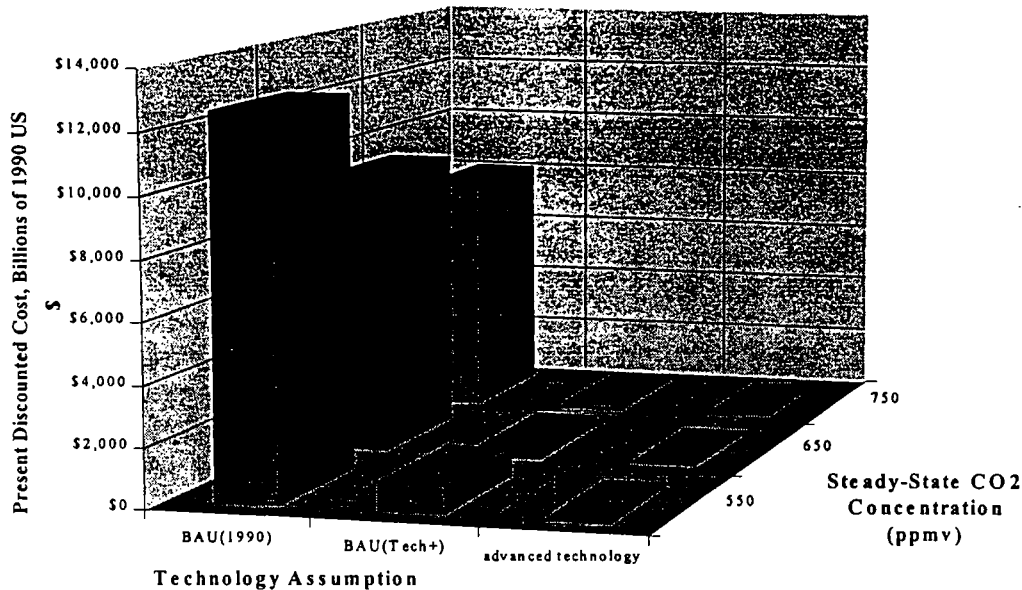


Figure 12

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

APPENDIX

Key Assumptions about Technology Scenarios:

IS92a (Tech+)

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

Advanced Energy Technology

- Advanced solar/wind/fusion
 - The cost of solar/wind power reaches a busbar cost of \$0.04/kWh by 2020 and
 - the cost decreases at 0.5 %/year thereafter.
- Low cost biomass
 - By the year 2020, 20% of the biomass resource is available at \$1.40/GJ and
 - 80% is available at \$2.40
- Advanced liquefied hydrogen fuel cells for transport



United States Department of State

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

Washington, D.C. 20520

February 18, 1997

TO: DISTRIBUTION

FROM: OES - Eileen Claussen

SUBJECT: Climate Change Meeting

There will be a meeting of the Assistant Secretary's Climate Change Group on Wednesday, February 19th at 3:30 p.m. in Room 7835 of Main State. In order to facilitate the discussion, please limit participation to principles plus one. Please confirm your attendance with Lilly Roots Wiggins at (202)647-1554 to be cleared into the building. Attached for your information are copies of the draft agenda, as well as short handouts that we will discuss at our session.

Attachments:
As Stated

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CEQ	Steve Seidel	456-6546
NSC	David Sandalow	456-2710

**Climate Change: Assistant Secretaries Meeting
February 19, 1997, 3:30 p.m.
Room 7835
Department of State**

Agenda

- 1) Outlook for AGBM 6
- 2) Outstanding Issues/Further Work
- 3) Road to AGBM 7
- 4) U.S. National Action Plan
- 5) Other business
 - Outreach
 - Impacts Work

Handouts:

- Climate Change: Further Work
- International Opportunities
- Position Preparation and Clearance Process: Suggested Schedule for Climate Work
- Recent press clippings (not faxed)
- Framework Compilation (not faxed)

Suggested Schedule for Climate Work
(2/19/97)

- February 19** Assistant Secretaries Meeting: Work Assignments
- March 10** First draft circulated to agencies at staff level (IWG/GEA)
- March 12** Comments due; IWG/GEA meeting to discuss comments and drafts
- March 14** Revised drafts updated with comments/distributed to Assistant Secretaries
- March 18** Assistant Secretaries Meeting
- March 18-25** Meetings with stakeholders (Hill, and environmental and private sector NGOs)
- March 21** Papers revised based on Assistant Secretaries input
- March 25** Assistant Secretaries Meeting to clear final papers
- March 27** Final papers distributed to Deputies
- April 1** Deputies Committee Meeting to adopt U.S. position
- April 4** Public meeting to announce U.S. position

**Climate Change: Further Work
(2/19/97)**

1. * Budget (White House with support of IAT)
 - Initial budget level and period?
2. Emissions Trading (DOE and EPA)
 - How to operationalize trading in the protocol?
3. Developing Country Initiative (USCSP)
 - U.S. carrot to encourage developing countries?
4. * Joint Implementation (EPA and DOE)
 - Additional provisions on calculation, measurement, monitoring, verification, review and reporting?
5. Reporting/Compliance (State with EPA, Justice and USTR)
 - National reporting, review mechanism, multilateral consultative process and compliance procedures
 - * Consequences of non-compliance?
6. Annex C gases/sectors (OSTP with EPA, DOE, USDA and NOAA)
 - What gases/sectors will be included
 - * What GWPs will be used?
7. * Non-Annex C gases /sectors (Article 2, para. 7) (EPA, DOE, USDA)
 - What measures will be proposed to address these?
8. * Annex B commitments (State)
 - Candidate countries and potential commitment(s)?
9. Borrowing (State)
 - Possible additional constraints?

* INDICATES WORK THAT MUST BE DONE BEFORE APRIL 1

Format for Work Products

All papers should follow the following structure: Issue, Background, Options (if appropriate), Recommendation(s), and Draft Text (for inclusion in U.S. Protocol Proposal). Papers should be no more than 5 pages in length, shorter when possible.

Opportunities for Climate Meetings

Feb 24 - Mar 7	FCCC Subsidiary Body Meetings (Bonn, Germany)
Mar 11-12	Brazil Common Agenda Meeting (Washington, D.C.)
Mar 21-23	Dresden Meeting (Dresden, Germany)
Mar 24-27	Vice President's Trip to China, Korea and Japan
Apr 8-10	High Level CSD Meeting (New York)
May 5-6	G-7 Environment Ministers Meeting (Miami, Florida)
Jun 9-11	APEC Environment Ministers Meeting (Toronto, Canada)
Jun 20-22	G-7 Meeting (Denver, CO)
Jun 23-27	UN General Assembly Special Session (UNGASS; New York)
July 28- Aug 8	FCCC Subsidiary Body Meetings

THE WHITE HOUSE
WASHINGTON

February 20, 1997

MEMORANDUM FOR DISTRIBUTION

FROM: ELGIE HOLSTEIN
DAVID SANDALOW

SUBJECT: Climate Change

Please see attached for discussion at our meeting tomorrow.

cc: JIAF
SS
mm

2/20/97

CLIMATE CHANGE WORKPLAN

The overview paper on domestic policies has now been circulated to the Deputies. The next step is to begin a more detailed assessment of the major policy alternatives described in that paper.

I. DOMESTIC POLICY OPTIONS

1. Emissions trading program design: Develop and evaluate options for auctions, allocations and combinations of the two. Options should also include a comprehensive trading regime and one that is limited to sectors. Where feasible, options should be evaluated through the Interagency Analytical Team (IAT) models to assess economic impacts including impacts on key sectors.

LEAD: EPA with DOE, Commerce

2. Technology diffusion: Develop options for expanding technology diffusion programs, drawing on the experience of such programs to date and on existing analyses (e.g, post-2000 analyses). Efforts should focus on options that could result in significant reductions and should include estimates of costs and potential greenhouse gas reductions or enhancements of sinks by sector.

LEAD: EPA with DOE, USDA and Commerce

3. Regulatory and standards approaches: Develop and evaluate the costs and impacts of policies that would achieve substantial reductions in greenhouse gases in significant sectors. Analysis should not duplicate work already done (e.g. , options examined in the context of Car Talk) and should include options in areas where legislation is pending.

LEAD: DOE with EPA, USDA and Commerce

4. Auction revenue options: Develop and evaluate options related to the reflow of revenues that would be generated if an emissions trading regime were instituted and designed to include auctions. This work should be coordinated with the emissions trading design options and with the IAT modeling.

LEAD: Treasury with DOE and EPA

5. Sectoral impacts: This paper will draw from the work described above and present policy options, with estimated costs and emissions reductions, by sector.

LEAD: Dept of Commerce with OSTP, DOE, USDA, and EPA.

Timetable: Draft of papers with a first cut on costs and impacts of options by March 14 for Assistant Secretary review. Revised papers for Deputies by March 31. This schedule recognizes that detailed proposals will require a longer period to develop and would be prepared with guidance from the Deputies.

II. TECHNOLOGY RESEARCH AND DEVELOPMENT

A range of options are being developed on climate technology research and development for possible inclusion on the agenda at the upcoming G-7 meeting. CEQ will be chairing a senior meeting on this topic next week.

III. LONG-TERM CONCENTRATIONS/EMISSIONS AND IMPACTS

OSTP is completing a redraft of its paper on the emissions and concentrations and will present it at the Assistant Secretaries meeting on Friday, February 21. An initial paper on health and environmental impacts has been prepared and circulated by EPA. A more extensive paper reflecting additional work underway at a number of agencies in response to a request from the Vice President is being coordinated by OSTP and should be available in several weeks.

IV. PUBLIC OUTREACH

EPA will circulate a draft Federal Register notice based on the overview paper, seeking public input in the form of written comments. Work is underway to prepare a Hill/NGO briefing on the economic analysis. A public outreach plan will be presented to the Assistant Secretaries in the near future.

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

Most discussions have focused on what steps might be taken in the medium term (2010-2020) to reduce emissions of greenhouse gases. Such actions represent only an initial step and, by themselves, would fall far short of significantly reducing the risks of climate change. Much more long-term planning will be necessary to achieve the goal of the Framework Convention on Climate Change:

"stabilization of greenhouse gas concentrations . . . at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should . . . allow ecosystems to adapt naturally to climate change; ensure that food production is not threatened; and enable economic development to proceed in a sustainable manner."

This paper describes emissions paths that would be necessary to achieve various longer-term goals of stabilizing atmospheric concentrations of greenhouse gases. It also explores the implications that a longer term goal has for shaping near-term policy decisions.

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

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

I. GLOBAL EMISSIONS AND ATMOSPHERIC CONCENTRATIONS

In the absence of any actions specifically to limit carbon dioxide emissions, the Intergovernmental Panel on Climate Change (IPCC), as shown in Figure 1, estimated that current emissions (as shown by the 2 upper lines labeled Business as Usual [BAU]) of 6 billion tons of carbon per year could grow to between 15-25 billion tons of carbon by 2050 and continue to

increase through the end of the next century.

Global CO₂ Emissions & Concentrations

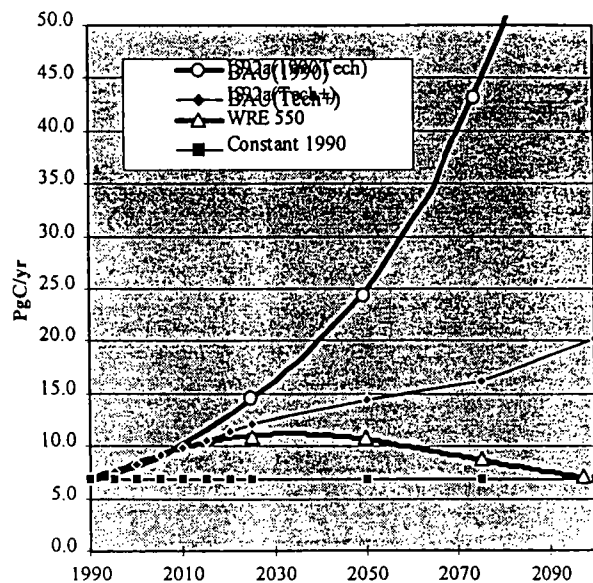


Figure 1

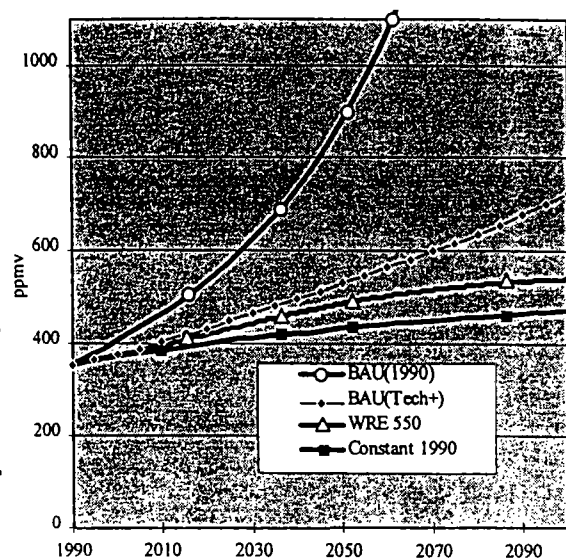


Figure 2

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

If it were possible to cap global emissions in both developed and developing countries at 1990 levels, figure 2 (line labeled "constant 1990") shows that concentrations would nonetheless continue to rise throughout the next century and beyond, eventually exceeding a doubling of preindustrial levels. (Note that the other greenhouse gases make the effective concentration about 20% higher than indicated by CO₂ alone.)

Figure 3 shows the projected long-term atmospheric concentrations if emissions were stabilized at different levels. The figure shows that if emissions were stabilized at current levels (6 PgC/yr), atmospheric concentrations would grow to almost 500 ppm by 2100 and continue increasing thereafter. It also shows that if worldwide emissions are frozen at 10 PgC/yr, roughly 33 percent higher than today's level, then atmospheric concentrations would more than double from pre-industrial levels by 2100, and continue to increase thereafter.

CO2 Concentrations Associated with BAU(Tech+) and Alternative Energy Related Emissions Stabilization Levels

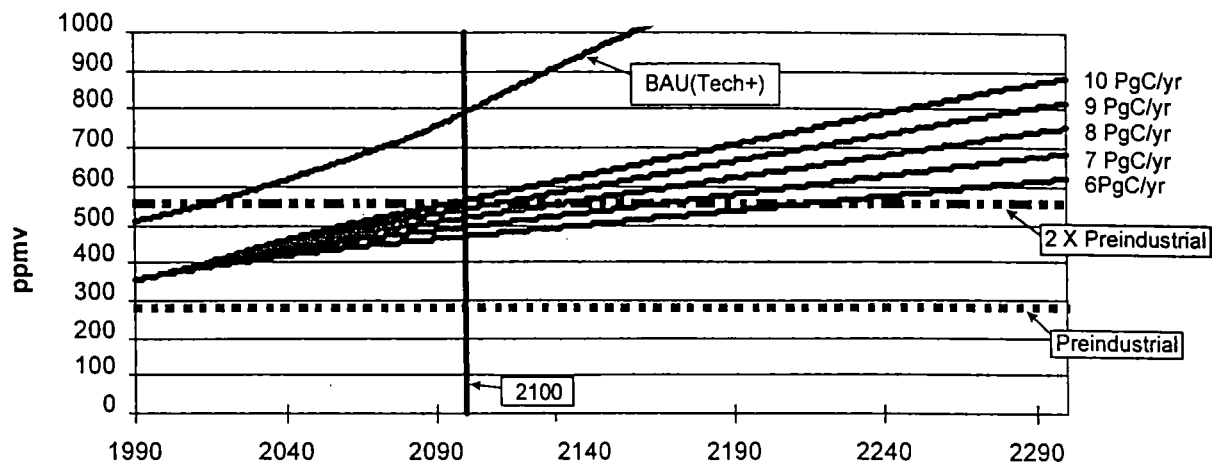


Figure 3

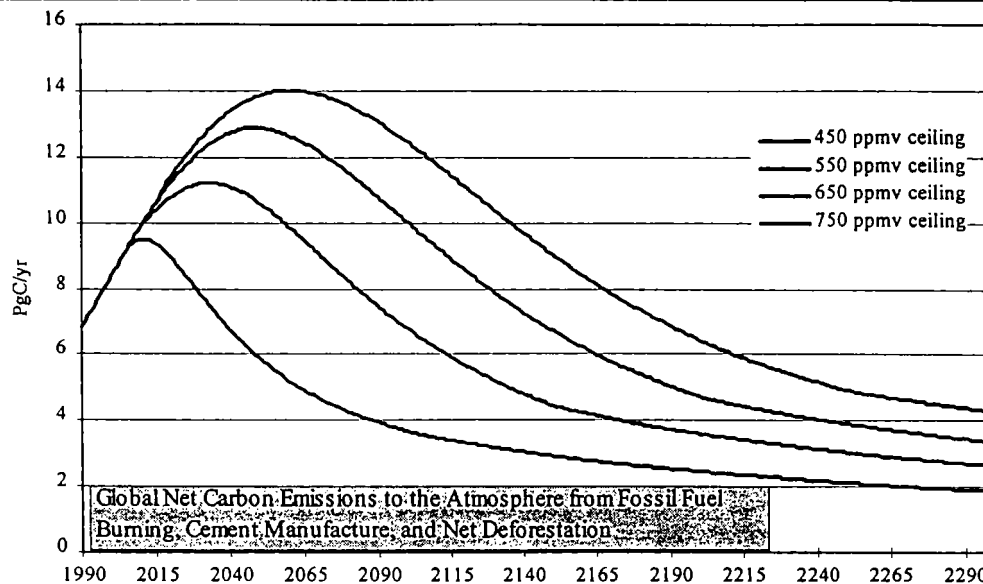
Table 1 shows how various concentration targets relate to emissions pathways. For example, to meet a 550 ppmv concentration goal, global emissions must begin to deflect from the business-as-usual curve by 2013. In this scenario, emissions would peak at 9.7 PgC/yr in 2033 and drop rapidly thereafter.

Researchers have examined in some detail the annual emissions paths required to meet atmospheric carbon concentration targets of 450 to 750 ppm. These targets require significant reductions in cumulative projected global carbon emissions; and as shown in Figure 3, all of them require dramatic reductions in annual emissions rates sometime during the next century. To achieve 450 ppm target – which still represents a two-thirds increase in atmospheric concentrations over preindustrial levels – annual emissions must begin declining steeply within the next quarter-century and must fall to less than half the current rate by 2100. To achieve a 550 ppm concentration target – which represents about a doubling in atmospheric concentrations – annual emissions must begin declining steeply during the second quarter of the century. Furthermore, these budgets must be distributed both across countries and across time.

The relationship between CO2 concentrations and emissions pathways (energy emissions only)*				
Steady-State Concentration →	450	550	650	750
	ppmv	ppmv	ppmv	ppmv
Deflection Date BAU (Tech+) ^a	2007	2013	2018	2023
Maximum Emission Date	2011	2033	2049	2062
Maximum Emission ^b	8.0	9.7	11.4	12.5

^a The deflection date is the year in which emissions first fall below BAU emissions.

^b Maximum PgC/yr fossil fuel carbon emissions. If other greenhouse gases were included, emissions would be effectively 20% higher; thus, reductions would have to occur sooner than the deflection date noted to achieve a given concentration.



* - note: the curves in the graph represent slightly different values than those in the table because the graph takes cement manufacture and deforestation into account in addition to energy emissions.

Figure 4

II. DEVELOPED AND DEVELOPING COUNTRY EMISSION TRENDS

Figure 5 presents current and projected emissions of carbon dioxide for developed and developing countries. Of the current emissions of roughly 6 billion tons, approximately two-thirds are from developed and one-third from developing countries. The U.S. is currently the largest emitter of carbon dioxide, with China the second largest source. However, on a per capita basis, the U.S. emits about 5 tons of carbon per capita, compared to an average of approximately 4 tons per capita in Japan and Western Europe, and 0.4 tons per capita for developing countries. Figure 6 shows per capita emissions for the BAU case out to 2100. While per capita differences remain large over time, by the middle of the next century, developing countries would become a source for more than half of total global emissions.

Annex I and Non-Annex I Fossil Fuel Carbon Emissions: BAU(Tech+)

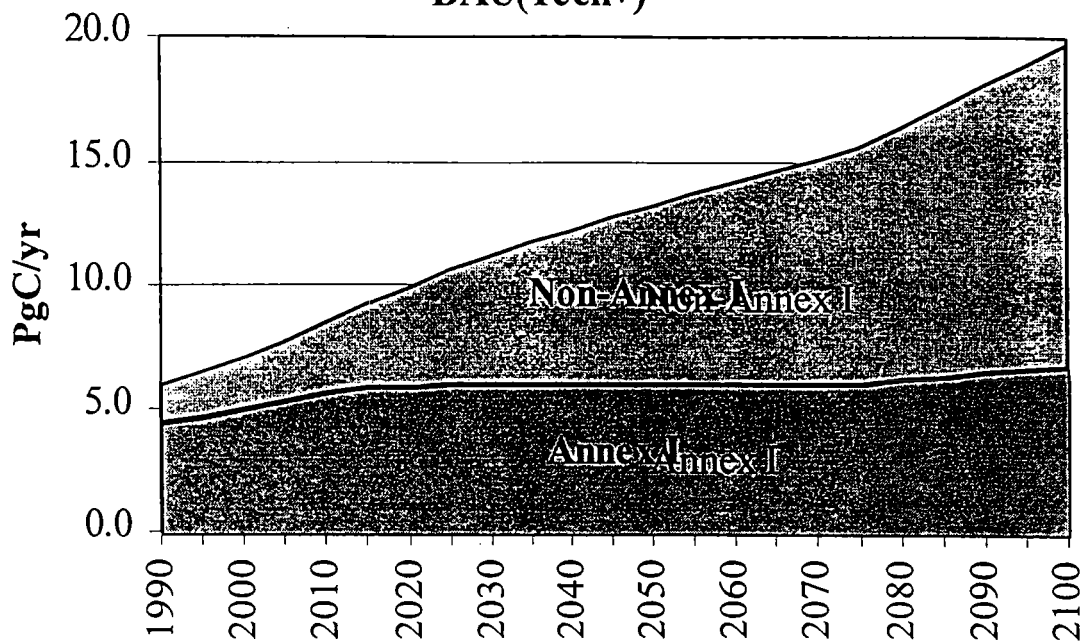


Figure 5

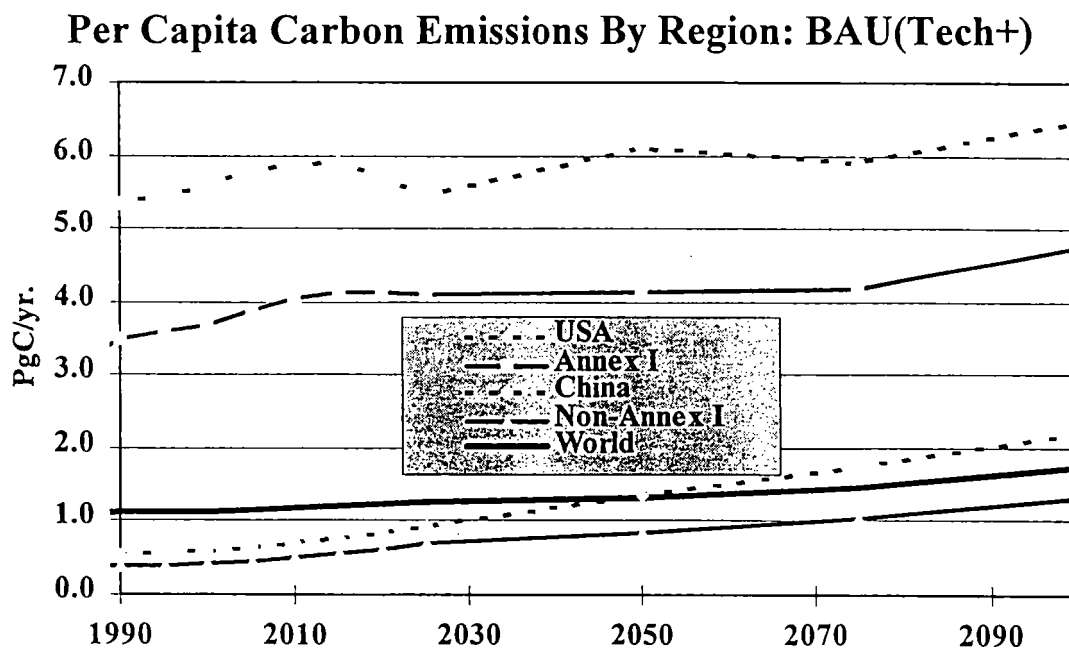


Figure 6

III. ILLUSTRATIVE EMISSION REDUCTION SCENARIOS

Limited mid-term actions to reduce emissions by developed countries alone have little impact on shifting the atmospheric concentrations curve. The top line in Figure 7 shows the small change

in concentrations if Annex I (developed countries) freeze emissions at 1990 levels in the year 2010. Successive lines show what a coal ban in various parts of the world (beginning in 2020) might do to emissions and concentrations. Without the participation of developing countries, concentrations will not stabilize.

Global Paths for BAU(Tech+), Annex I Emissions Stabilization, Coal Bans

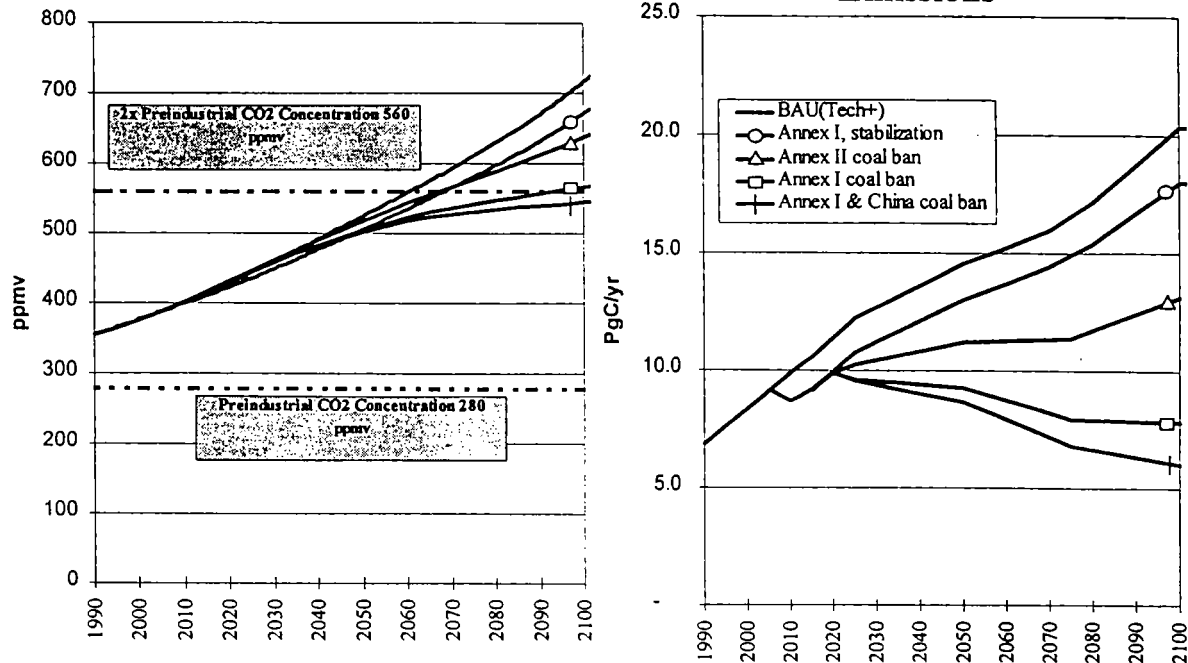
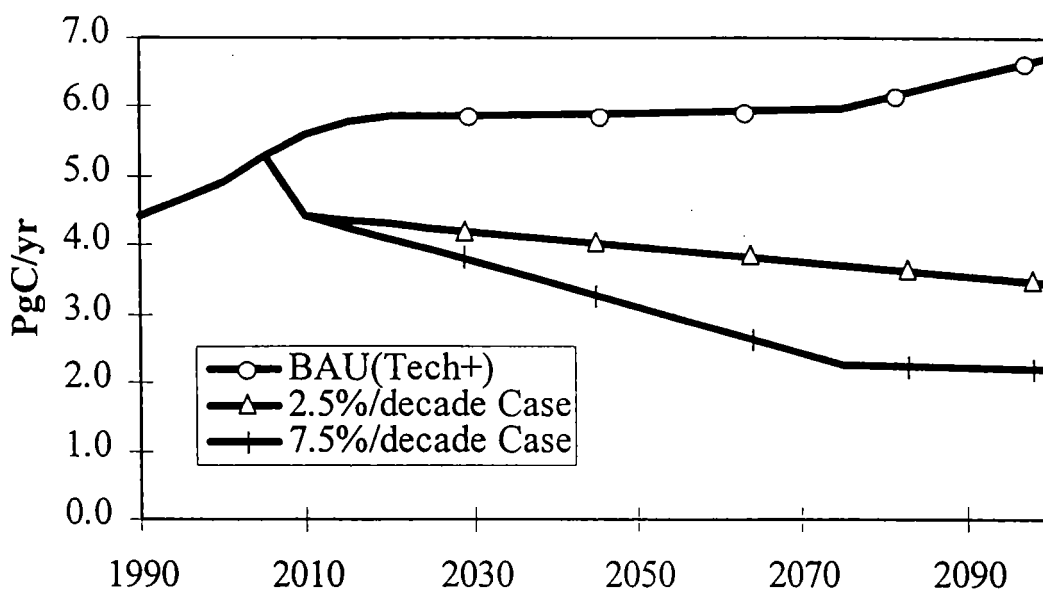


Figure 7

Annex I Fossil Fuel Carbon Emissions: BAU(Tech+), and 2.5%/Decade, & 7.5%/Decade Reductions



2.5%/Decade Case assumes that Annex I nations stabilize emissions at 1990 levels in 2010 and then reduce emissions at 2.5%/decade through the year 2100.

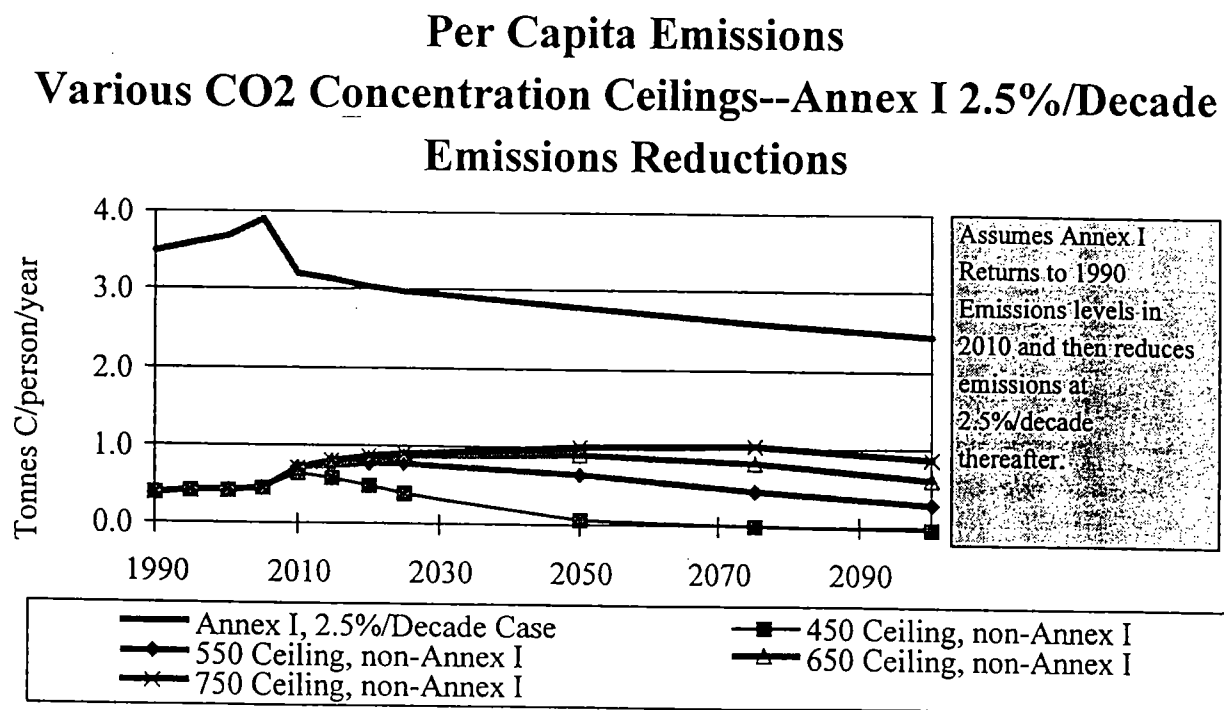
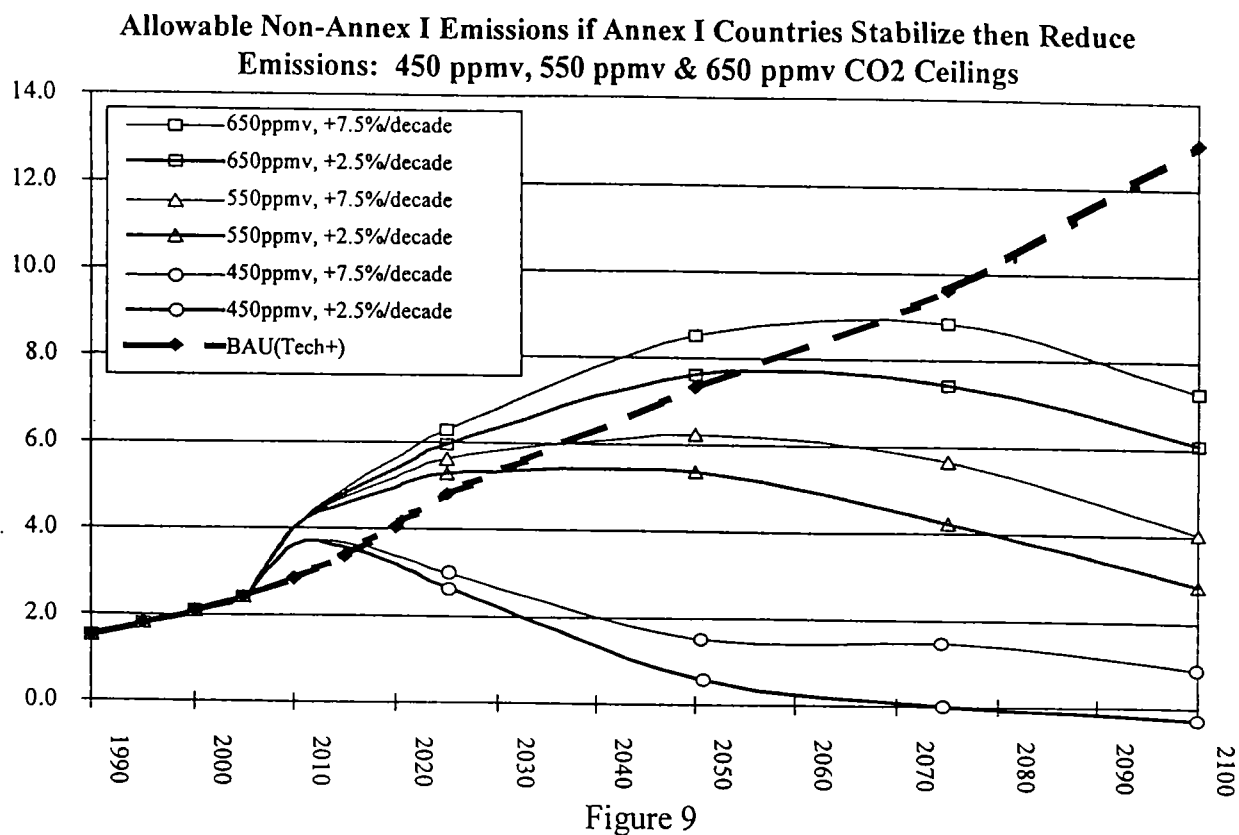
7.5%/Decade Case assumes that Annex I nations stabilize emissions at 1990 levels in 2010 and then reduce emissions at 7.5%/decade until they are 50% of 1990 levels after which time they are held constant.

Figure 8

Figure 8 illustrates two possible emissions profiles for developed (Annex I) countries. Both scenarios assume a freeze in emissions at 1990 levels in 2010. On the hatched line, emissions are then reduced by 2.5% per decade and in the lower line they are reduced at 7.5% per decade. The highest line is the business-as-usual (TECH+) scenario from the IPCC.

Figure 9 is based on the Annex I pathways described in Figure 6. They show the pathway developing countries would need to follow to stabilize concentrations at 450 ppm, 550 ppm and 650 ppm. These figures show that to achieve stabilization at 550, developing countries would be able to emit on their currently projected path until about 2020 before significant reductions would be required.

Figures 10 and 11 show the **per capita** emissions for both developed and developing countries that result from the scenarios described in the previous two figures. They show that under these scenarios, developed country emissions stay substantially greater than those in developing countries (which rise to 1 TC/person only in the 650 ppm case).



Per Capita Emissions

Various CO2 Concentration Ceilings--Annex I 7.5%/Decade Emissions Reductions

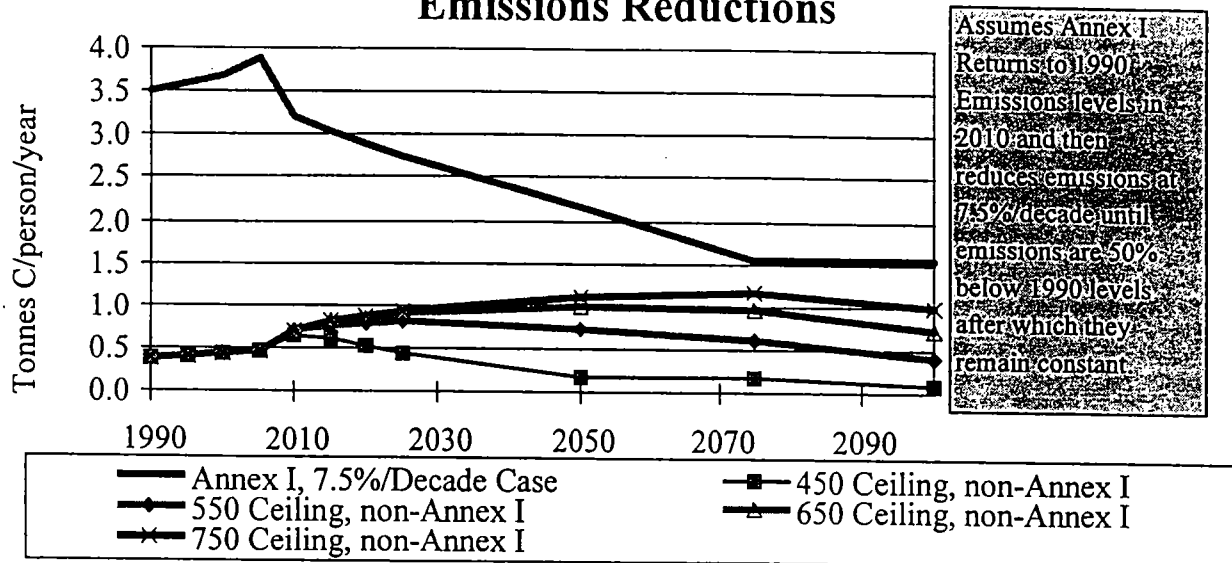


Figure 11

IV. THE ROLE OF TECHNOLOGY AND IMPACTS ON COSTS

As suggested in Figure 1, the rate of technological change can play a very important role in determining the level at which atmospheric concentrations can be stabilized. Figure 11 looks specifically at the costs associated with different technology cases. It looks at three specific cases:

- 1990 tech: assumes no technological change from 1990
- 1990 tech +: assumes significant improvements in reducing the costs of alternative fuels and in improving efficiency;
- Advanced tech: assumes even further advances and cost savings.

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

Figure 11 shows for each of these technology cases, the total costs associated with achieving three different levels of atmospheric concentrations: 550, 650 and 750 ppm. The estimated costs under the assumption that no technological progress is possible were found to be about \$12 trillion or 1.2% of total world GDP, compared to \$1 trillion or 0.12% of GDP assuming substantial progress in reduction technologies. In the advanced technology case, which assumes very substantial non-fossil alternatives will be available by 2020, the costs are greatly reduced. However, the assumed cost and performance of the alternative technologies would only

become achievable with significant increases in research and development investments. For example, funding in conservation and renewables is about half of what it was 15 years ago, despite substantial proposed increases each year of the Clinton Administration.

The Relationship Between Technology and Minimum Cost of Stabilizing the Atmosphere Below Various Ceilings

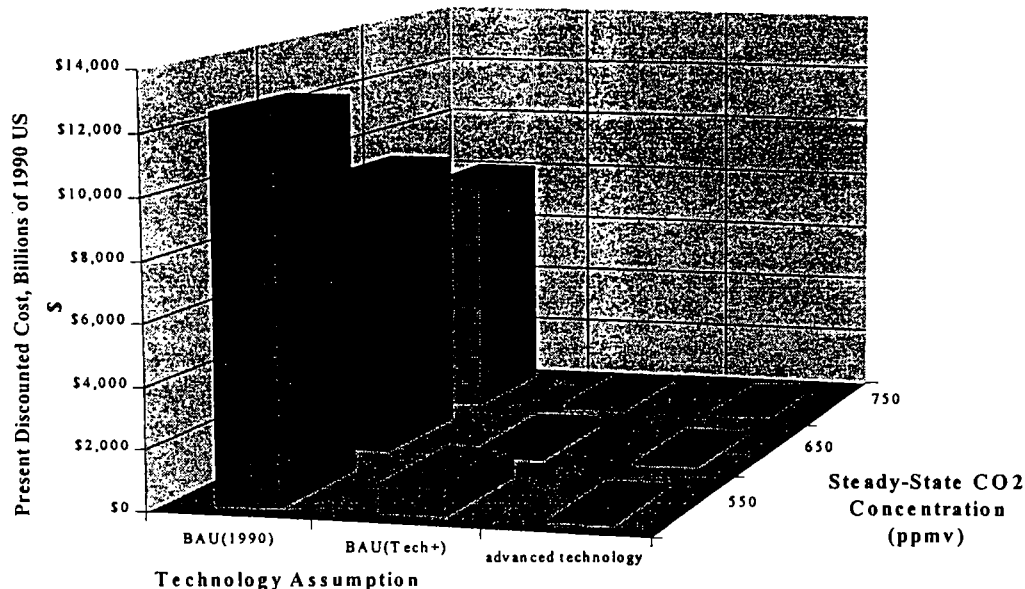


Figure 12

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

APPENDIX

Key Assumptions about Technology Scenarios:

IS92a (Tech+)

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

Advanced Energy Technology

- Advanced solar/wind/fusion
 - The cost of solar/wind power reaches a busbar cost of \$0.04/kWh by 2020 and
 - the cost decreases at 0.5 %/year thereafter.
- Low cost biomass
 - By the year 2020, 20% of the biomass resource is available at \$1.40/GJ and
 - 80% is available at \$2.40
- Advanced liquefied hydrogen fuel cells for transport

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

cc: JAF
JS

To: Assistant Secretaries Climate Change Group Group
(see attached list) **Date:** February 20, 1997

Fax #: See attached list **Pages:** 10, including this cover sheet.

From: William N. White
Special Assistant to David Gardiner

Subject: Emissions, Concentrations and Consequences paper

COMMENTS:

Please find attached the latest draft of the paper entitled "Emissions, Concentrations and Consequences". This is the first part of a two part fax. The second part will be sent by Rosina Bierbaum of OSTP later today. Please review this paper to prepare for a discussion at tomorrow's meeting of the Assistant Secretaries' Climate Change Group. Please call me or Diane Anderson at 260-4332 if you do not receive a complete transmission.

Emissions, Concentrations, and Their Consequences

Concerns about the potential effects of human induced climate change lead to the signing of the Framework Convention on Climate Change (FCCC), whose ultimate objective is to achieve "... stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." Concentrations of greenhouse gases have already risen significantly above those of the preindustrial era as a result of past emissions: concentrations of carbon dioxide, methane, and nitrous oxide have risen by about 30%, 145% and 15% respectively. Concurrently, global mean surface temperatures have increased 0.6 to 1.2°F since the late 19th century. In the absence of emissions control policies, concentrations are projected to rise further yet. For example, by 2100 the concentration of carbon dioxide is projected to be 30 to 150% higher than today's level. The projected increases in concentrations of carbon dioxide and other greenhouse gases are estimated to further warm the surface of the earth by an average of 1.6 to 6.3°F by 2100. This rate of warming is probably greater than any sustained rate of warming of the last 10,000 years, or since the innovation of agriculture (IPCC, WG I Summary for Policy Makers, 1995).

Most estimates of the effects of climate change are those associated with a doubling of the preindustrial concentration of carbon dioxide to approximately 550 parts per million (ppm), or an increase in all greenhouse gas concentrations that together would have an equivalent capacity to trap heat. Little information is available on the effects associated with other concentration levels.

The climatic changes that would result from an equivalent doubling of greenhouse gases would have pervasive effects, some of them irreversible, on the environment and human societies. Unfortunately, the tools and information available to predict specific impacts and convert them into monetized damages are limited at this time, hampering the ability to undertake a more comprehensive cost-benefit assessment of climate change policies. Nevertheless, some impact analyses have indicated substantial possible costs associated with inaction, providing an important context for considering the economic costs associated with policies to reduce greenhouse gas emissions.

Health Effects

Climate change will affect the health of human populations in diverse ways and adverse effects are likely to outweigh beneficial effects substantially (WHO, 1996). One source of adverse effects is illness and death from summertime heat stress. In 44 US cities, summer heat related deaths are estimated to increase 70-150% by 2050, even if people adjust physiologically and behaviorally to changing climate conditions and make some adjustments to urban infrastructure (Figure 1, Kalkstein and Greene, 1997). The

elderly are at greatest risk in the US and urban populations in developing countries are also especially vulnerable to heat stress.

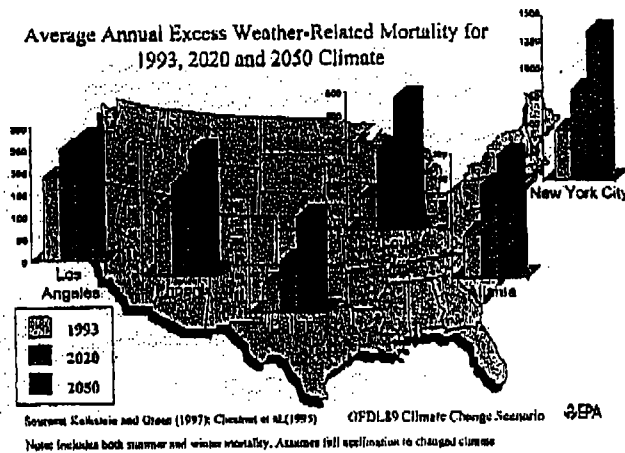


Figure 1

climate change (Figure 2). Globally, the population potentially exposed to malaria could increase by one-third, with a possibility of 50-80 million additional malaria cases per year relative to a baseline of 500 million cases (IPCC, WG II Report, 1995). The incidence of water borne infectious diseases such as cholera and diarrheal diseases may also increase due to the effects of climate change on water supply, water quality, and sanitation (WHO, 1996).

Climate change can reduce air quality and increase levels of air borne pollen

and spores which exacerbate respiratory disease, asthma, and allergic disorders. In addition, controls to reduce greenhouse gas emissions would simultaneously reduce atmospheric concentrations of air pollutants such as fine particles, NO_x, ozone, and heavy metals including mercury. For example, capping CO₂ emissions at 1990 levels has been estimated to yield co-control reductions of up to 2.3 million tons of NO_x emissions and 0.9 million tons of SO₂

Changes in Potential Malaria Transmission

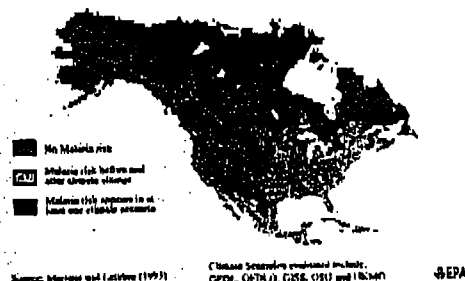


Figure 2

emissions in 2010. Co-control reductions in these pollutants would bring local air quality and health benefits that would add to and be more immediate than the climate related health benefits of greenhouse gas emission reductions.

Water Resources

Human welfare is also placed at risk by changes in the availability of fresh water that may result from climate change. Changes in precipitation and increased evapotranspiration due to higher temperatures from 2xCO₂ climate change can be expected to cause large changes in water runoff in some regions, affecting the quantity and quality of water supplies for domestic and industrial uses, irrigation, hydropower generation, navigation, stream ecosystems and water based recreation. Increased variability in the hydrologic cycle is expected to result in more severe droughts and/or floods in some places but less severe in others (IPCC, WG I Report, 1995).

Areas of greatest vulnerability are those where water supplies and quality are already problems, such as arid and semi-arid regions of the world and some low lying coastal areas, deltas and small islands. In some cases these areas coincide with conflict prone areas which are highly dependent on water originating in areas outside their borders such as Cambodia, Syria, Sudan, Egypt and Iraq (IPCC, WG II Report, 1995).

In the United States, the Colorado River Basin would suffer decreased summer runoff, coinciding with peak demand for irrigation, unless precipitation also increases substantially. Reductions in runoff of up to 25 percent in the basin are projected under some scenarios of 2xCO₂ climate change. Runoff losses of this magnitude in water short regions such as the Colorado River basin are likely to adversely affect water deliveries, exacerbate salinity problems, reduce hydropower generation, and reduce water storage in reservoirs (Nash and Gleick, 1993).

Forests and Natural Areas

Climate change can dramatically alter the geographic distributions of individual tree species and of forest and vegetation types (see Figure 3). One-third of the Earth's forests would undergo a major change in the type of vegetation that could be supported as a result of CO₂ doubling. In boreal forests, which are the forests most vulnerable to climate change, two-thirds of the currently forested area may undergo a change in vegetation type. In some instances, a change in vegetation type will result in a loss of forest area as the land converts to grassland or shrubland. Globally, forested areas may decline 10 percent after forests reach a new equilibrium under a new climate (IPCC, WG

II Report, 1995).

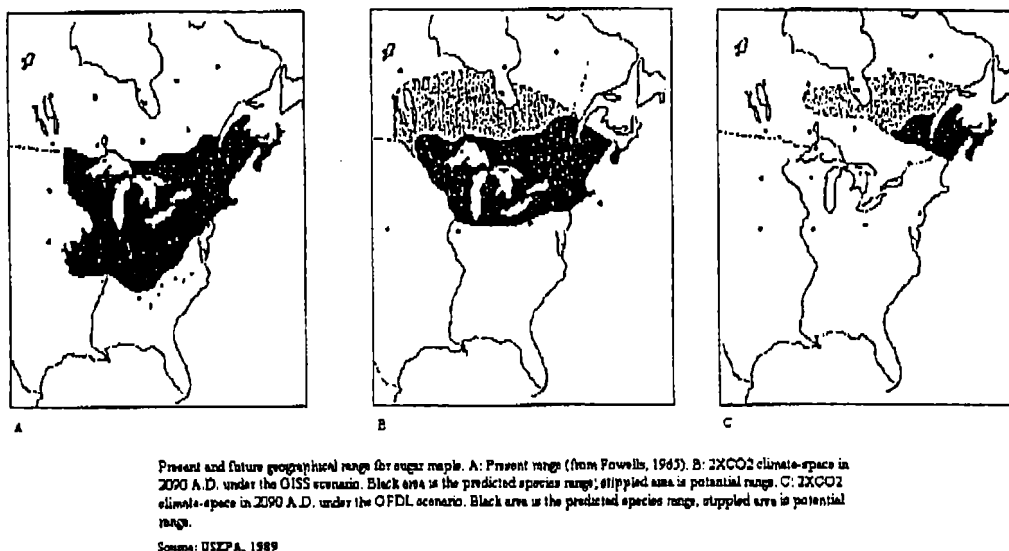


Figure 3

In the United States, western conifer forests could decrease in area and be replaced by broadleaf forests; eastern deciduous forests may be replaced by grasslands along their western boundary. Total forested area in the United States could either increase or decrease after forests reach a new equilibrium with a 2xCO₂ climate. Projections of decreases are as high as 15 percent (VEMAP, 1995).

Loss of Habitat for Brown Trout from a Doubling of CO₂

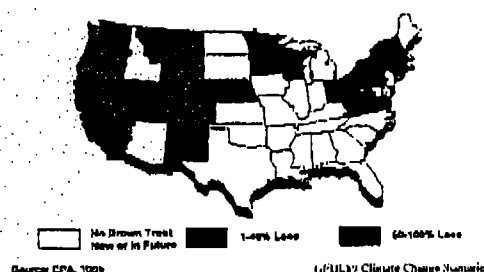


Figure 4

could be supported and potentially result in losses of habitat for cold water fish species such as Brook, Brown, Rainbow and Cutthroat trout (Figure 4).

Wildlife habitat could be altered substantially with repercussions for wildlife abundance, local species survival, and global species survival. For example, a potential change from boreal forest to northern hardwood in the Boundary Waters Canoe Area would result in an area currently suitable for moose changing to one more suitable for white-tailed deer (Botkin, 1989). As another example, increases in water temperatures of rivers and streams would change the types of fish that

Wetlands represent another critical set of ecological systems at risk from climate change. For example, the IPCC found that precipitation changes and salt water intrusion

from sea level rise could adversely affect the ecological communities of the Florida Everglades and degrade the habitat for many species of wading birds. The wetlands of the prairie pothole region of North America, which supports half the waterfowl population of this continent, could diminish in area and change dramatically in character in response to climate change according to the IPCC. Although not specifically assessed by the IPCC, such changes could be devastating to migratory bird populations and species survival.

Coastal Areas

With a doubling of CO₂, sea level would continue to rise for several centuries, with the best estimate of the equilibrium rise being at least seven feet. In the next century, sea level is projected to rise about 20 inches, which is over three times the 6 inch rise experienced over the last century. Along most of the U.S. Atlantic and Gulf Coasts, sea level is projected to rise one foot in the next fifty years and two feet in the next century. The IPCC estimates that a 50 cm rise in sea level would increase the population at risk from storm surges from roughly 45 million at present to over 90 million world wide.

Rising sea level erodes beaches and coastal wetlands, causes the gradual inundation of low lying areas and increases the vulnerability in coastal areas to flooding from storm surges and intense rainfall. A one foot rise could erode ocean beaches 100-150 feet over the next fifty years, which would threaten the first few rows of houses along many barrier islands and other resorts. A two foot rise would inundate 3000 to 7000 square miles of coastal lowlands and 20-45 percent of U.S. coastal wetlands. Rising sea level and lower river flows will increase salinity levels in aquifers and estuaries, tentially harming drinking water supplies in California's Central Valley, Philadelphia, New York, and Miami. Rising sea level could also change the character of coastal areas. For

example, along the Chesapeake Bay and other estuaries, the small sandy beaches and wetland shores could gradually be replaced with walls of steel, rock, wood, and concrete.

Blackwater National Wildlife Refuge (Maryland)
Surface Classification: 1938 and 1980

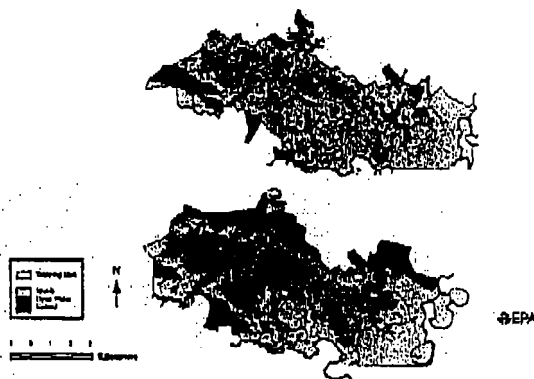


Figure 5

Agriculture and Food Supply

Climate strongly affects crop yields and projected changes under a CO₂ doubling can exceed 30 or 40 percent for some crops and locations (Figure 6). But despite the potentially large changes in yields, global food production is not expected to change substantially. This is because farming practices are considered to be highly adaptable to different climates, because production of important food crops can shift to new locations in response to changes in climate, and because CO₂ has beneficial effects for plant photosynthesis and water use efficiency that can offset deleterious effects of changes in climate. Regional food production, however, may be substantially affected. Agricultural production could decline significantly in developing countries while being only slightly affected in developed countries. Production decreases in developing countries have been estimated to increase the population at risk from hunger by 5 to 50 percent, or 40 million to 300 million persons (Rosenzweig, Parry and Fischer, 1995).

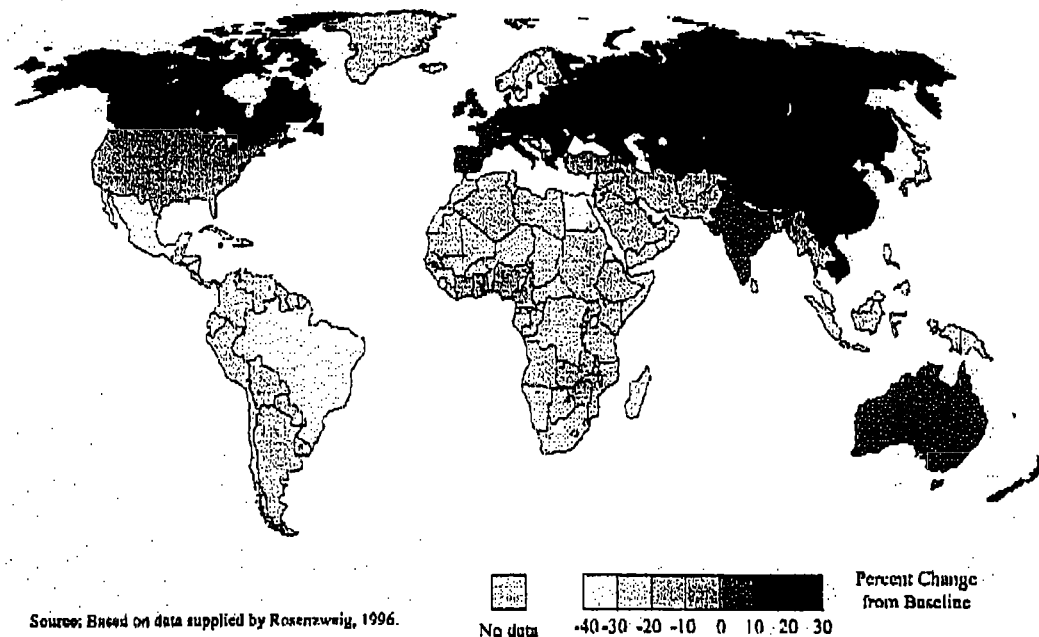


Figure 6 Estimated change in average wheat yield for GISS 2xCO₂ scenario.

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There are various feedback effects between the atmosphere, oceans, and terrestrial systems that amplify or dampen changes in climate that are projected to result from human emissions of greenhouse gases. Uncertainties about these effects are largely responsible for differences in the warming projected by different models for a doubling of carbon dioxide. But because of the complexity and non-linearity of the processes and interactions, abrupt, large and unpredicted changes in climate and/or sea level are possible.

There are also potentially significant feedbacks not accounted for in climate and sea level rise projections. For example, the rates of warming projected to result if no further actions are taken to control greenhouse gas emissions would cause suitable climates for many tree species to move polewards at rates that are an order of magnitude greater than the species can migrate (IPCC, WG II Report, 1995). This could cause significant losses of forest productivity and dieback of forests. As a result, enormous quantities of carbon could be released to the atmosphere and significantly amplify the warming. Though the probabilities of such events are considered to be low, they are expected to grow the more rapid is the rate of warming (IPCC, WG I Report, 1995).

Emissions

While little can be said about the effects associated with concentrations other than 550 ppm CO₂ equivalent, it is likely that uncontrolled emissions will result in higher concentrations. While 550 ppm is approximately the concentration of CO₂ that would result if current global emissions were permanently capped at the current emission level of 6 billion tons, the mid-range estimate of the IPCC projects growth of CO₂ emissions to 13 billion tons by 2050 and 20 billion tons by 2100.

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have been roughly 570 billion metric tons of carbon equivalent (GtCe), of which about 450 GtC have been carbon.¹

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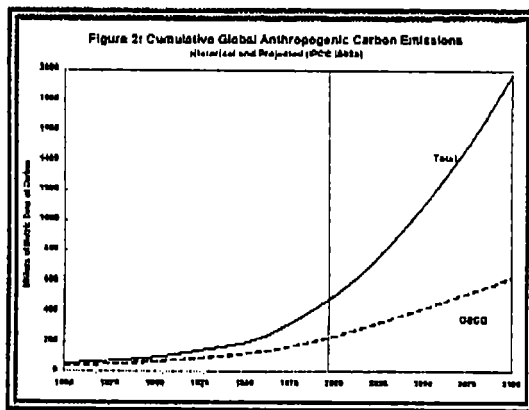


Figure 2

More than 75% of all fossil emissions in history have occurred since 1945, and 50% have occurred since 1970. About 40% of total carbon emissions have accumulated in the atmosphere, raising the stock of atmospheric carbon by nearly 30% from 280 ppm (parts per million) to over 360 ppm. Somewhat less than half of current emissions are accumulating in the atmosphere, while the rest is absorbed in natural sinks (the oceans and biosphere) through processes that are as yet only

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THE WHITE HOUSE
WASHINGTON

February 20, 1997

MEMORANDUM FOR DISTRIBUTION

FROM: ELGIE HOLSTEIN
DAVID SANDALOW

SUBJECT: Climate Change

There will be a meeting tomorrow, Friday, February 21 from 1:00-2:30 in OEOB Room 231. We will start promptly at 1:00.

The agenda is:

1. Next Steps on Economic Analysis
2. Next Steps on Domestic Policy Development
3. Hill Modeling Briefing
4. Concentrations/Emissions Paper

Everyone on the attached list has been cleared into the building. If you have questions concerning clearance, please call Wendy Philleo (456-6224).

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cc: JAF
JS

To: Assistant Secretaries Climate Change Group Group
(see attached list) **Date:** February 20, 1997

Fax #: See attached list **Pages:** 10, including this cover sheet.

From: William N. White
Special Assistant to David Gardiner

Subject: Emissions, Concentrations and Consequences paper

COMMENTS:

Please find attached the latest draft of the paper entitled "Emissions, Concentrations and Consequences". **This is the first part of a two part fax. The second part will be sent by Rosina Bierbaum of OSTP later today.** Please review this paper to prepare for a discussion at tomorrow's meeting of the Assistant Secretaries' Climate Change Group. Please call me or Diane Anderson at 260-4332 if you do not receive a complete transmission.

Emissions, Concentrations, and Their Consequences

Concerns about the potential effects of human induced climate change lead to the signing of the Framework Convention on Climate Change (FCCC), whose ultimate objective is to achieve "... stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." Concentrations of greenhouse gases have already risen significantly above those of the preindustrial era as a result of past emissions: concentrations of carbon dioxide, methane, and nitrous oxide have risen by about 30%, 145% and 15% respectively. Concurrently, global mean surface temperatures have increased 0.6 to 1.2°F since the late 19th century. In the absence of emissions control policies, concentrations are projected to rise further yet. For example, by 2100 the concentration of carbon dioxide is projected to be 30 to 150% higher than today's level. The projected increases in concentrations of carbon dioxide and other greenhouse gases are estimated to further warm the surface of the earth by an average of 1.6 to 6.3°F by 2100. This rate of warming is probably greater than any sustained rate of warming of the last 10,000 years, or since the innovation of agriculture (IPCC, WG I Summary for Policy Makers, 1995).

Most estimates of the effects of climate change are those associated with a doubling of the preindustrial concentration of carbon dioxide to approximately 550 parts per million (ppm), or an increase in all greenhouse gas concentrations that together would have an equivalent capacity to trap heat. Little information is available on the effects associated with other concentration levels.

The climatic changes that would result from an equivalent doubling of greenhouse gases would have pervasive effects, some of them irreversible, on the environment and human societies. Unfortunately, the tools and information available to predict specific impacts and convert them into monetized damages are limited at this time, hampering the ability to undertake a more comprehensive cost-benefit assessment of climate change policies. Nevertheless, some impact analyses have indicated substantial possible costs associated with inaction, providing an important context for considering the economic costs associated with policies to reduce greenhouse gas emissions.

Health Effects

Climate change will affect the health of human populations in diverse ways and adverse effects are likely to outweigh beneficial effects substantially (WHO, 1996). One source of adverse effects is illness and death from summertime heat stress. In 44 US cities, summer heat related deaths are estimated to increase 70-150% by 2050, even if people adjust physiologically and behaviorally to changing climate conditions and make some adjustments to urban infrastructure (Figure 1, Kalkstein and Greene, 1997). The

elderly are at greatest risk in the US and urban populations in developing countries are also especially vulnerable to heat stress.

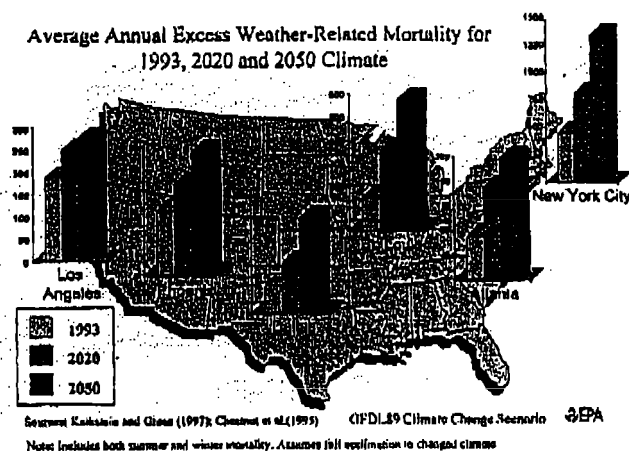


Figure 1

climate change (Figure 2). Globally, the population potentially exposed to malaria could increase by one-third, with a possibility of 50-80 million additional malaria cases per year relative to a baseline of 500 million cases (IPCC, WG II Report, 1995). The incidence of water borne infectious diseases such as cholera and diarrheal diseases may also increase due to the effects of climate change on water supply, water quality, and sanitation (WHO, 1996).

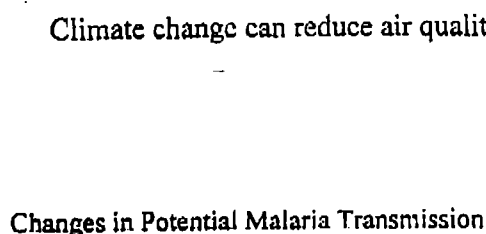


Figure 2

The incidence of infectious diseases, which are still the world's leading cause of fatalities, may increase as a result of climate change. Climate change may extend the geographic ranges of disease-carrying vectors such as mosquitos, which can increase the populations exposed to diseases such as malaria, dengue and yellow fever. In North America, the area of potential malaria transmission may expand as a result of 2xCO₂

Climate change can reduce air quality and increase levels of air borne pollen and spores which exacerbate respiratory disease, asthma, and allergic disorders. In addition, controls to reduce greenhouse gas emissions would simultaneously reduce atmospheric concentrations of air pollutants such as fine particles, NO_x, ozone, and heavy metals including mercury. For example, capping CO₂ emissions at 1990 levels has been estimated to yield co-control reductions of up to 2.3 million tons of NO_x emissions and 0.9 million tons of SO₂

emissions in 2010. Co-control reductions in these pollutants would bring local air quality and health benefits that would add to and be more immediate than the climate related health benefits of greenhouse gas emission reductions.

Water Resources

Human welfare is also placed at risk by changes in the availability of fresh water that may result from climate change. Changes in precipitation and increased evapotranspiration due to higher temperatures from 2xCO₂ climate change can be expected to cause large changes in water runoff in some regions, affecting the quantity and quality of water supplies for domestic and industrial uses, irrigation, hydropower generation, navigation, stream ecosystems and water based recreation. Increased variability in the hydrologic cycle is expected to result in more severe droughts and/or floods in some places but less severe in others (IPCC, WG I Report, 1995).

Areas of greatest vulnerability are those where water supplies and quality are already problems, such as arid and semi-arid regions of the world and some low lying coastal areas, deltas and small islands. In some cases these areas coincide with conflict prone areas which are highly dependent on water originating in areas outside their borders such as Cambodia, Syria, Sudan, Egypt and Iraq (IPCC, WG II Report, 1995).

In the United States, the Colorado River Basin would suffer decreased summer runoff, coinciding with peak demand for irrigation, unless precipitation also increases substantially. Reductions in runoff of up to 25 percent in the basin are projected under some scenarios of 2xCO₂ climate change. Runoff losses of this magnitude in water short regions such as the Colorado River basin are likely to adversely affect water deliveries, exacerbate salinity problems, reduce hydropower generation, and reduce water storage in reservoirs (Nash and Gleick, 1993).

Forests and Natural Areas

Climate change can dramatically alter the geographic distributions of individual tree species and of forest and vegetation types (see Figure 3). One-third of the Earth's forests would undergo a major change in the type of vegetation that could be supported as a result of CO₂ doubling. In boreal forests, which are the forests most vulnerable to climate change, two-thirds of the currently forested area may undergo a change in vegetation type. In some instances, a change in vegetation type will result in a loss of forest area as the land converts to grassland or shrubland. Globally, forested areas may decline 10 percent after forests reach a new equilibrium under a new climate (IPCC, WG

II Report, 1995).

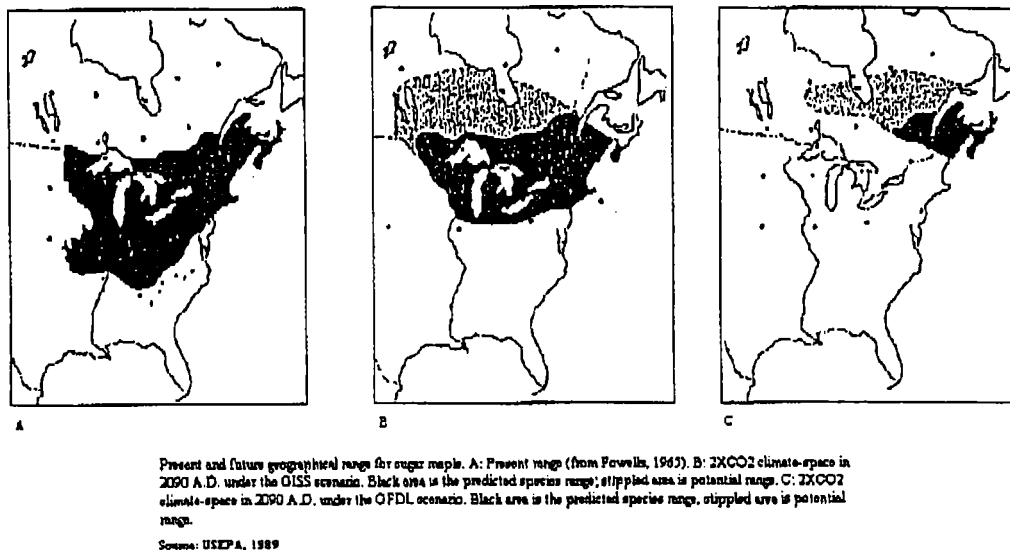


Figure 3

In the United States, western conifer forests could decrease in area and be replaced by broadleaf forests; eastern deciduous forests may be replaced by grasslands along their western boundary. Total forested area in the United States could either increase or decrease after forests reach a new equilibrium with a 2xCO₂ climate. Projections of decreases are as high as 15 percent (VEMAP, 1995).

Loss of Habitat for Brown Trout from a Doubling of CO₂

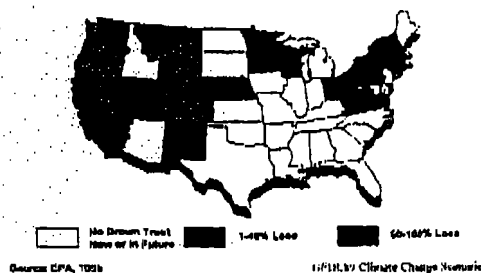


Figure 4

could be supported and potentially result in losses of habitat for cold water fish species such as Brook, Brown, Rainbow and Cutthroat trout (Figure 4).

Wetlands represent another critical set of ecological systems at risk from climate change. For example, the IPCC found that precipitation changes and salt water intrusion

Wildlife habitat could be altered substantially with repercussions for wildlife abundance, local species survival, and global species survival. For example, a potential change from boreal forest to northern hardwood in the Boundary Waters Canoe Area would result in an area currently suitable for moose changing to one more suitable for white-tailed deer (Botkin, 1989). As another example, increases in water temperatures of rivers and streams would change the types of fish that

from sea level rise could adversely affect the ecological communities of the Florida Everglades and degrade the habitat for many species of wading birds. The wetlands of the prairie pothole region of North America, which supports half the waterfowl population of this continent, could diminish in area and change dramatically in character in response to climate change according to the IPCC. Although not specifically assessed by the IPCC, such changes could be devastating to migratory bird populations and species survival.

Coastal Areas

With a doubling of CO₂, sea level would continue to rise for several centuries, with the best estimate of the equilibrium rise being at least seven feet. In the next century, sea level is projected to rise about 20 inches, which is over three times the 6 inch rise experienced over the last century. Along most of the U.S. Atlantic and Gulf Coasts, sea level is projected to rise one foot in the next fifty years and two feet in the next century. The IPCC estimates that a 50 cm rise in sea level would increase the population at risk from storm surges from roughly 45 million at present to over 90 million world wide.

Rising sea level erodes beaches and coastal wetlands, causes the gradual inundation of low lying areas and increases the vulnerability in coastal areas to flooding from storm surges and intense rainfall. A one foot rise could erode ocean beaches 100-150 feet over the next fifty years, which would threaten the first few rows of houses along many barrier islands and other resorts. A two foot rise would inundate 3000 to 7000 square miles of coastal lowlands and 20-45 percent of U.S. coastal wetlands. Rising sea level and lower river flows will increase salinity levels in aquifers and estuaries, tentially harming drinking water supplies in California's Central Valley, Philadelphia, New York, and Miami. Rising sea level could also change the character of coastal areas. For

example, along the Chesapeake Bay and other estuaries, the small sandy beaches and wetland shores could gradually be replaced with walls of steel, rock, wood, and concrete.

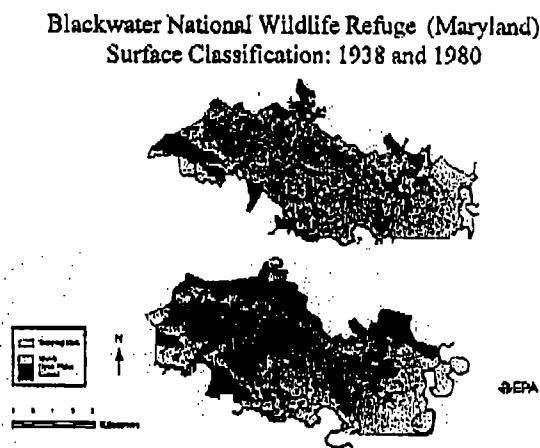


Figure 5

Agriculture and Food Supply

Climate strongly affects crop yields and projected changes under a CO₂ doubling can exceed 30 or 40 percent for some crops and locations (Figure 6). But despite the potentially large changes in yields, global food production is not expected to change substantially. This is because farming practices are considered to be highly adaptable to different climates, because production of important food crops can shift to new locations in response to changes in climate, and because CO₂ has beneficial effects for plant photosynthesis and water use efficiency that can offset deleterious effects of changes in climate. Regional food production, however, may be substantially affected. Agricultural production could decline significantly in developing countries while being only slightly affected in developed countries. Production decreases in developing countries have been estimated to increase the population at risk from hunger by 5 to 50 percent, or 40 million to 300 million persons (Rosenzweig, Parry and Fischer, 1995).

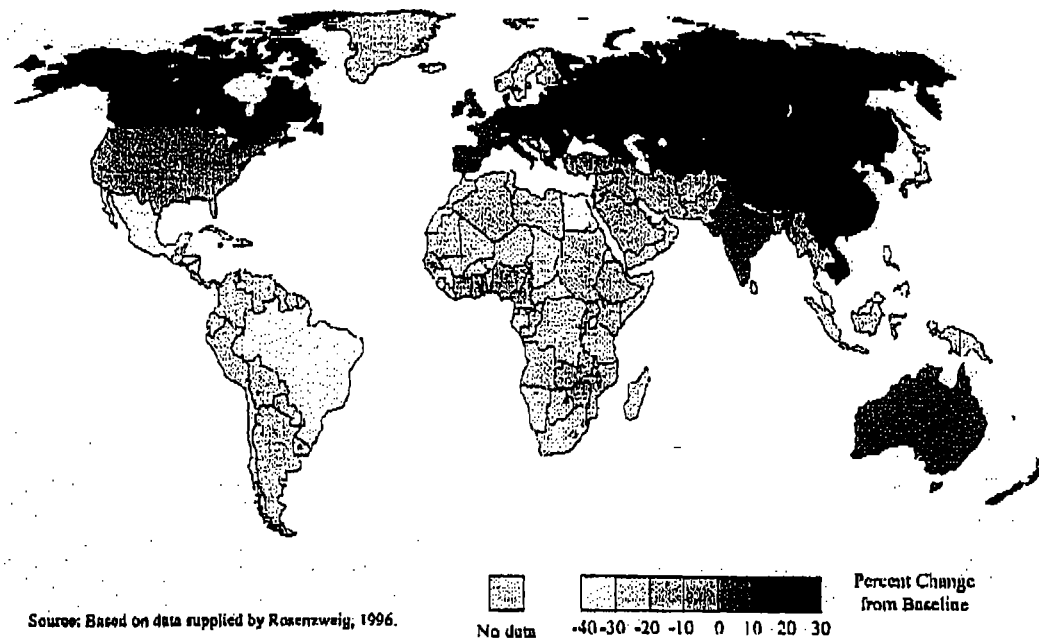


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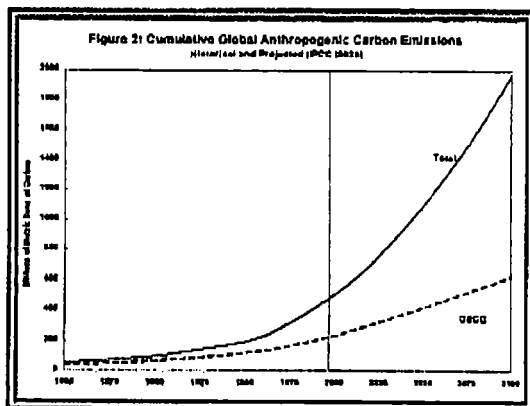


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Date: 25 February 97

To: Jeff Frankel
Alicia Munnell

From: Jason Shogren

RE: Modeling Issues to consider for the Upcoming Deputies meetings on Thursday

1. Revenue Recycling.

In the modeling runs, permits are auctioned off with the revenues being split 60/40 toward reducing profit/income taxes. This 60/40 split cuts GDP losses by 2/3 relative to a grandfathering scheme. Somebody will have to explain where this 60/40 split came from and why it is the only one we considered. A question that should be addressed-- how robust are these big GDP savings to alternative splits in revenue recycling? Other splits might be run to see if the investment modeling decisions are credible.

2. Technology.

Going back to the technology-on-steroids (1.75 AEEI) question. Talking with Janet Yellen, she asked the following question--ignoring global climate change for the moment, if society decided to tighten its belt by consuming less and investing more, would we think that the biggest productivity gains could be achieved by investing in more energy efficient capital rather than in some other form of capital, say like human capital? This option is not reflected in the modeling choices as far as I can tell.

3. Most Optimistic Scenario.

There might be some merit in asking the modelers to run the most optimist scenario now (e.g., 1.75 tech., auctioning and revenue recycling) to see what it looks like exactly. The favorite strategy of the EPA is to keep moving up the bar--more and more optimistic. If we can establish an upper bound and if this upper bound is unreasonable, then we can start moving the modeling runs downward rather than upward as is the case now.

4. Borrowing and Budget Periods.

Borrowing remains a contentious issue. Mark Mazur suggested that we could give borrowing up if in return we can get a multi-year budget period that uses average emission levels as the target. The multi-year averaging might serve the same purpose without all the red flags of a no-teeth agreement.

5. Regional results.

Attached are some new regional results from the SGM model (EPA). The last page shows the implicit carbon price for Annex I trading (with 0.01% and 0.75% improvements in the carbon to GDP ratio). The technology assumption is important--prices are 3 times greater when technology follows historical patterns.

Date: 27 February 1997

To: Jeff Frankel
Alicia Munnell

FROM: Jason Shogren

RE: Deputies' meeting on climate change policy

Attachments: IAT model runs

BRIEFING FOR DEPUTIES' MEETING ON CLIMATE CHANGE

Purpose

The meeting has been called to present the first round of results on the costs of greenhouse gas controls, from the Interagency Analysis Team (IAT), chaired by Ev Ehrlich. Ev plans to brief Capitol Hill soon, but says the briefing will include only a description of the work plan.

Other business will also be on the agenda.

General Background

The briefing will include results for the base case, and for some of the policy cases. The IAT has focused a comparison between two cases:

- The base case -- i.e., with no new policies.
- The climate treaty case, in which the U.S. caps total greenhouse emissions, and then allows domestic firms to trade rights to emit carbon ("cap and trade"), with several variations.

Variations examined to date include:

- cap U.S. emissions at 1990 levels by 2010; hold emissions constant after that;
- cap U.S. emissions at 1990 levels, plus or minus 10 percent;
- cap U.S. emissions at 1990 levels by 2020;
- auction permits, or give them to existing emitters ("grandfathering");

- use auction proceeds to reduce the deficit or to reduce business and personal taxes;
- allow no trading, trading only within Annex 1, or worldwide trading.

The modelers have compared several variables:

- levels of GDP
- real consumption
- fuel consumption and price by fuel type
- price of carbon permits

Ev will most likely present the price of carbon permits (the implicit tax on carbon), together with changes in price of different fuels.

For example, to stabilize emissions at 1990 levels in 2010, the SGM model (from EPA) calculated the following permit prices (\$1995) per ton of carbon for the year 2010:

case	---rate of energy efficiency improvement---	
	base case	very fast (1.75)
U.S. stabilizes without trading	110	57
with Annex 1 trading only	96	55
with worldwide trading	n/a	19

The same model calculates that permit prices in Western Europe would be about three times as high for each variation. *without trading*

Speed of technical change. CEA and Treasury remained concerned for some time that the IAT is assuming very fast technical change in its modeling of climate control costs. CEA/Treasury believe the chosen range is considerably higher than the historical evidence can support. In the base case, the energy/GDP ratio improves at one percent annually, which we believe is on the high side of historical experience; econometric estimates of the rate of energy efficiency improvement, apart from price effects, range from 0.5 to 1.0 percent annually. In the policy cases, the energy/GDP ratio improves at 1.25 to 1.75 percent annually.

Announcement effect. The IAT asserts that the rate of energy efficiency improvement will jump from 1 percent to 1.25 percent annually solely because of the "announcement effect"--i.e., merely from the government's announcement of a policy. The idea is that once the U.S. signs a treaty limiting carbon emissions, more money will flow into R&D on energy efficiency. This assumption means that we will reach one-third of our reduction goal for free. Most economists, on the other hand, would say that people will not respond to an announcement unless they believe it would be costly not to. People may very well invest more in innovation, but at some cost. Treasury and CEA staff have sent a memo to Ev Ehrlich asking that the models also be run using rates of technical change consistent with historical evidence.

We should continue to ask for the implicit R&D investment costs to achieve these high rates of technical change. Standard estimates of the social rate of return on R&D range from about 30 to 50%.

Emission banking and borrowing. An efficient trading program requires *when* as well as *where* trading. This means *emission banking*, allowing firms save or borrow emission credits. A minimum-cost control path would allow higher emissions in the near term in exchange for lower emissions later. In contrast, an early-action control path is expensive for three reasons: it requires the premature retirement of the capital stock, it fails to take advantage of technological changes, and it crowds out other productive investment. Unfortunately, intertemporal trading has not been discussed recently, and it may or may not be still on the agenda. Jeff has pressed the idea of emissions *windows* rather than single-year targets. If the window is wide enough, this is equivalent to emissions banking. **CEA should continue to focus attention on this point.**

Statement by Arrow, Solow, Nordhaus, et al.

On Thursday, February 13, the press carried a story that 2000 economists, including six Nobel laureates, have signed a statement supporting measures to reduce the threat of climate change. The statement endorses conclusions from last year's report by the Intergovernmental Panel on Climate Change (IPCC), that governments should take steps to reduce the threat of damage from global warming, that proper policies can significantly reduce greenhouse gas emissions without harming the American economy, and that market-based policies can significantly lower the costs of control.

Some within the Administration have claimed that this statement endorses the Administration's position. In fact, the statement is far more general than the Administration's position.

ECONOMISTS' STATEMENT ON CLIMATE CHANGE

We the undersigned agree that:

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

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

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

Talking Points (basically the same as Treasury):

- Concerned about the direction of the modeling work.
 - o The IAT is assuming very fast technical change in its modeling of climate control costs. CEA and Treasury believe the chosen range is higher than the historical evidence can support. While there may be good reasons for believing the rate will double because of U.S. government action, we would like to see model runs using rates of technical change consistent with historical evidence. And CEA would like to see the implied R&D investment costs to achieve these rates of technical change given a documented social rate of return to R&D.
 - o An efficient trading program requires *when* as well as *where* trading. Unfortunately, intertemporal trading has not been discussed recently, and may be slipping off the agenda. We would like to see how banking and borrowing affect compliance costs. Multi-year targets with averaging could be considered as a substitute for borrowing.
 - o No one in the IAT is looking at possible benefits from averting climate change impacts -- so we won't have an idea of whether the costs are offset by equivalent benefits. Our choices for a climate protocol will be based on rough guesses.

Today's meeting served to highlight some of the differences in how the Markal-Macro, DRI, and SGM models address the distributional effects of policies. Markal-Macro focuses on energy industry effects of policies such as changes in the relative market shares of different fuels and final energy uses among major sectors in the economy. DRI focuses on the macro effects of policies as well as their differential impact on firms and consumers. SGM focuses on the international effects of policies such as trading on the implicit price of carbon. Below are some comments concerning the results from each of these models that were presented at the meeting.

Markal-Macro

DRI - EPA

Both EPA and DOE reported results from the DRI model under stabilization and an annual rate of decrease in the energy/GDP ratio (E/GDP) of 1.25%. EPA estimated GDP loss under various scenarios where permits were either given away free or auctioned. There was one "free" scenario where companies were grandfathered according to their 1990 emissions. The three auctioning scenarios included cases where (a) revenues were used to reduce the deficit, (b) revenues were recycled 60% to firms and 40% to consumers in the form of lump sum payments, and (c) revenues were recycled 60% to firms and 40% to consumers by reducing marginal tax rates. EPA's deficit reduction scenario was the most expensive in terms of lost GDP. The cheapest was the auctioning scenario where marginal tax rates were reduced (an undiscounted reduction of GDP below baseline equal to \$1,948 billion through 2020 versus approximately \$1,096 billion). Grandfathering and 60/40 lump sum recycling were in-between at costs of \$1,556 billion and \$1,608 billion respectively.

COMMENTS: These results raise the question whether investor and consumer behavior is being adequately depicted in the DRI model. The \$500 billion difference between the economic impact in the 60/40 lump sum scenario versus the 60/40 change in marginal tax rate scenario appears excessive. Similarly, the nearly identical impact between Grandfathering (which is essentially a 100% lump sum payment to firms) and the 60/40 lump sum scenario seems implausible. Also, the much greater cost of deficit reduction (\$340 billion more than the second most costly alternative) is problematic.

DRI - DOE

DOE also presented one estimate of costs under Grandfathering and three under auctioning. However, all of their auctioning scenarios assumed lump-sum redistribution of revenues. The three auctioning scenarios included cases where (a) revenues were used to reduce the deficit, (b) revenues were recycled 60% to firms and 40% to consumers, and (c) revenues were recycled 100% to consumers. DOE's cost estimates were similar to EPA for the three scenarios both examined. DOE estimates for the 100% recycling scenario (not made by EPA), suggest that it is the cheaper than any other alternative examined by either agency (approximately \$800 billion).

COMMENTS: DOE's estimates raise the same questions about investment behavior in the DRI model as the EPA predictions. Besides the marked differences in GDP over the twenty year period, DOE's material indicates GDP rising above baseline estimates after 2015 in the

Grandfathering scenario. This rise is driven, apparently, by real investment more than \$100 billion above baseline estimates. In fact, investment is shown to rise above baseline estimates after 2015 in all DRI-DOE runs.

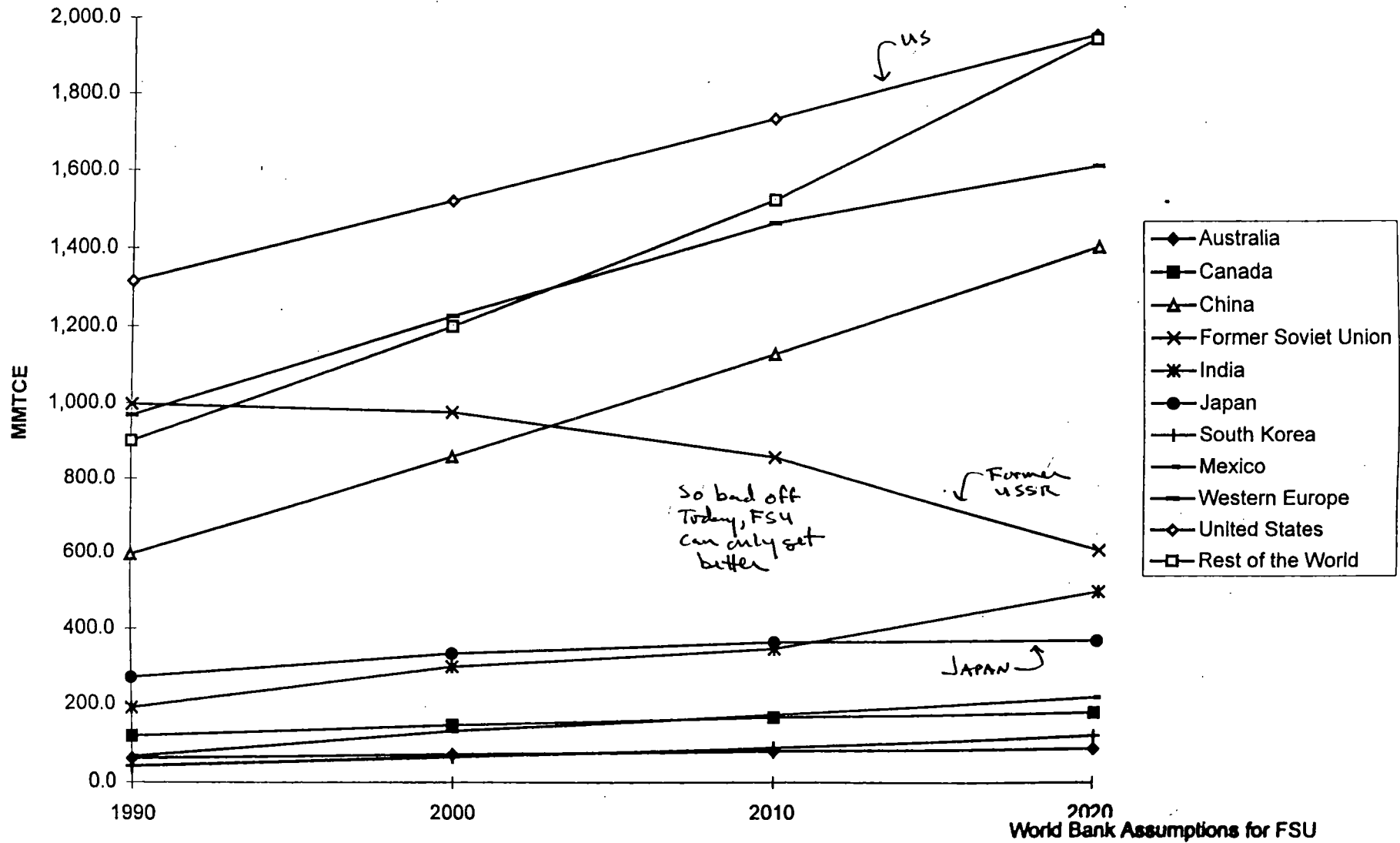
SGM

EPA presented the estimates from the SGM model of the implicit price of carbon for stabilization under different trading scenarios. These scenarios were no trading (for 1.25% and 1.75% rates of decline in E/GDP); Annex I trading (for 1.00% and 1.75% rates of decline in E/GDP); and global JI (for a 1.75% rate of decline in E/GDP). The critical result was the effect of assumptions about the rate of improvement in energy efficiency on the implicit price of carbon (and, therefore, on the costs of reducing CO₂) in Annex I countries. At 1.00%, the price was \$104 by 2020. At 1.75%, it was \$33 in 2020.

COMMENTS: Certain refinements in the SGM to improve its ability to predict the differential impact of global policies on individual countries would be helpful. One would be the ability to predict the impact of JI programs of varying scope and size. The estimates presented today appear to have assumed a JI program with effects comparable to a world-wide permit trading program. Also, the ability to estimate carbon leakage and the impact of permit allocation formulas that reflect factors other than each participating country's historical rate of emissions would be useful.

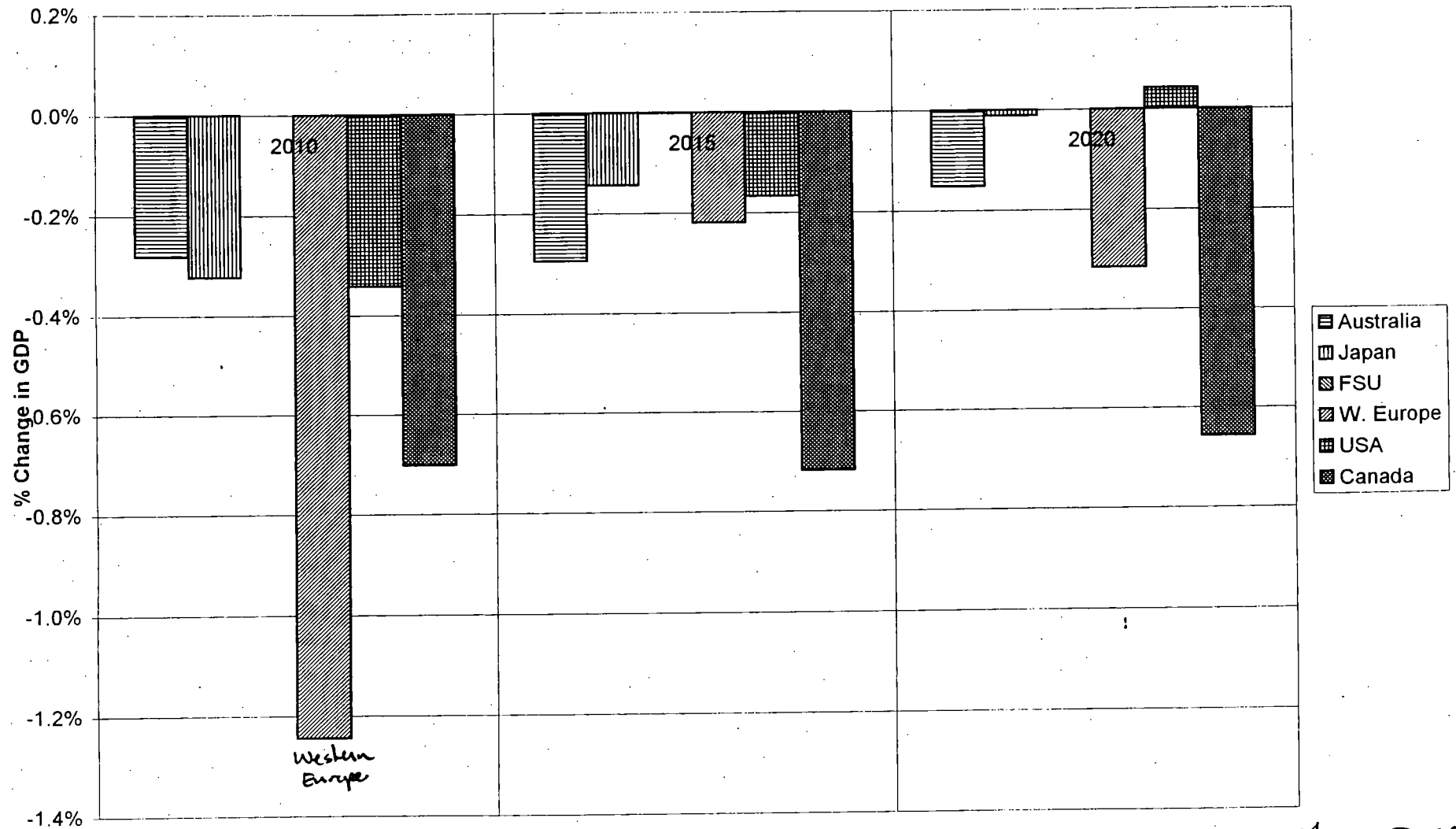
FURTHER COMMENT: It would be useful to make estimates of GDP loss for the least cost scenario consistent with the assumptions that the IAT is willing to accept. This scenario would assume a 1.75% annual rate of decline in E/GDP and auctioning of permits. The allocation formula consistent with this scenario is not clear, so one purpose of this exercise would be to identify that formula. The major purpose of the exercise, however, to prepare for any questions that may arise if the policy preferred by decision-makers deviates from the least cost scenario.

SGM Baseline Carbon Emissions (MMTCE)



Change in GDP: Independent Stabilization Relative to Basecase

⇒ NO TRADING



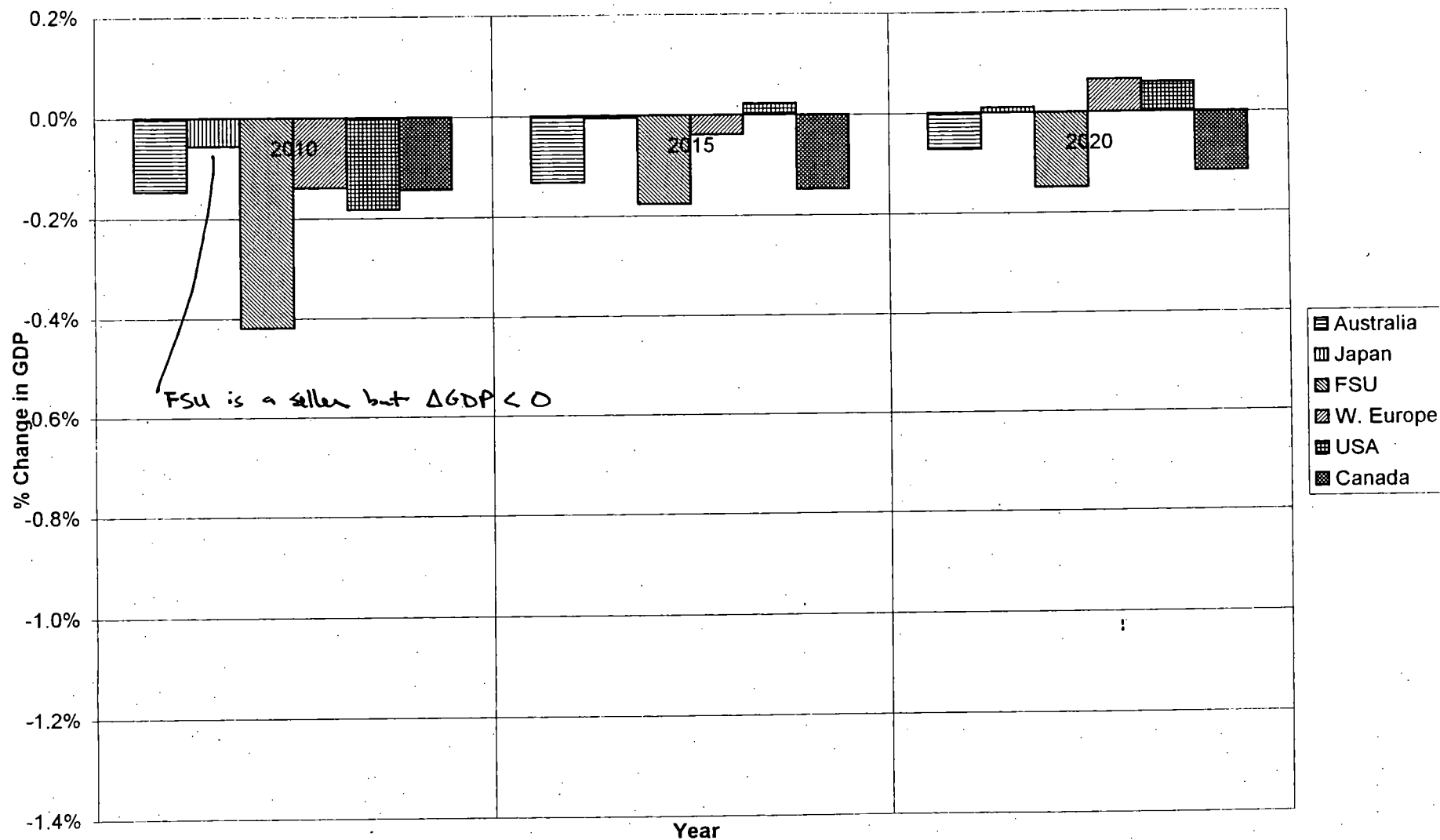
→ Have they estimated the cost of achieving this 75% yr

0.75% increase in innovation and diffusion spurred by policy

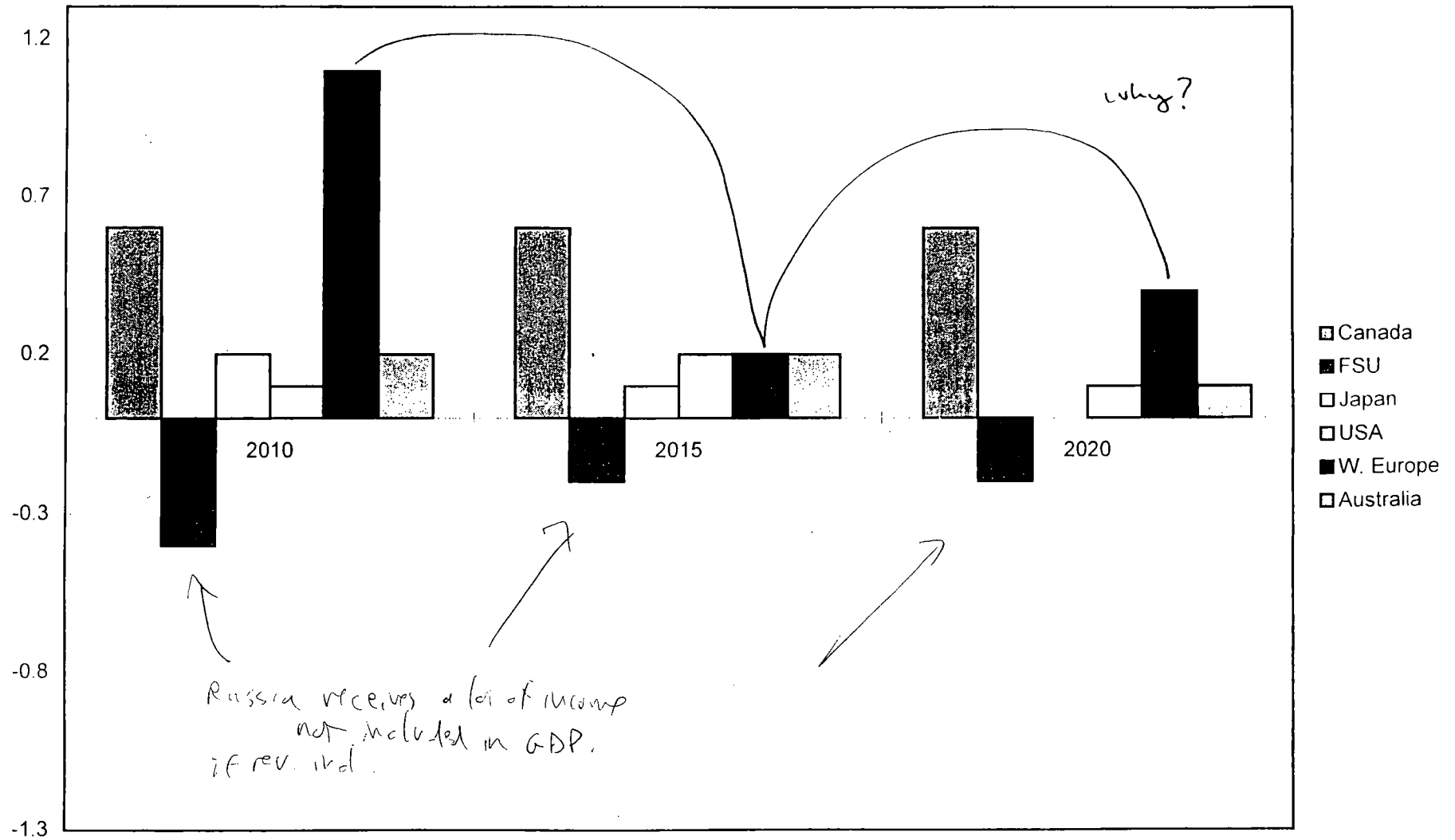
↳ C/GDP

FSU E/GDP projections from World Bank and others (Planecon, Hughes, PNL)

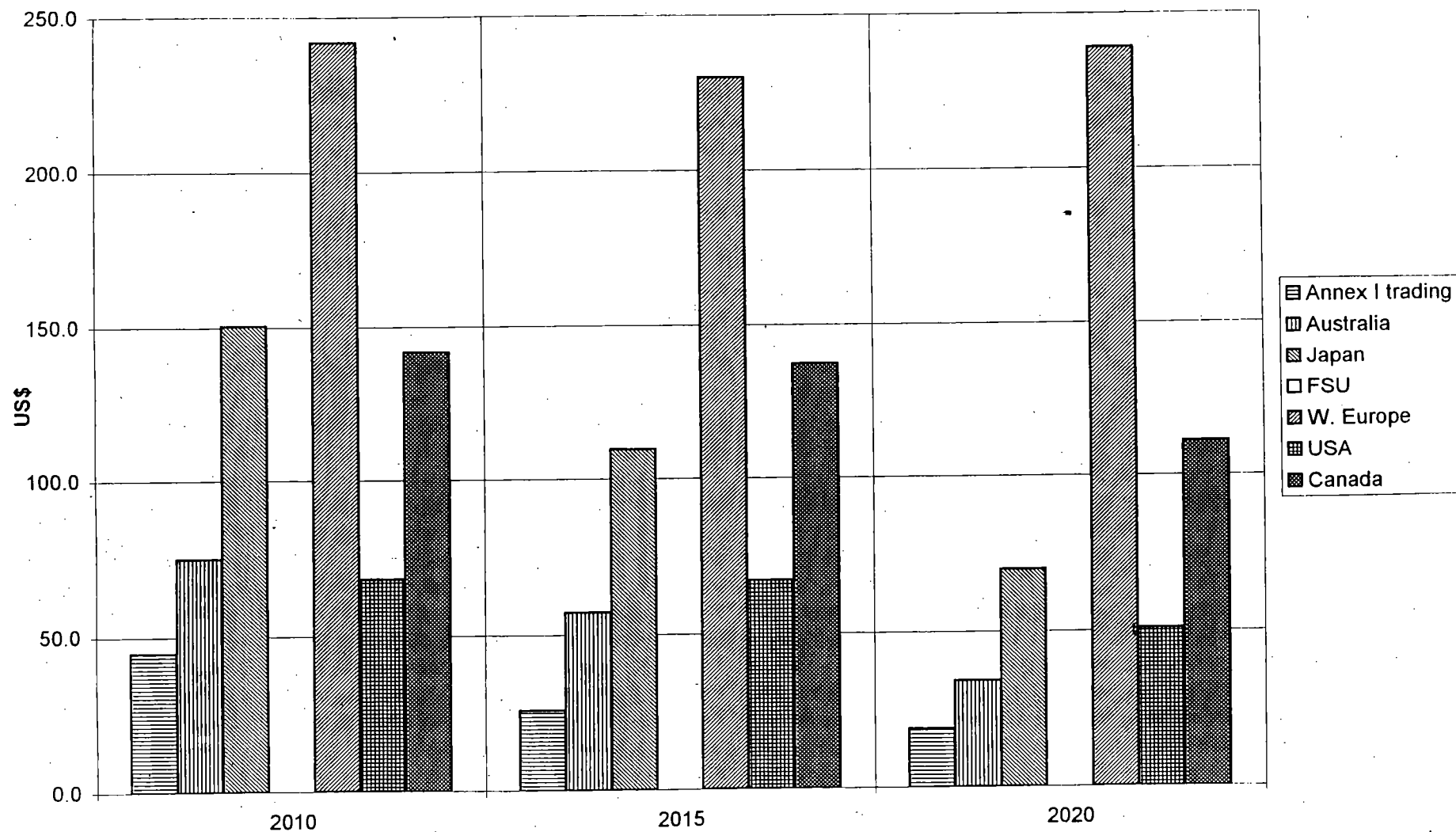
Change in GDP: Annex I Trading Relative to Basecase



Percent GDP Differences Between Independent Stabilization and Annex I Trading



Implied permit prices for no trading, Annex I trading cases

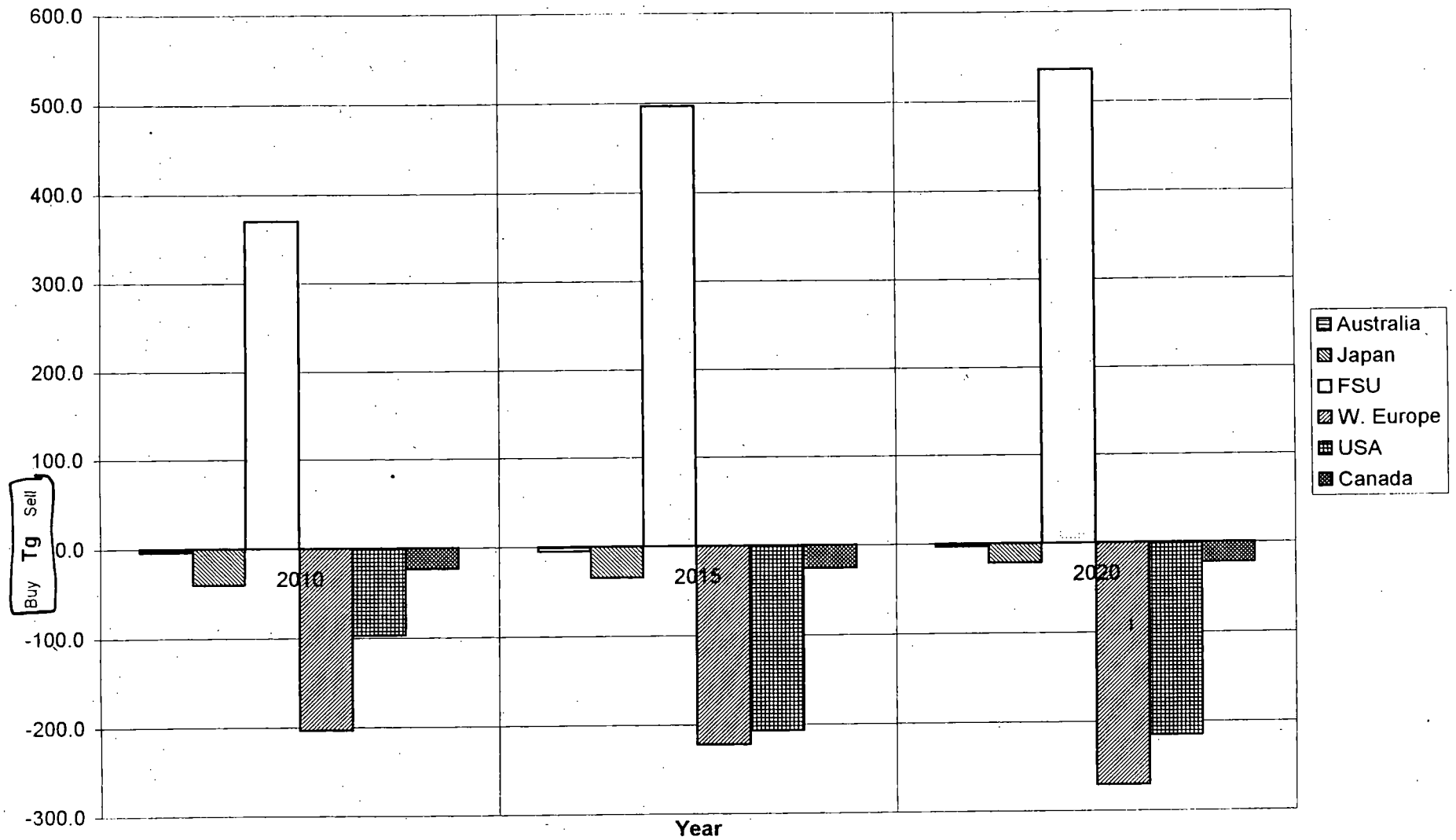


0.75% increase in innovation and diffusion spurred by policy

cost estimate?

FSU E/GDP projections from World Bank, others (Planecon, Hughes, and PNL)

Level of permit trading across Annex I countries



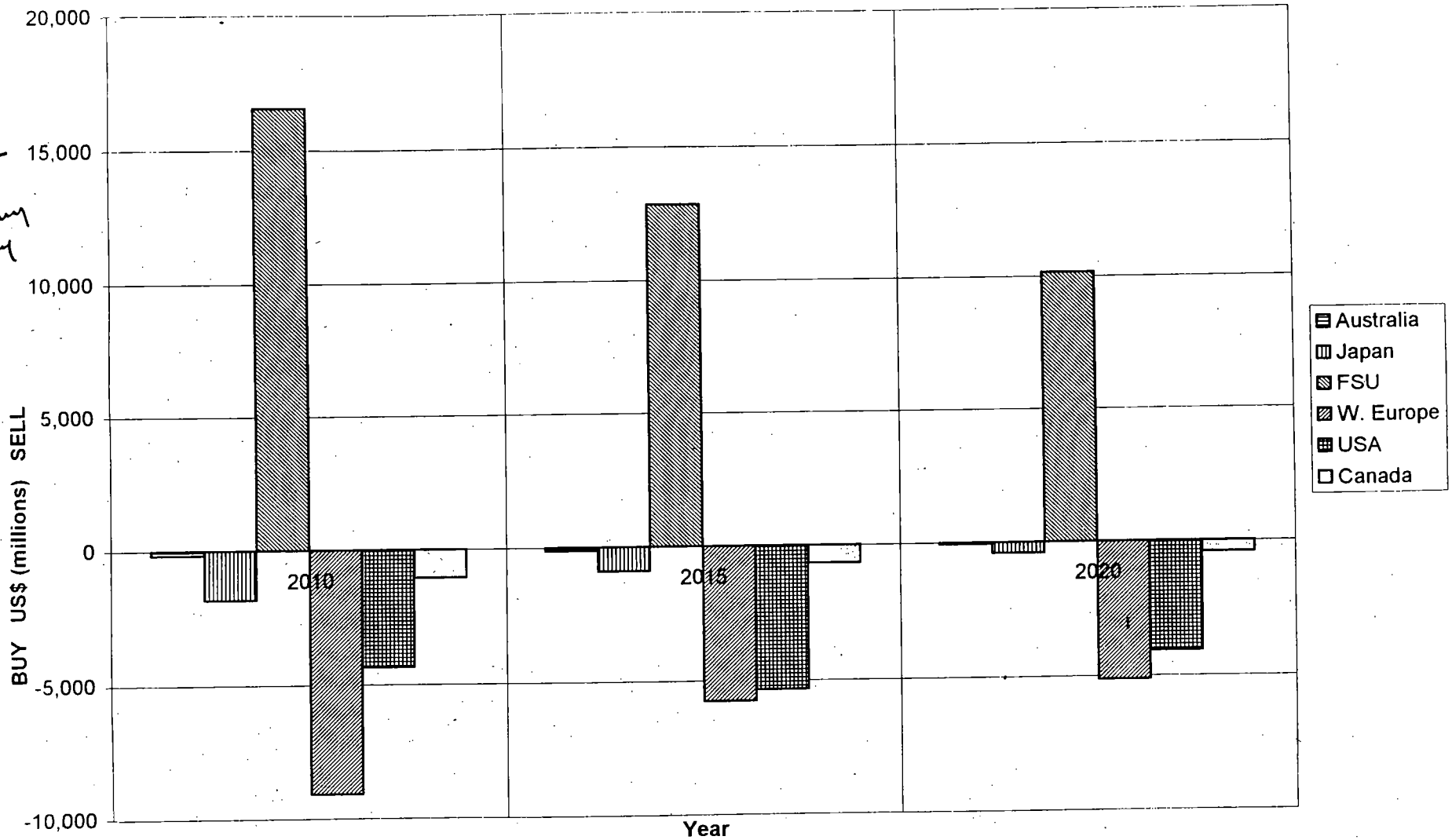
0.75% increase in innovation and diffusion spurred by policy

FSU E/GDP projections from World Bank and others (Planecon, Hughes, PNL)

Total value of traded permits

~ How is this calculated

2 times the US economy today

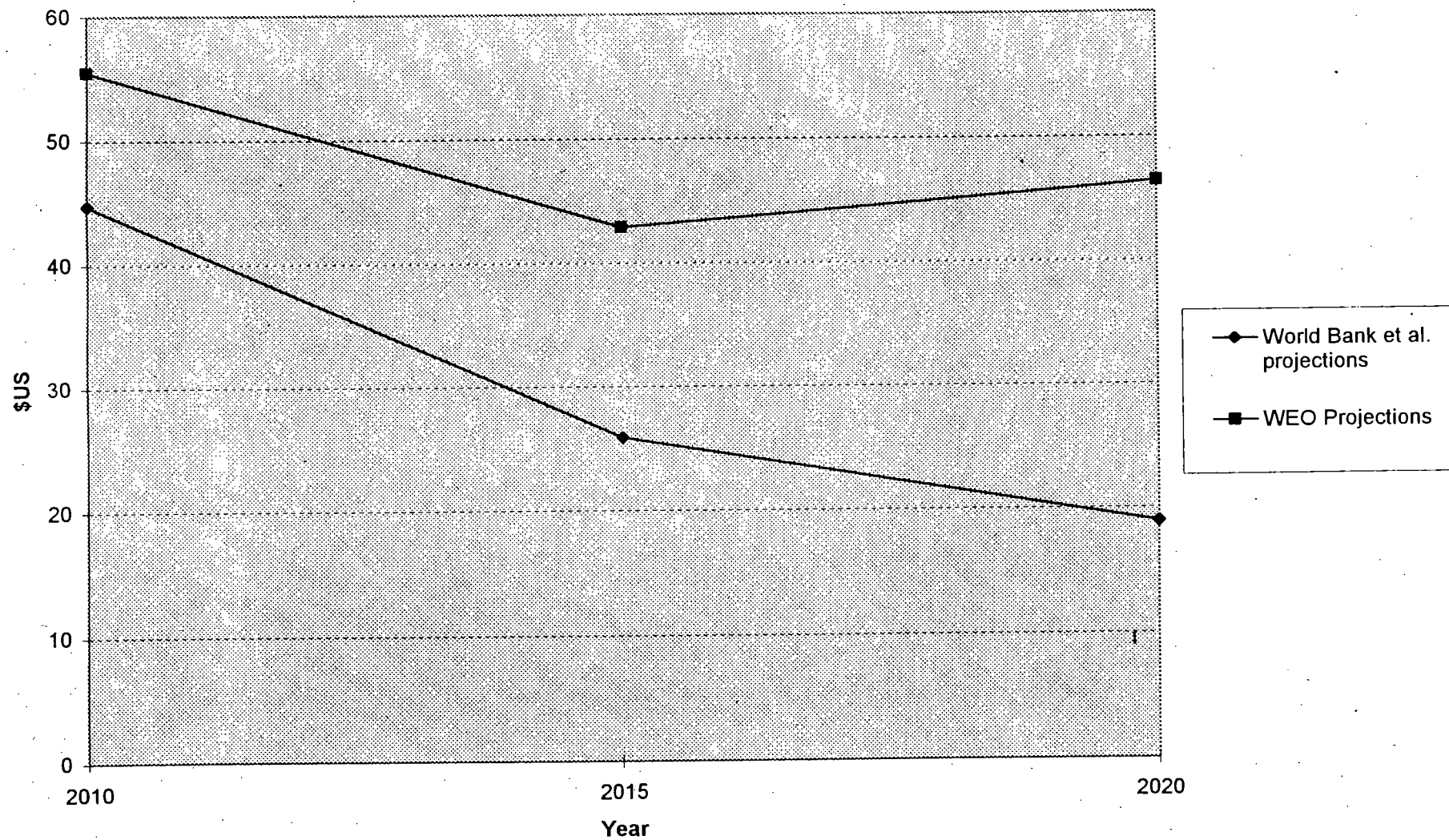


0.75% increase in innovation and diffusion spurred by policy

FSU E/GDP projections from World Bank, others (Planecon, Hughes, and PNL)

achieve achieve

Annex I permit prices are strongly influenced by FSU energy efficiency



Stabilization in Annex I countries

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

Most discussions have focused on what steps might be taken in the medium term (2010-2020) to reduce emissions of greenhouse gases. Such actions represent only an initial step and, by themselves, would fall far short of significantly reducing the risks of climate change. Much more long-term planning will be necessary to achieve the goal of the Framework Convention on Climate Change:

"stabilization of greenhouse gas concentrations . . . at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should . . . allow ecosystems to adapt naturally to climate change; ensure that food production is not threatened; and enable economic development to proceed in a sustainable manner."

This paper describes emissions paths that would be necessary to achieve various longer-term goals of stabilizing atmospheric concentrations of greenhouse gases. It also explores the implications that a longer term goal has for shaping near-term policy decisions.

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

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

I. GLOBAL EMISSIONS AND ATMOSPHERIC CONCENTRATIONS

In the absence of any actions specifically to limit carbon dioxide emissions, the Intergovernmental Panel on Climate Change (IPCC), as shown in Figure 1, estimated that current emissions (as shown by the 2 upper lines labeled Business as Usual [BAU]) of 6 billion tons of carbon per year could grow to between 15-25 billion tons of carbon by 2050 and continue to

increase through the end of the next century.

Global CO₂ Emissions & Concentrations

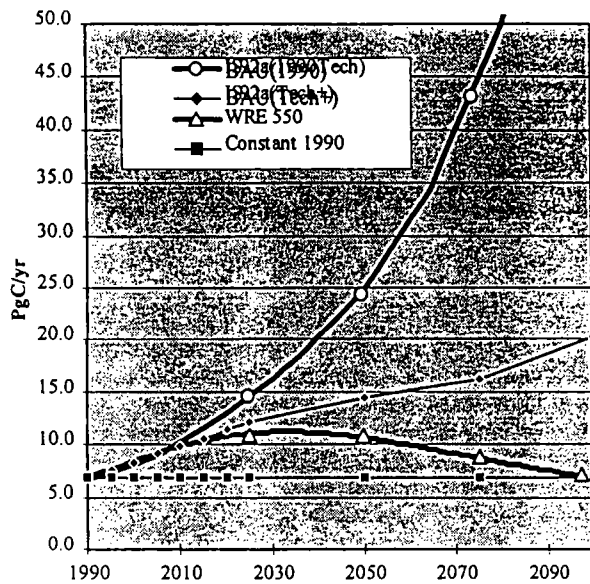


Figure 1

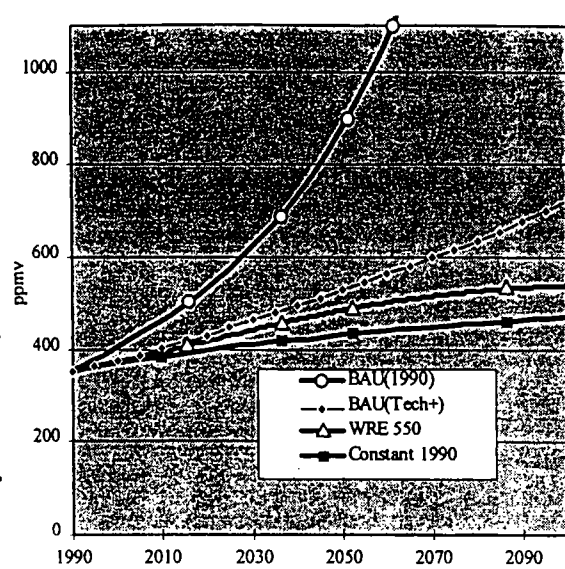


Figure 2

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

If it were possible to cap global emissions in both developed and developing countries at 1990 levels, figure 2 (line labeled "constant 1990") shows that concentrations would nonetheless continue to rise throughout the next century and beyond, eventually exceeding a doubling of preindustrial levels. (Note that the other greenhouse gases make the effective concentration about 20% higher than indicated by CO₂ alone.)

Figure 3 shows the projected long-term atmospheric concentrations if emissions were stabilized at different levels. The figure shows that if emissions were stabilized at current levels (6 PgC/yr), atmospheric concentrations would grow to almost 500 ppm by 2100 and continue increasing thereafter. It also shows that if worldwide emissions are frozen at 10 PgC/yr, roughly 33 percent higher than today's level, then atmospheric concentrations would more than double from pre-industrial levels by 2100, and continue to increase thereafter.

CO2 Concentrations Associated with BAU(Tech+) and Alternative Energy Related Emissions Stabilization Levels

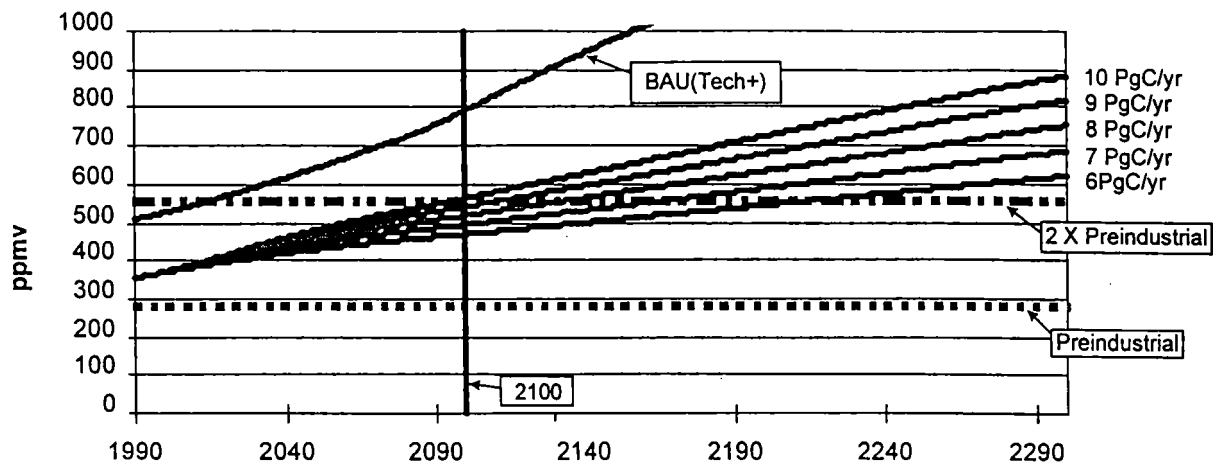


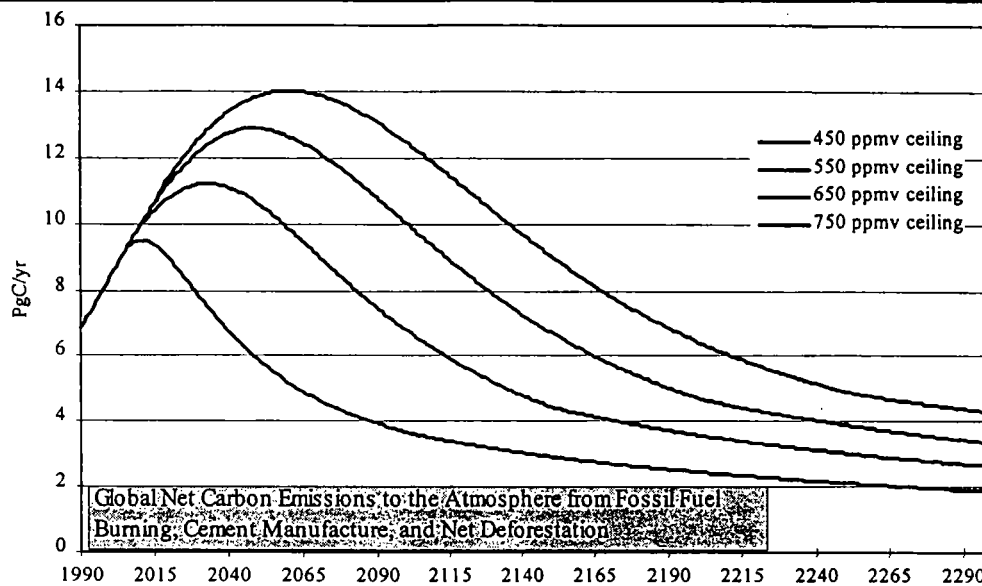
Figure 3

Table 1 shows how various concentration targets relate to emissions pathways. For example, to meet a 550 ppmv concentration goal, global emissions must begin to deflect from the business-as-usual curve by 2013. In this scenario, emissions would peak at 9.7 PgC/yr in 2033 and drop rapidly thereafter.

Researchers have examined in some detail the annual emissions paths required to meet atmospheric carbon concentration targets of 450 to 750 ppm. These targets require significant reductions in cumulative projected global carbon emissions; and as shown in Figure 3, all of them require dramatic reductions in annual emissions rates sometime during the next century. To achieve 450 ppm target – which still represents a two-thirds increase in atmospheric concentrations over preindustrial levels – annual emissions must begin declining steeply within the next quarter-century and must fall to less than half the current rate by 2100. To achieve a 550 ppm concentration target – which represents about a doubling in atmospheric concentrations – annual emissions must begin declining steeply during the second quarter of the century. Furthermore, these budgets must be distributed both across countries and across time.

The relationship between CO2 concentrations and emissions pathways (energy emissions only)*				
Steady-State Concentration →	450	550	650	750
	ppmv	ppmv	ppmv	ppmv
Deflection Date BAU (Tech+) ^a	2007	2013	2018	2023
Maximum Emission Date	2011	2033	2049	2062
Maximum Emission ^b	8.0	9.7	11.4	12.5

^a The deflection date is the year in which emissions first fall below BAU emissions.
^b Maximum PgC/yr fossil fuel carbon emissions. If other greenhouse gases were included, emissions would be effectively 20% higher; thus, reductions would have to occur sooner than the deflection date noted to achieve a given concentration.



* - note: the curves in the graph represent slightly different values than those in the table because the graph takes cement manufacture and deforestation into account in addition to energy emissions.

Figure 4

II. DEVELOPED AND DEVELOPING COUNTRY EMISSION TRENDS

Figure 5 presents current and projected emissions of carbon dioxide for developed and developing countries. Of the current emissions of roughly 6 billion tons, approximately two-thirds are from developed and one-third from developing countries. The U.S. is currently the largest emitter of carbon dioxide, with China the second largest source. However, on a per capita basis, the U.S. emits about 5 tons of carbon per capita, compared to an average of approximately 4 tons per capita in Japan and Western Europe, and 0.4 tons per capita for developing countries. Figure 6 shows per capita emissions for the BAU case out to 2100. While per capita differences remain large over time, by the middle of the next century, developing countries would become a source for more than half of total global emissions.

Annex I and Non-Annex I Fossil Fuel Carbon Emissions: BAU(Tech+)

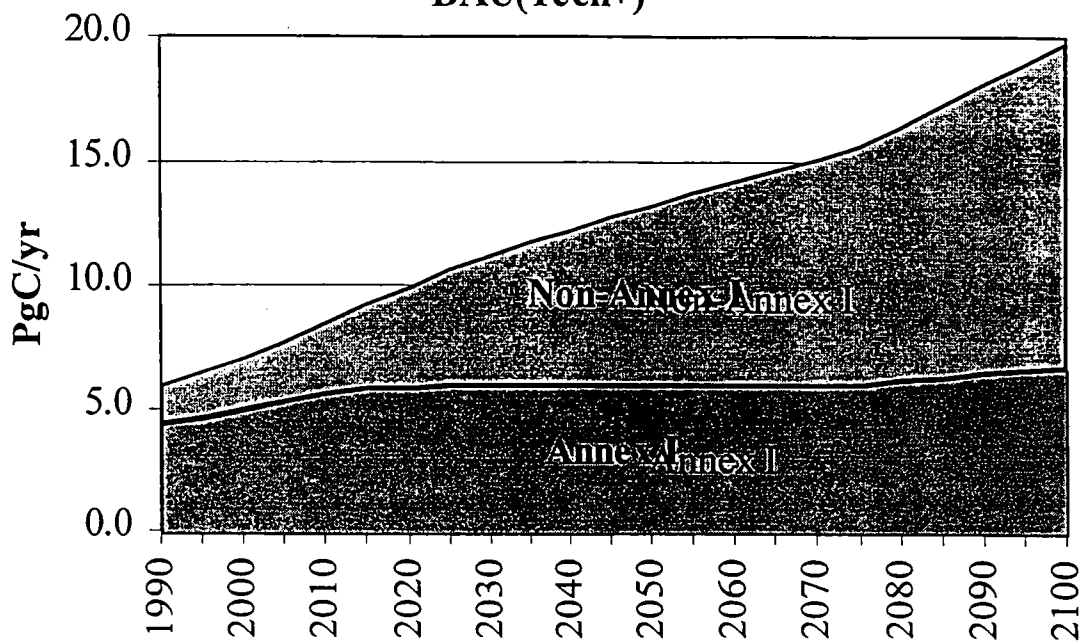


Figure 5

Per Capita Carbon Emissions By Region: BAU(Tech+)

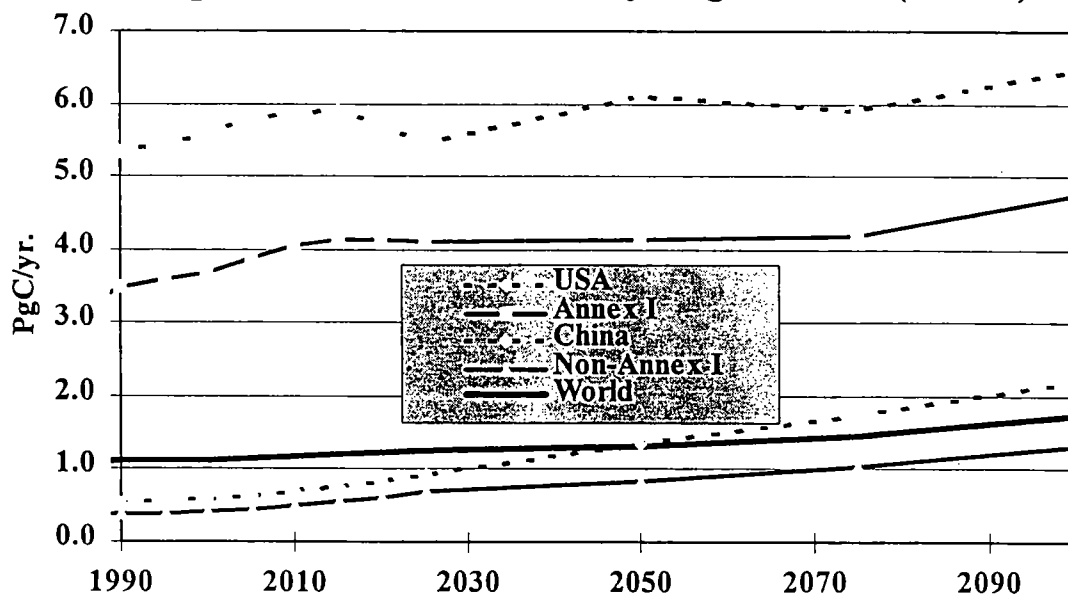


Figure 6

III. ILLUSTRATIVE EMISSION REDUCTION SCENARIOS

Limited mid-term actions to reduce emissions by developed countries alone have little impact on shifting the atmospheric concentrations curve. The top line in Figure 7 shows the small change

in concentrations if Annex I (developed countries) freeze emissions at 1990 levels in the year 2010. Successive lines show what a coal ban in various parts of the world (beginning in 2020) might do to emissions and concentrations. Without the participation of developing countries, concentrations will not stabilize.

Global Paths for BAU(Tech+), Annex I Emissions Stabilization, Coal Bans

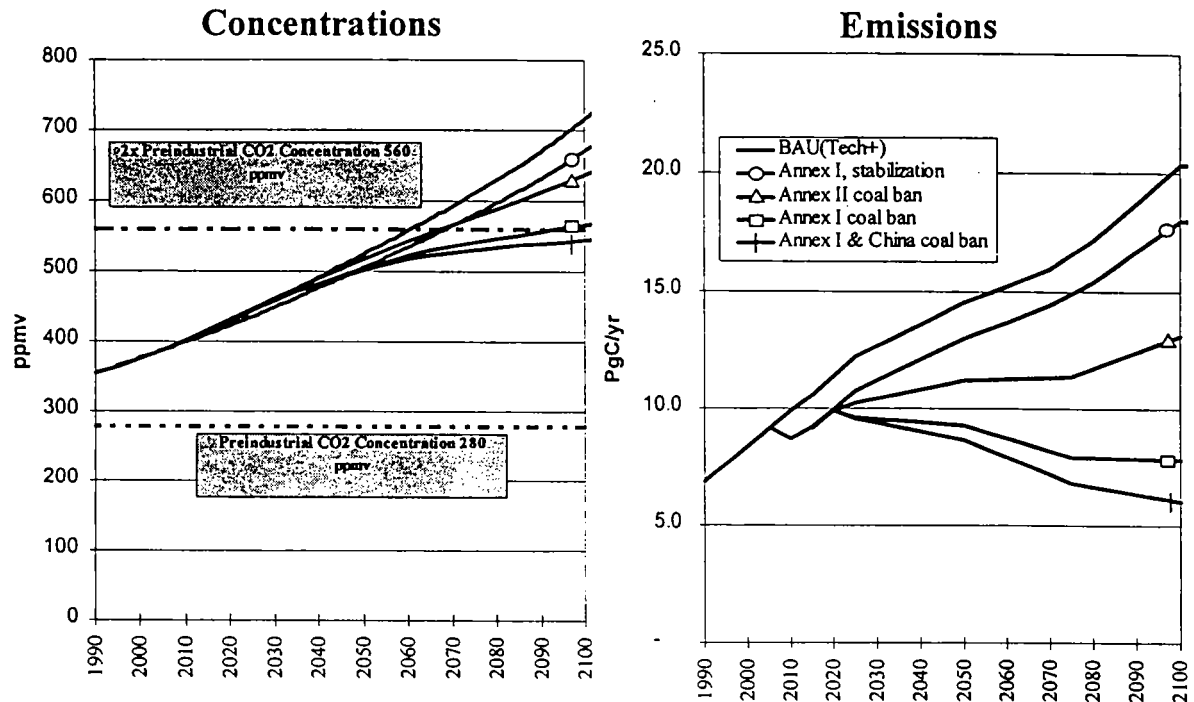
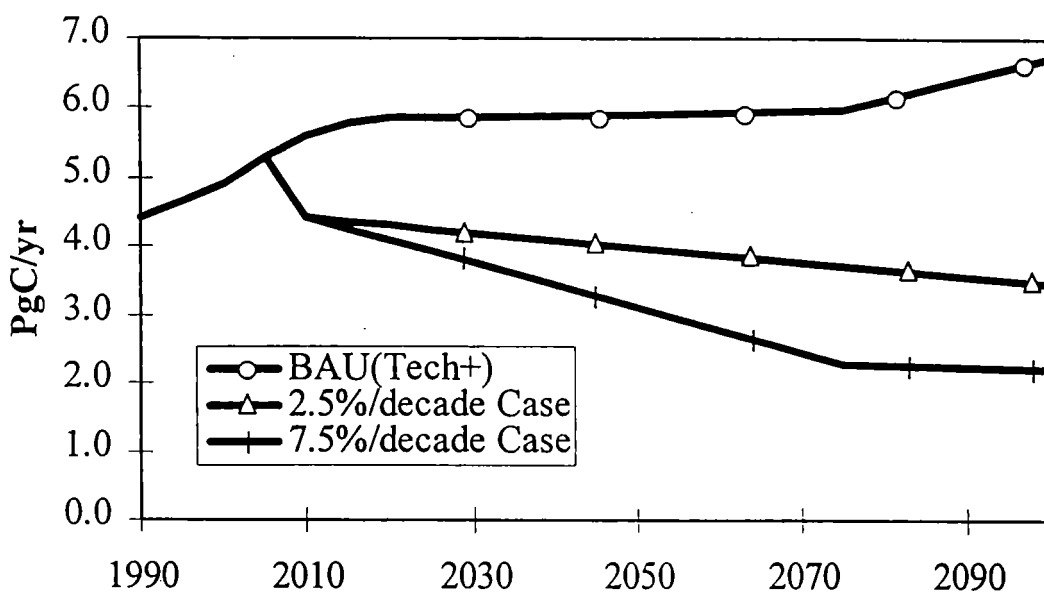


Figure 7

Annex I Fossil Fuel Carbon Emissions: BAU(Tech+), and 2.5%/Decade, & 7.5%/Decade Reductions



2.5%/Decade Case assumes that Annex I nations stabilize emissions at 1990 levels in 2010 and then reduce emissions at 2.5%/decade through the year 2100.

7.5%/Decade Case assumes that Annex I nations stabilize emissions at 1990 levels in 2010 and then reduce emissions at 7.5%/decade until they are 50% of 1990 levels after which time they are held constant.

Figure 8

Figure 8 illustrates two possible emissions profiles for developed (Annex I) countries. Both scenarios assume a freeze in emissions at 1990 levels in 2010. On the hatched line, emissions are then reduced by 2.5% per decade and in the lower line they are reduced at 7.5% per decade. The highest line is the business-as-usual (TECH+) scenario from the IPCC.

Figure 9 is based on the Annex I pathways described in Figure 6. They show the pathway developing countries would need to follow to stabilize concentrations at 450 ppm, 550 ppm and 650 ppm. These figures show that to achieve stabilization at 550, developing countries would be able to emit on their currently projected path until about 2020 before significant reductions would be required.

Figures 10 and 11 show the **per capita** emissions for both developed and developing countries that result from the scenarios described in the previous two figures. They show that under these scenarios, developed country emissions stay substantially greater than those in developing countries (which rise to 1 TC/person only in the 650 ppm case).

Allowable Non-Annex I Emissions if Annex I Countries Stabilize then Reduce Emissions: 450 ppmv, 550 ppmv & 650 ppmv CO₂ Ceilings

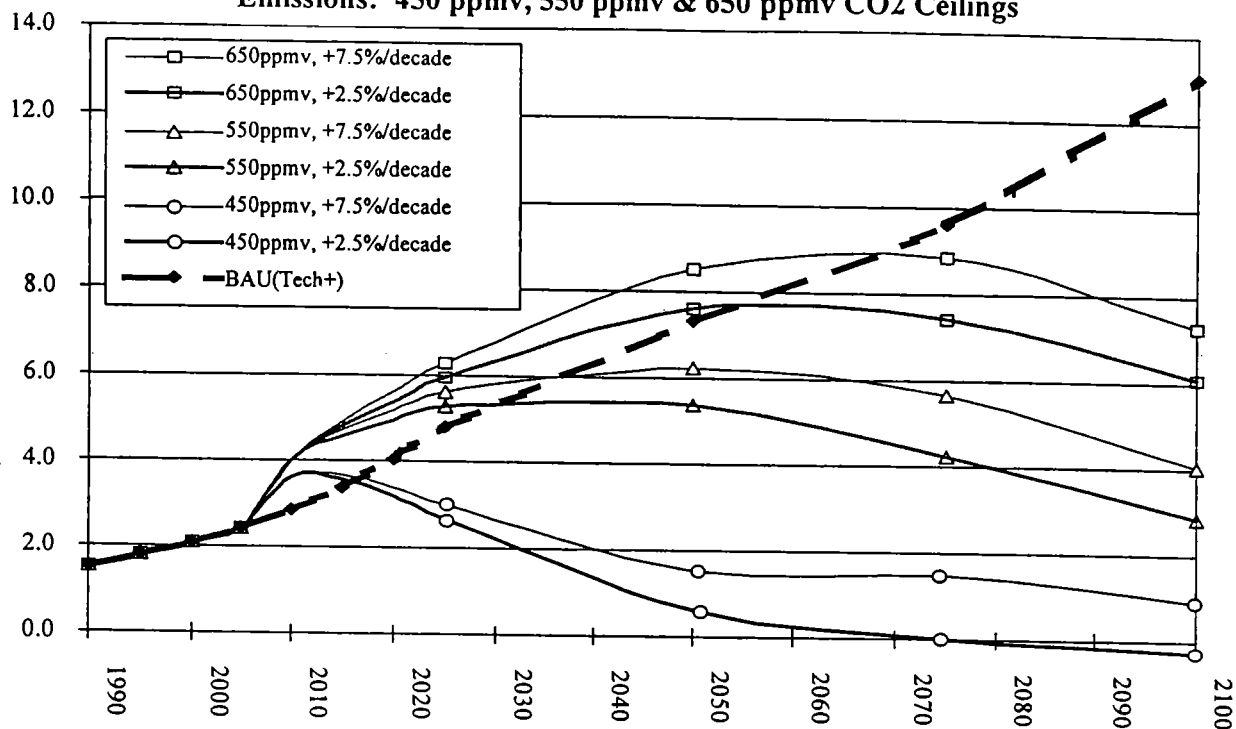


Figure 9

Per Capita Emissions Various CO₂ Concentration Ceilings--Annex I 2.5%/Decade Emissions Reductions

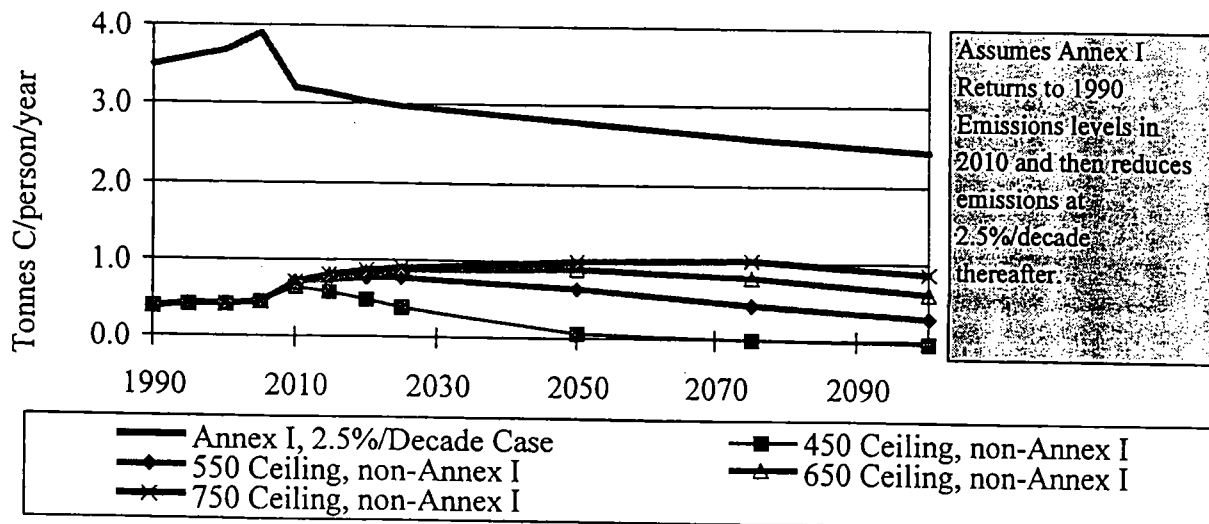


Figure 10

Per Capita Emissions

Various CO2 Concentration Ceilings--Annex I 7.5%/Decade Emissions Reductions

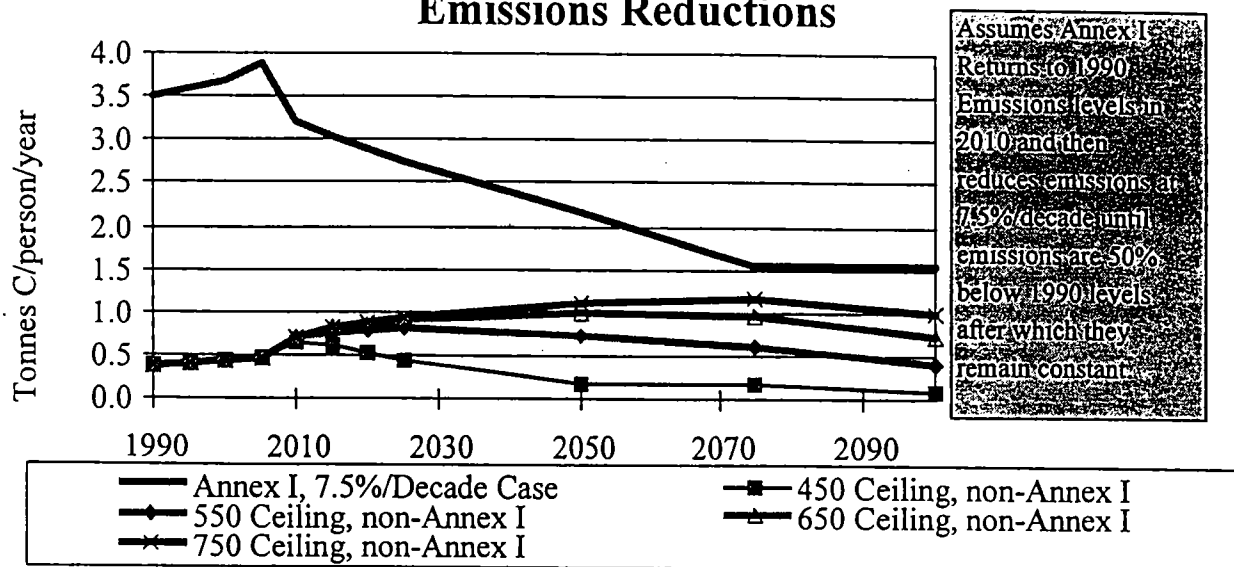


Figure 11

IV. THE ROLE OF TECHNOLOGY AND IMPACTS ON COSTS

As suggested in Figure 1, the rate of technological change can play a very important role in determining the level at which atmospheric concentrations can be stabilized. Figure 11 looks specifically at the costs associated with different technology cases. It looks at three specific cases:

- 1990 tech: assumes no technological change from 1990
- 1990 tech +: assumes significant improvements in reducing the costs of alternative fuels and in improving efficiency;
- Advanced tech: assumes even further advances and cost savings.

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

Figure 11 shows for each of these technology cases, the total costs associated with achieving three different levels of atmospheric concentrations: 550, 650 and 750 ppm. The estimated costs under the assumption that no technological progress is possible were found to be about \$12 trillion or 1.2% of total world GDP, compared to \$1 trillion or 0.12% of GDP assuming substantial progress in reduction technologies. In the advanced technology case, which assumes very substantial non-fossil alternatives will be available by 2020, the costs are greatly reduced. However, the assumed cost and performance of the alternative technologies would only

become achievable with significant increases in research and development investments. For example, funding in conservation and renewables is about half of what it was 15 years ago, despite substantial proposed increases each year of the Clinton Administration.

The Relationship Between Technology and Minimum Cost of Stabilizing the Atmosphere Below Various Ceilings

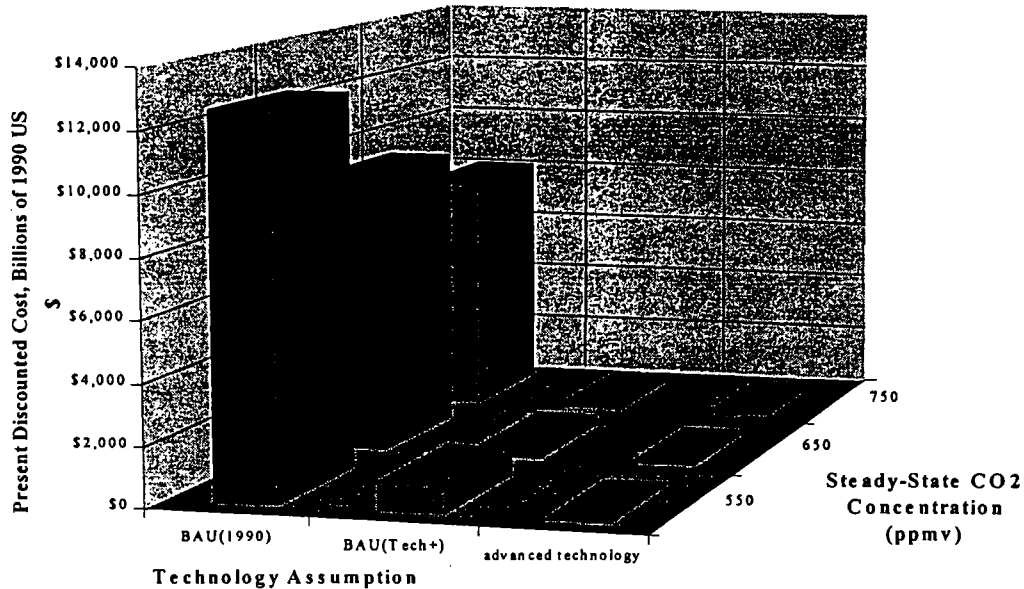


Figure 12

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

APPENDIX

Key Assumptions about Technology Scenarios:

IS92a (Tech+)

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

Advanced Energy Technology

- Advanced solar/wind/fusion
 - The cost of solar/wind power reaches a busbar cost of \$0.04/kWh by 2020 and
 - the cost decreases at 0.5 %/year thereafter.
- Low cost biomass
 - By the year 2020, 20% of the biomass resource is available at \$1.40/GJ and
 - 80% is available at \$2.40
- Advanced liquefied hydrogen fuel cells for transport

Date: 25 February 97

To: Jeff Frankel
Alicia Munnell

From: Jason Shogren

RE: Modeling Issues to consider for the Upcoming Deputies meetings on Thursday

1. Revenue Recycling.

In the modeling runs, permits are auctioned off with the revenues being split 60/40 toward reducing profit/income taxes. This 60/40 split cuts GDP losses by 2/3 relative to a grandfathering scheme. Somebody will have to explain where this 60/40 split came from and why it is the only one we considered. A question that should be addressed-- how robust are these big GDP savings to alternative splits in revenue recycling? Other splits might be run to see if the investment modeling decisions are credible.

Not a key
issue

2. Technology.

Going back to the technology-on-steroids (1.75 AEEI) question. Talking with Janet Yellen, she asked the following question--ignoring global climate change for the moment, if society decided to tighten its belt by consuming less and investing more, would we think that the biggest productivity gains could be achieved by investing in more energy efficient capital rather than in some other form of capital, say like human capital? This option is not reflected in the modeling choices as far as I can tell.

3. Most Optimistic Scenario.

There might be some merit in asking the modelers to run the most optimist scenario now (e.g., 1.75 tech., auctioning and revenue recycling) to see what exactly it looks like. The favorite strategy of the EPA is to keep moving up the bar--more and more optimistic. If we can establish an upper bound and if this upper bound is unreasonable, then we can start moving the modeling runs downward rather than upward as is the case now.

4. Borrowing and Budget Periods.

Borrowing remains a contentious issue. Mark Mazur suggested that we could give borrowing up if in return we can get a multi-year budget period that uses average emission levels as the target. The multi-year averaging might serve the same purpose without all the red flags of a no-teeth agreement.

Yes

check my
develop
3 yrs.

5. Regional results.

Attached are some new regional results from the SGM model (EPA). The last page shows the implicit carbon price for Annex I trading (with 0.01% and 0.75% improvements in the carbon to GDP ratio). The technology assumption is important--prices are 3 times greater when technology follows historical patterns.

SGM International Base Case

Gross Domestic Product

	1990	2000	2010	2020
Australia (Bil Aust. \$85)	257	334	433	514
Canada (Bil Can. \$85)	521	663	842	949
China (100 Bil. Yuan, 1985)	13	30	63	111
Former Soviet Union (Bil. Rubles, 85)	768	597	879	1,218
India (100 Mil. Rupees, 1985)	26,735	42,635	63,670	91,244
Japan (Bil. Yen, 1985)	370,365	453,586	538,036	588,575
South Korea (Bil. Won, 1985)	96,563	162,082	289,873	447,605
Mexico (Bil. Peso, 1985)	59,066	84,996	123,736	168,462
Western Europe (Bil. US\$, 1985)	3,322	4,421	5,528	7,030
United States (Bil US\$, 1992)	6,139	7,544	9,179	10,573
Rest of the World (Bil. US\$, 1985)	1,585	2,278	3,260	4,477

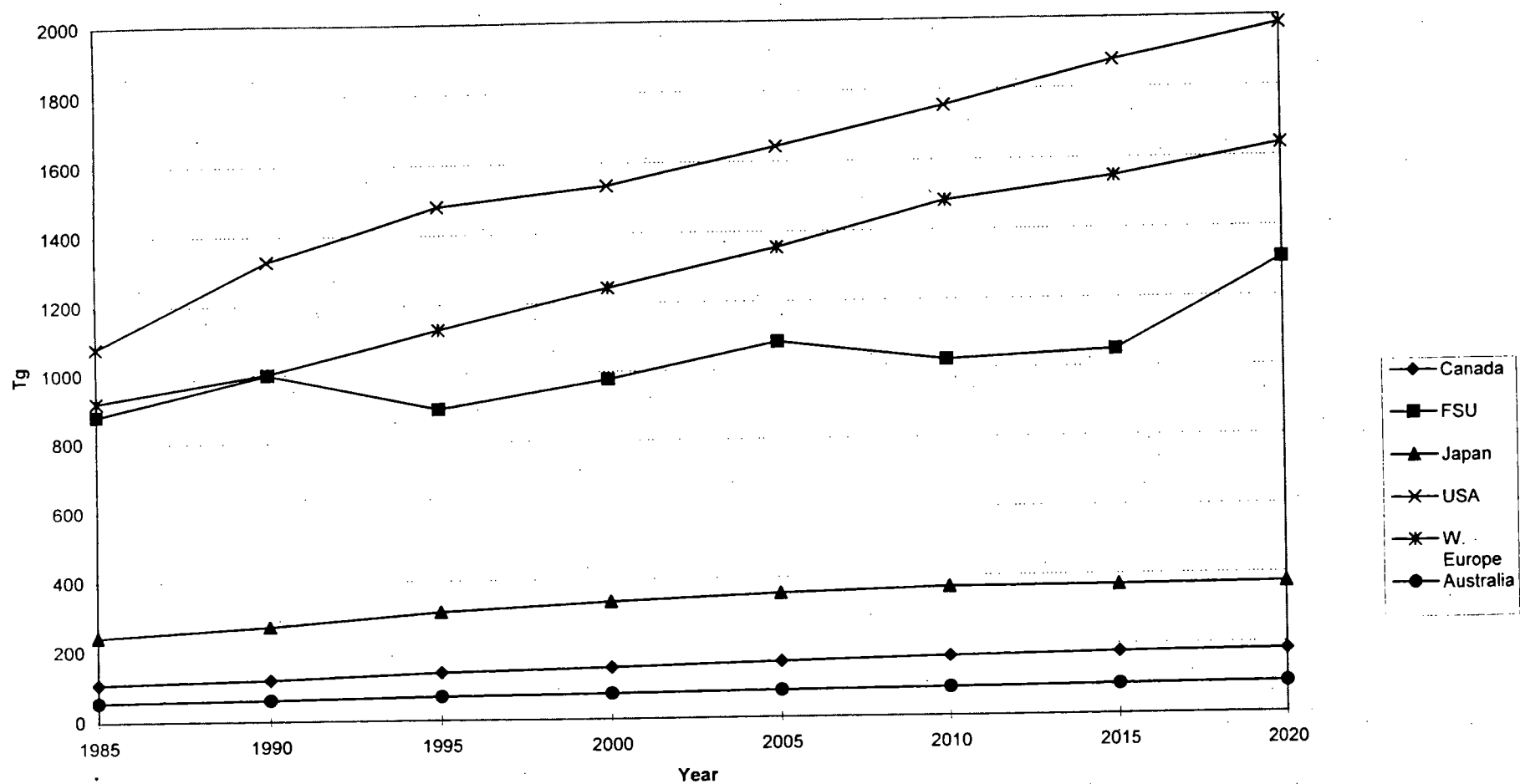
Total Energy Consumption (Quads)

	1990	2000	2010	2020
Australia	3	4	4	4
Canada	10	11	12	13
China	27	38	49	62
Former Soviet Union	56	51	58	71
India	7	11	13	19
Japan	15	17	18	19
South Korea	3	4	6	8
Mexico	5	7	9	12
Western Europe	62	76	85	93
United States	80	91	101	110
Rest of the World	49	65	81	102

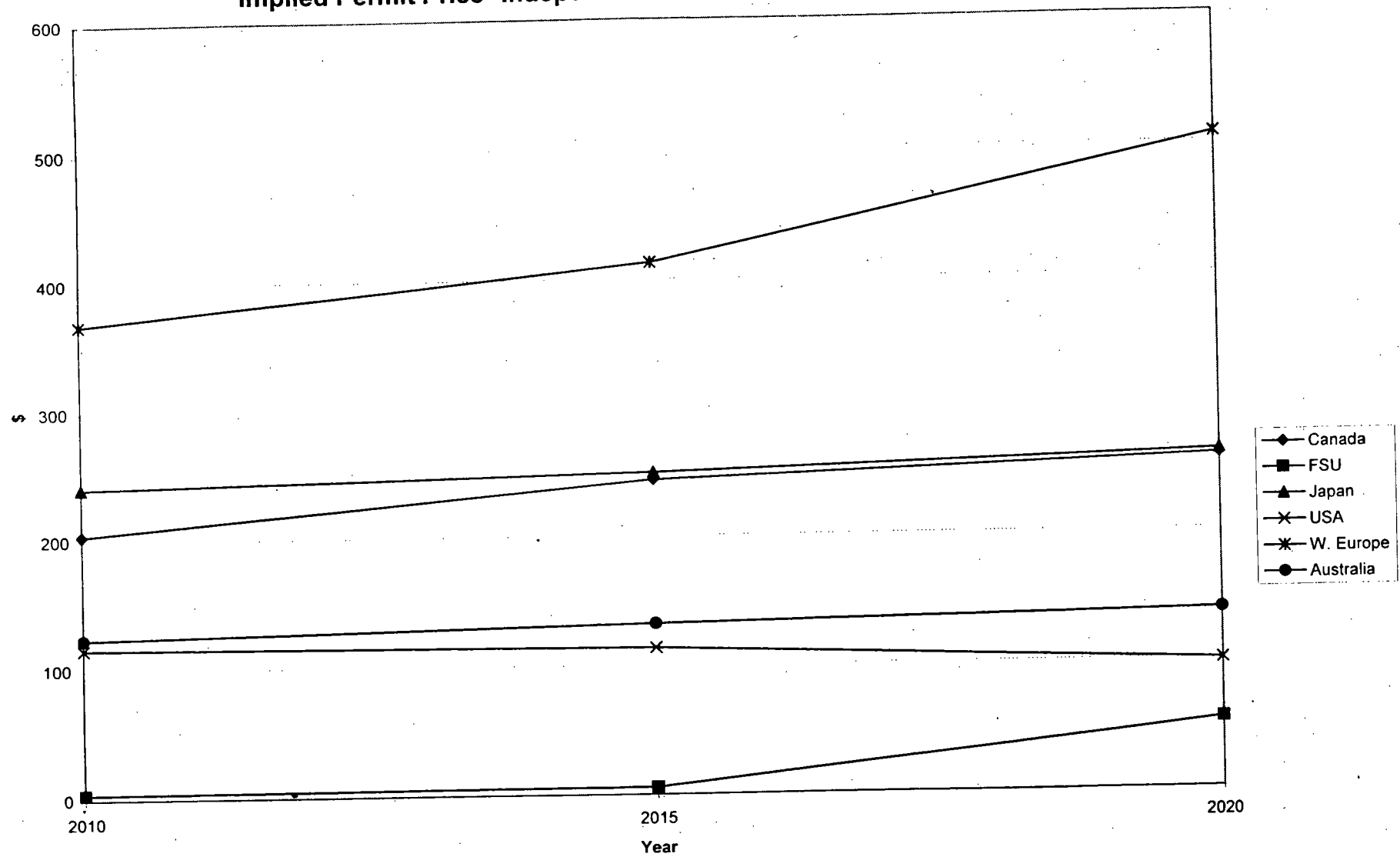
Total Carbon Emissions MMTCE

	1990	2000	2010	2020
Australia	60.4	71.7	80.5	86.8
Canada	117.4	146.9	168.6	180.1
China	595.9	859.0	1,130.5	1,405.5
Former Soviet Union	967.0	967.0	1,011.0	1,290.0
India	191.3	301.0	350.7	501.5
Japan	271.6	336.4	367.8	373.0
South Korea	40.7	65.2	89.0	120.1
Mexico	65.2	131.0	175.4	221.2
Western Europe	969.0	1,226.6	1,464.3	1,613.7
United States	1,315.9	1,520.1	1,736.3	1,958.1
Rest of the World	901.0	1,199.6	1,523.1	1,946.4
Total Carbon Emissions MMTCE	5,495.4	6,824.5	8,097.2	9,696.4

Baseline Emissions

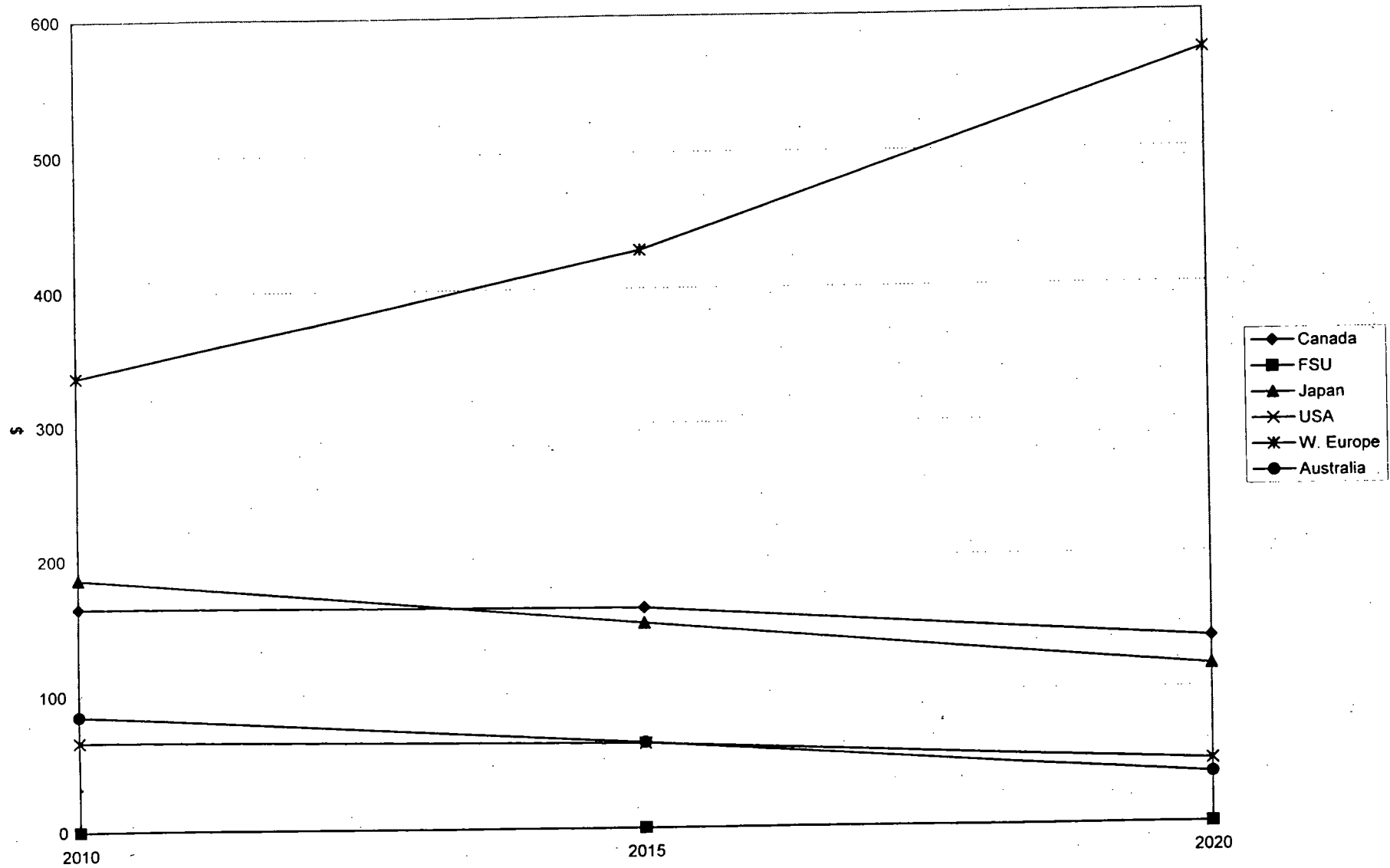


Implied Permit Price--Independent Stabilization--No Announcement Effect

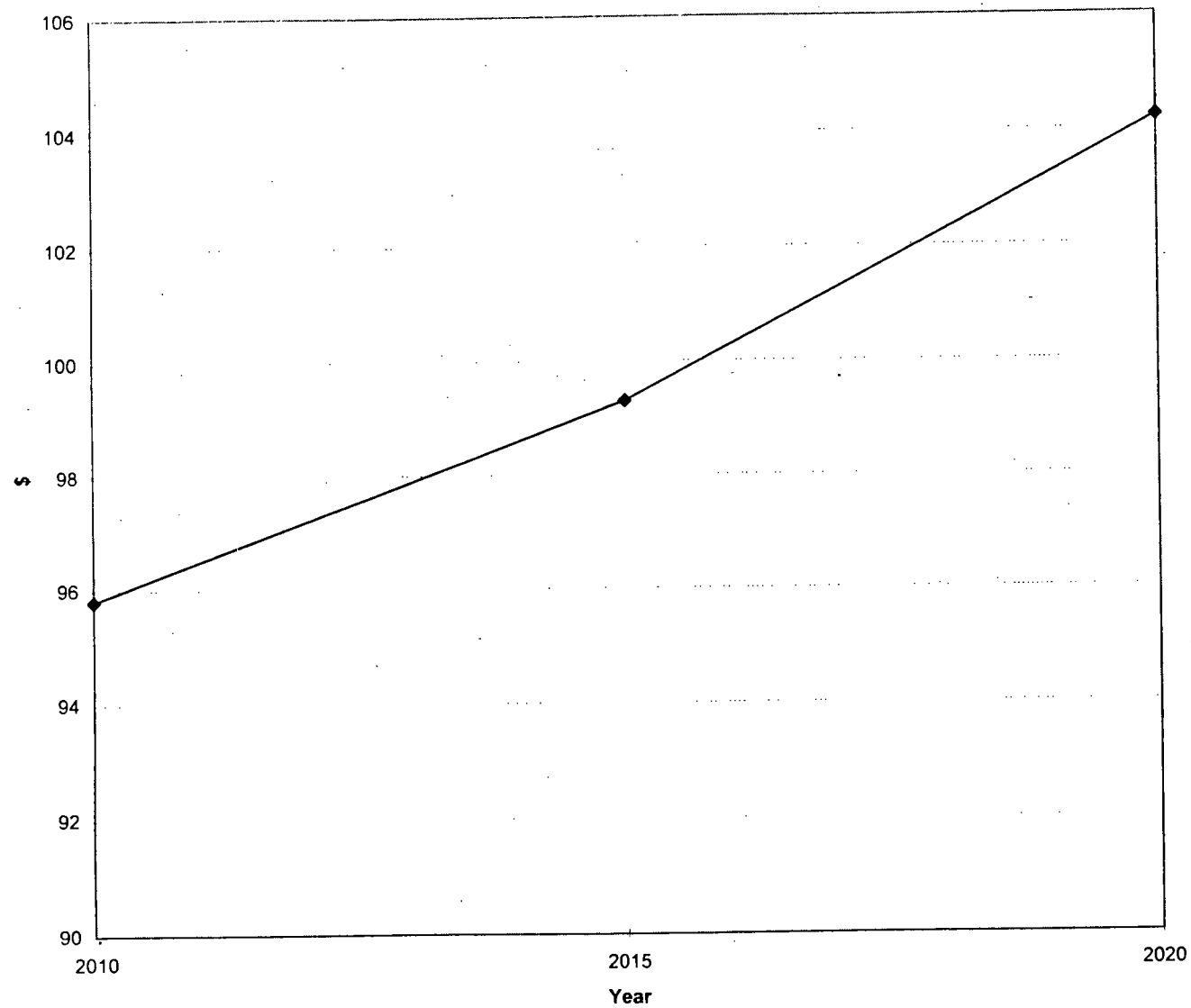


Implied Permit Price--Independent Stabilization, 0.75% increase in C/GDP

carbon efficiency

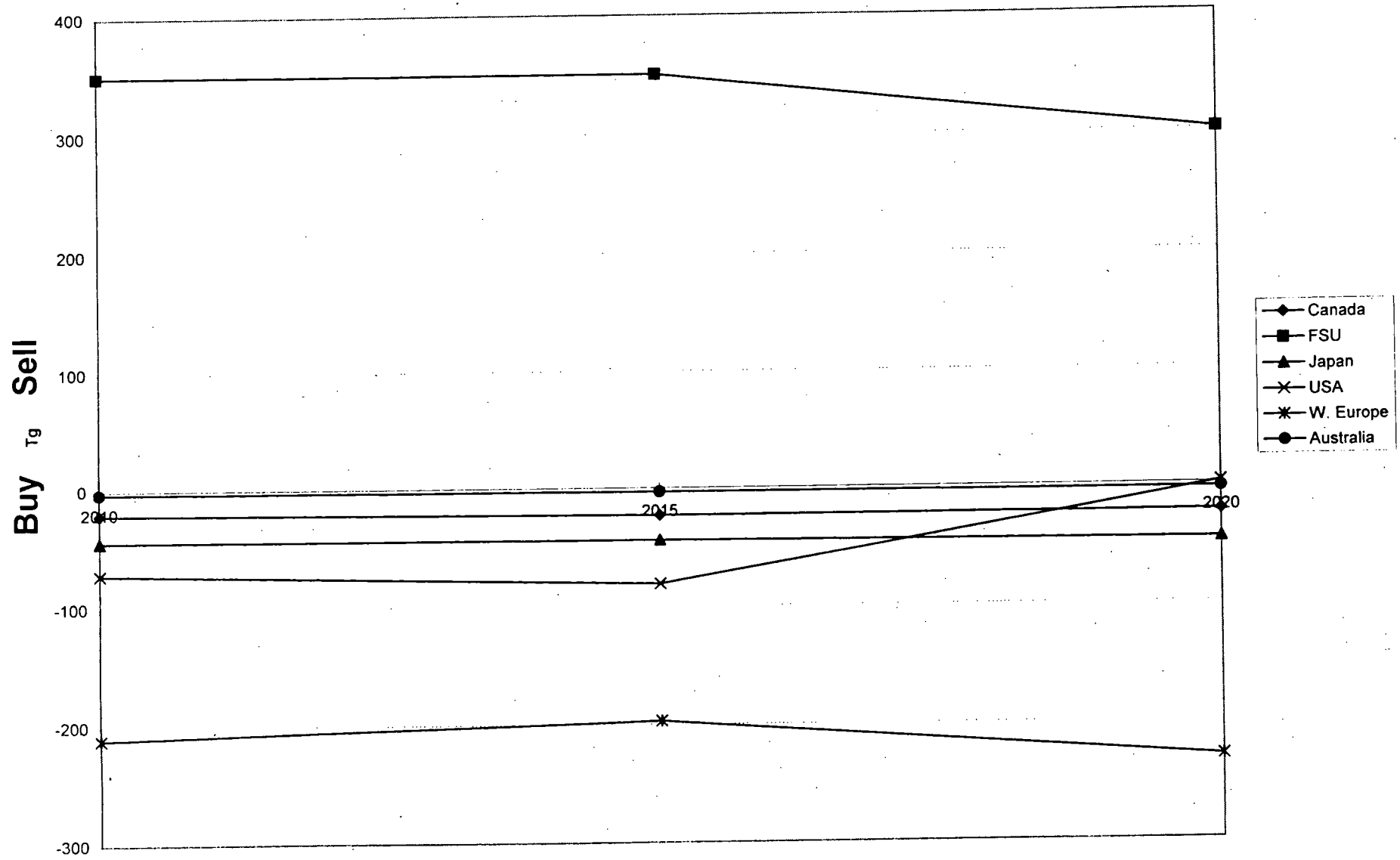


Implied Permit Price--Annex I Trading--No Announcement Effect

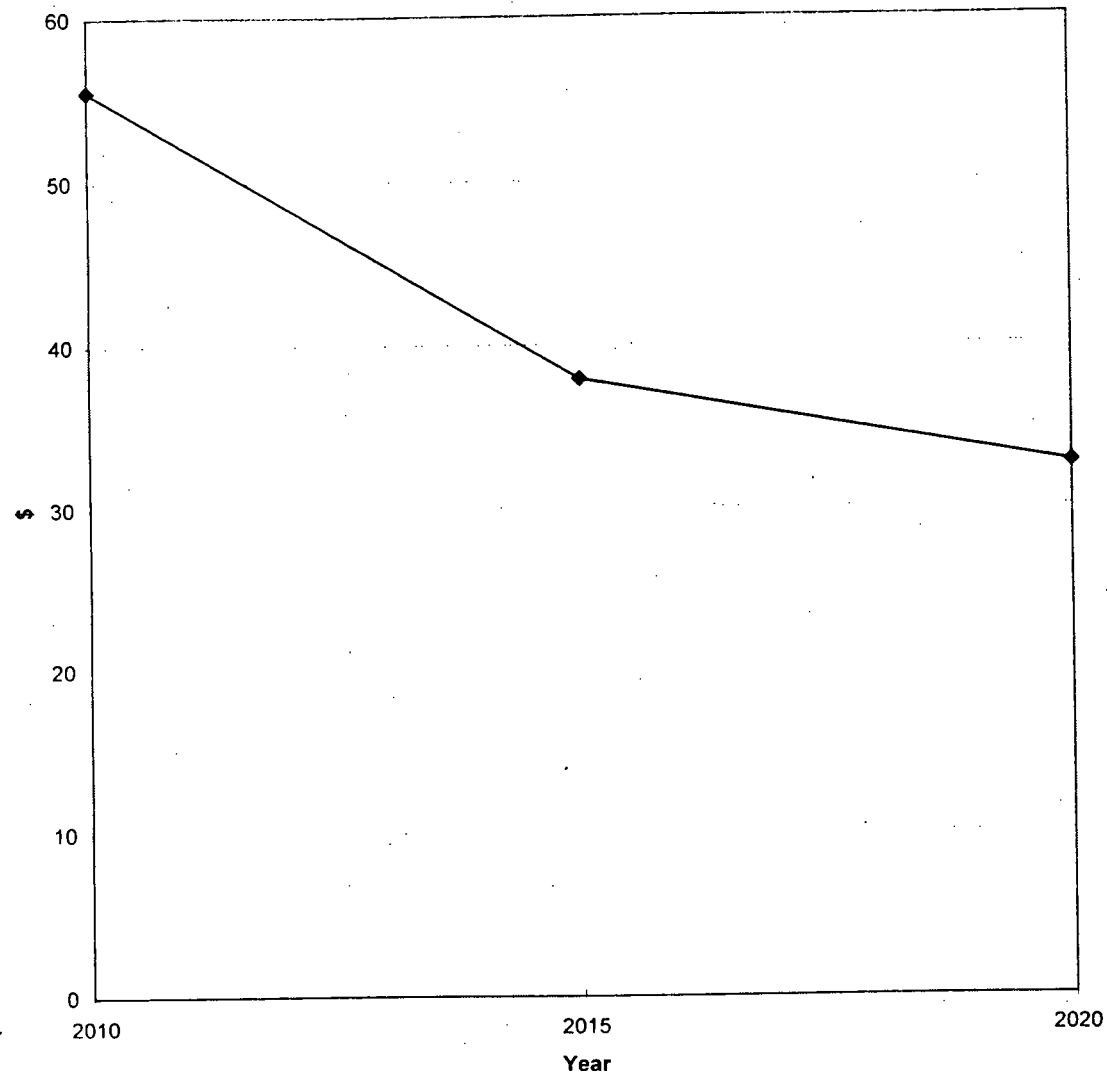


$\approx 10\%$ increase in
price over
10 years.

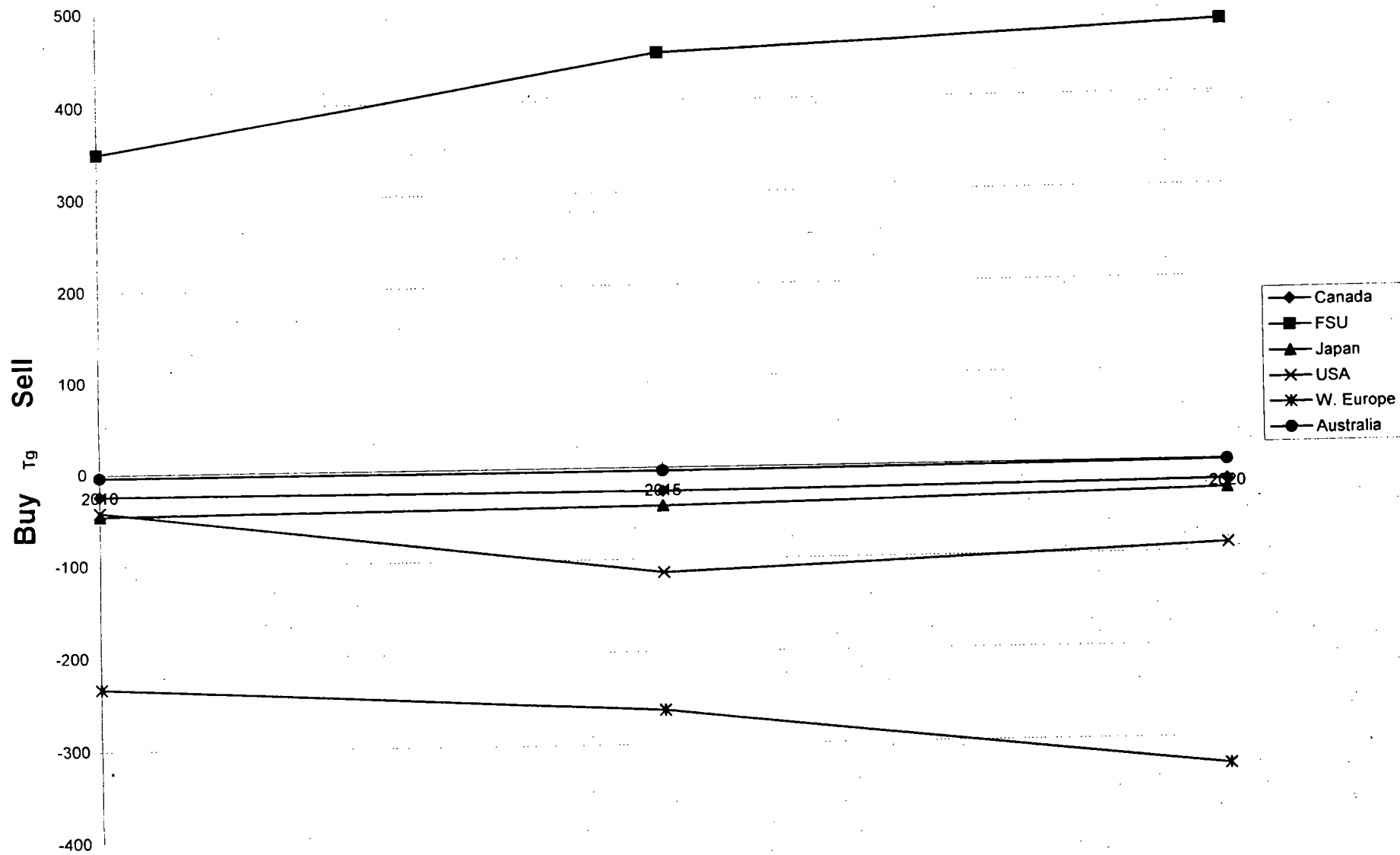
Permit Trading--Annex I Trading--No Announcement Effect



Implied Permit Price--Annex I Trading--0.75% increase in C/GDP



Permit Trading--Annex I Trading--0.75% increase in C/GDP



Implicit Permit Price (\$/Ton C)

CCAP

— US Only Stab (0.25%) Indus
 US Only Stab (0.75%) Indus.
 Annex I Trading (0.0%)
 Annex I Trading (0.75%)
 Global JI (0.75%)

	2010		2015		2020
\$	81	\$	81	\$	65
\$	57	\$	56	\$	42
\$	95	\$	99	\$	104
\$	55	\$	38	\$	33
\$	19	\$	11	\$	9



Deputies' consideration and feedback are requested regarding the following:

I. The Assistant Secretaries group has concluded that a combination of policy responses appear capable of (1) achieving realistic medium-term emission budgets (levels to be determined), and (2) promoting technological changes needed for longer-term emission reductions. These include:

- Emissions cap(s), with emissions trading to promote efficiency and lower costs.
- Programs to increase the pace of technology diffusion (CCAP, potentially expanded).
- Increased support for R&D on GHG-reducing technologies (relevant to both medium- and long-term).
- Potential to build GHG reductions into other current policy initiatives (ISTEA, electricity restructuring).
- Potential for selected standards and regulations (e.g., product efficiency standards).

II. The AS group recommends that all five areas be pursued, although possibly on different schedules.

- 1) Options for expanding or refocusing *technology diffusion* and *R&D* should be developed and evaluated right away, with a possible goal of announcing support for new initiatives as early as this summer (possibly, in connection with G-7), and to integrate any additional resource needs of these programs into the next (FY99) budget cycle.
- 2) Options for *cap and trade* design have been developed to a level sufficient to familiarize senior policy makers with general contours and capacity of this approach to achieve objectives. Further option development should be pursued now only to the levels relevant to modeling economic impact of various potential budgets. Development and deputy-level consideration of more detailed proposals (e.g., addressing sectoral- or firm-level allocations) should be deferred until after Kyoto (after cap size, and timing have been determined).
- 3) Potential to achieve GHG reductions through *ISTEA* is already being explored by EPA and DOT. Potential for same through *electricity restructuring* legislation is being explored by EPA and DOE. This work should be brought forward in context of Administration processes for taking positions this winter in both areas, with the climate deputies group as the focal point for making sure climate change is appropriately addressed in those areas.

- 4) Options for additional *product efficiency standards* or other *direct regulatory approaches* should be deliberately pursued where not especially controversial. Potential options should be developed for possible announcement as early as this summer. Strategy for motor vehicle area needs to be discussed.

III. The AS group also recommends that a paper exploring the five approaches under consideration should be made public (possibly through a white paper, or Federal Register publication), with a view to engaging Congress and stakeholders in comment and discussion. This should be part of a broader strategy to enhance public knowledge of climate change risks, reasons for actions, economic analysis, etc.

Budget Size and Timetable:

What do we have to know, and when do we have to know it?

Background. The Convention has a "six months notice" rule for proposals, i.e., proposals for adopting amendments/protocols in Kyoto in December have to be circulated to the Parties in June. Counting time needed for translation into all UN languages, the Convention Secretariat has set April 15 as the final deadline for Parties to submit proposals.

- The notice requirement is similar to that in US administrative law. The proposals have to put the Parties on fair notice of the character, magnitude, and timing of commitments they will be asked to adopt in Kyoto. The process does not require the exact final text to be proposed in April -- Parties can negotiate changes in proposals and adopt them in December, so long as they are reasonable outgrowths of the proposals made by April.

Having already made our structural proposals, when do we have to say more on budget levels or time frames?

1) *February-March negotiating session?* The US does not need to provide further information on budget size or timetable for this negotiating session. Our structural proposals have already been advanced in the US proposed protocol text.

- The Secretariat has compiled all of the proposals submitted in January into one massive document. This compilation will be unwieldy for negotiating purposes. The goal of the February meeting is to start blending various proposals into a single text (perhaps a "Chairman's text") that covers and begins to merge options the Parties have advanced. Since some other Parties have proposed specific targets or dates, they will push for that text to reflect them.
- This process of creating a "Chairman's text" is not likely to be completed at this meeting, but will probably continue through April 15 under the direction of the Chairman and small group (which likely will include the U.S.).

2) *April 15 submission?* By April, any additional U.S. proposals will have to address only elements or issues not already raised. We probably can assume that our structural approach will be reflected in the evolving "Chairman's text" (as one option but probably not the only one). The main issues for the U.S. in April are likely to be making sure (1) that the range of percentages and dates for the budget period is as broad as we need it to be, and (2) that our proposals regarding developing countries are included.

- We should not view the April date as requiring us either (a) to have settled on a single "bottom line" budget and time frame, or (b) to defend all options within the ranges in

play.

- We may need to say what we are *ruling out* — i.e., what budgets are clearly too tight and clearly too lax; what time periods are clearly too soon and clearly too late. But there can still be a significant range — from X to Y percent of 1990 levels, from 20XX to 20YY — that we inform Congress, stakeholders, and other Parties we are still analyzing, reviewing, and considering.
- The real issue will be whether we need to propose budgets bigger or later than those already placed on the table by others. Others are likely to have put forward the more aggressive options. We may be under intense pressure from industry to put high/late options in play, and from environmentalists not to do so.
- Unpleasant as this prospect may be, determining the range that is not yet ruled out is a less daunting task for the next 10 weeks than coming to Administration (or wider) consensus on a specific budget/time frame from within that range.

3) *After April 15?* After this date, there will be two formal negotiating sessions, in August and October, prior to Kyoto. There probably will also be a number of “informal” negotiating meetings, starting with activity on the margins of the Council on Sustainable Development meeting in April. Increasingly, we will be called on for specifics, but we cannot now identify an exact date by which the international process will require the U.S. to determine and declare its bottom line as to budget and time frame. The timing of this step will be dictated as much by domestic considerations.

Conclusions: Our most pressing problem is making sure that the international process preserves the necessary range of options about budget size and timing. We must continue steady work forward on the development of policy options and economic modeling. We currently have some months left, however, before having to reach a bottom line conclusion.

Mead
~~2/5/97~~ 2/5/97 4pm

cc: JAF
JS

FAX TRANSMISSION

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

To: Assistant Secretaries
Climate Change Group
(See attached list)

Date: February 4, 1997

Fax #: See attached list

Pages: 20, including this cover sheet.

From: William N. White
Special Assistant to
David Gardiner

Subject: Revised overview paper

COMMENTS:

Please find attached the revised version of the overview paper, with attachments, based on comments and discussion at yesterday's Assistant Secretaries Group meeting. This paper will be discussed again tomorrow at the Assistant Secretaries meeting. Please call me at 260-4332 if you do not receive a complete transmission of this paper.

CMT TO EPA

11:20 am

Overview of Greenhouse Gas Mitigation Options

Introduction

Over the next century, important shifts in the global economy would be required to address climate change. (See attachments 1 and 2). While many mitigation options exist, some of these policies entail costs, increases in energy prices, or have important budgetary implications. Taking no action also involves costs since global warming can adversely affect both humans and ecosystems. This paper lays out the broad policy options available for limiting emissions, but does not analyze the costs and benefits of particular options. The options fall into three general categories based on their impact on future emissions:

- *Short-term options* seek to increase the rate at which existing energy efficient technologies are deployed in the marketplace by overcoming information and other barriers to their use. The Administration's efforts in the Climate Change Action Plan, currently funded at the level of \$183 million, rely on technology diffusion to reduce emissions and are eliminating one third of the amount of projected growth to the year 2010. Overcoming Congressional opposition to fully funding these programs would result in additional reductions (the President requested \$305 million for these programs in FY97).
- *Medium term options* would create new government infrastructure to internalize the costs of greenhouse gas emissions in the marketplace. This could take the form of additional standards and regulations or an emissions trading program. Such programs involve government imposed limits on emissions that can increase the costs of energy or restrict consumer choice.
- *Long term options* entail R&D. R&D can reduce control costs in all periods. However, it is particularly important in the long term, since controlling warming ultimately requires adopting an energy system that does not rely on fossil fuels. This would involve a substantial increase in the \$1.3 billion the federal government is currently spending on relevant R&D and reversing the long term trend of declining government and private R&D expenditures.

Technology Diffusion Programs

A wide range of energy saving technological options already exists, but is not being implemented. Studies by the National Academy of Sciences and the Office of Technology Assessment show that the diffusion of existing technologies could cut energy consumption by 20% or more at a net economic benefit. Technology diffusion programs seek to deploy this potential.

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

A number of market transformation programs are currently underway. The Administration's CCAP launched over 40 initiatives in 1993. Their goal was to return U.S. greenhouse gas emissions to 1990 levels by the year 2000. However, they have never been fully funded by Congress – despite current Administration analyses that these programs are eliminating about 1/3 of total emissions growth through the year 2010. Total expenditures on CCAP programs in 1997 is \$183 million. Congress has cut requested spending by 40% over the past two years.

1/3 (1997)
Possible additional actions include the following:

- Fully funding existing CCAP programs, with a sustained commitment to these programs beyond the year 2000.
- Establishing additional information and energy labeling programs for buildings. This sector consumes one-third of the nation's energy. An energy performance rating system for commercial buildings would provide better information to prospective buyers and renters. An information program involving energy bills could target both energy consumption (benchmarking consumers relative to others) and/or electric generation (requiring disclosure of fuel sources).
- Should a domestic emissions trading system be created, setting aside a reserve of allowances or a portion of auction revenues to reward new R&D investment and the production of efficient and renewable technologies.
- Creating a secondary market for energy efficiency financing.
- Pursuing sector-wide compacts in which entire industries could pledge improvements in energy intensity and benefit from shared information on technologies.
- Extending mandates for "green" government procurement to state and local levels.

*Already
done*

*Already
done at DOE*

Standards and Regulations

Limitations on greenhouse gas emissions could also take the form of standards and regulations. These would have to be imposed on a wide array of consumer goods and

industrial equipment and involve many government actions in which the tradeoffs among costs, emission reductions, and other product attributes would be contested. The resulting level of emissions would have to be consistent with the targets established by international agreement. Since total national greenhouse gas emissions would not be directly limited, such compliance would have to be projected based on an analysis of the impacts of the standards program. Such standards could include:

- *Direct limits on greenhouse gases:* Standards could specify allowable greenhouse gas emission levels per unit of output (or some other factor). For example, a powerplant could face a limit on the amount of carbon dioxide emitted per kilowatt of electricity generated. Another example is methane from some landfills, which is already controlled due to limits on emissions of volatile organic compounds. However, such a program would probably be inferior to an emissions allowance trading program (described below).
- *Minimum energy efficiency standards for energy consuming equipment:* Historically, these have targeted appliances and other residential and commercial equipment, as well as personal transportation (i.e., the Corporate Average Fuel Economy (CAFE) program). The total emission reductions of federal appliance standards implemented to date are estimated to be 14.2 MMTCE in the year 2000. Further development of standards could result in additional reductions.

Emissions of greenhouse gases from the transportation sector account for about one-third of total U.S. GHG emissions and are expected to grow by about 25% by 2010. The overall in-use fuel economy of the combined new light vehicle fleet (i.e., cars and light trucks such as minivans, sport utility vehicles, and pickup trucks) has begun to *decline*. In 1994, President Clinton convened a Federal Advisory Committee Policy Dialogue to assist in the development of measures to significantly reduce greenhouse gas emissions from personal motor vehicles ("CarTalk"). Although CarTalk ended without consensus among all members of the Committee, the process did result in a number of proposed policy options that could be pursued. (See Attachment 3).

Other Policies

In addition to the standards it sets, government indirectly affects the levels of greenhouse gas emissions through its policies towards transportation and energy market regulation. These also offer opportunities to generate reductions in greenhouse gas emissions. Most prominent among these are:

Electricity Restructuring: States are currently adopting retail competition for the electricity industry. This trend could be accelerated with federal legislation. Retail competition is expected to lower the price of electricity by as much as 20-25% in certain regions and change the fuel mix of generation. Preliminary EPA and DOE analysis indicates that utility greenhouse gas emissions could rise by as much as 2-6% as a result. To mitigate the environmental impacts of competition and maintain the environmental

benefits of current state level renewable and demand side management programs, a number of options have been adopted at the state level (for states that have already adopted competition) or are under consideration for the rest of the nation. These include:

- A “portfolio standard” for renewable energy or greenhouse gas emissions: This involves requiring that all generators meet a specified level of renewable generation or greenhouse gas emission reduction either by undertaking such projects themselves or purchasing “credits” from others who have.
- A social benefit fund: Revenue is collected by placing a charge on transmission service. The funds are then used to subsidize energy efficiency projects or low income consumers. California has already adopted this approach.
- Information disclosure requirements: Generators could be required to disclose the emission profiles of their generation, facilitating the marketing of “green” electricity.
- Additional air pollutant requirements: Many states are hesitant to adopt retail competition because they perceive that differing regional environmental requirements both put their electric industry at a competitive disadvantage and will result in more pollution being transported into their states. Thus, additional environmental requirements to “level the playing field” – which could include greenhouse gas emission reductions – are currently being debated.

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

- Congestion Mitigation and Air Quality Improvement Program: Additional funds could be targeted to transportation projects that reduce air emissions and energy consumption on a long-term sustainable basis.
- Brownfields Restoration: Successful redevelopment of brownfields can help revive inner city areas and reduce sprawl, thereby reducing vehicle miles traveled. By focusing job growth in inner city areas it encourages greater reliance on more energy efficient and environmentally sound transportation modes, including transit, walking, and bicycling. More funds could be made available for these projects.
- Incentive Funds: Climate actions through ISTEA can produce economic efficiency and reduce emissions, while increasing mobility choice and community livability. One option would be to create a \$500 million Fuel Efficiency Incentive Fund that

rewards the ten states that are able to reduce fuel consumption, on a per capita basis, the greatest over the next five years.

Emissions Trading

Emissions trading is a tool for meeting a total quantity limit on emissions. It involves allocating or auctioning emissions allowances to sources, and allowing the trading of allowances in a market with sufficient mechanisms to ensure compliance with targeted levels. Since emission trading involves the creation of new, marketable assets that can have substantial value, addressing distributional issues will be an important component of program design. Allocation rules or auction revenues offer the potential to redress unfair burdens resulting from the imposition of emission limitations.

Emission trading systems can offer both static and dynamic efficiency advantages over more traditional forms of regulation. The potential for static efficiency gains exists because emitters face different abatement costs. Emissions trading allows those with high abatement costs to purchase allowances from those whose costs are lower. Total costs would therefore be lower than through traditional regulations which require all polluters to comply with a specific standard. However, it should be noted that such a program involves people and firms adjusting to higher energy prices.

Under traditional regulation, firms have little incentive to investigate ways of abating pollution by more than the minimum required to comply with regulatory requirements. Firms under-invest in pollution control R&D since they can capture neither the full market benefits from such spending (since others benefit from learning of their successes), nor the full value of any resulting environmental improvements. Trading offers dynamic efficiency gains because of the incentive to continuously improve pollution abatement technologies in order to create "surplus" allowances for sale.

Experience in the United States has shown that final compliance costs for the programs that have incorporated emissions trading have, in general, been lower than ex ante expectations – often dramatically lower. While emissions trading is not the sole cause of this phenomenon, it has contributed to lower abatement costs in the acid rain program, the phase-out of Chlorofluorocarbons (CFCs), the "criteria" air pollution program, and the phase-out of lead in gasoline.

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

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

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

who allocated
^

- *Coverage:* While it may not be necessary to ensure that every ton of greenhouse gas is accounted for within an emission trading regime, the scope of coverage of the trading program should be sufficient to ensure compliance with targets set in accordance with an international agreement.
- *Administrative and compliance feasibility:* The number of sources involved in the trading program should be small enough to be administratively feasible and large enough to ensure market competition. In addition, monitoring and verification of permit compliance must be possible for those included in the program.
- *Potential to Diffuse Low Greenhouse Gas Technologies:* Alternative points of intervention should be evaluated for their ability to provide incentives for research, development, adoption and diffusion of low greenhouse gas technologies.
- *Market Impacts:* Any program that limits emissions will affect the bottom line of firms. The permit program will have economic impacts that vary depending on program design. For example, exempting certain sizes or categories of sources from permit requirements because of administrative or equity concerns (e.g., small boilers or home heating oil) has competitive implications within the energy market.
- *Wealth transfers:* Allocating permits redistributes wealth within the economy. The amount of redistribution can be large depending on the permit price (which is determined by the emissions target and the cost of fossil fuel substitutes). While one option would be to auction permits with revenues accruing to the government, another would be to award permits to sources based on historical rates of emissions. In the latter case, wealth would be transferred to whomever is allocated permits.

integrate

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

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

Research and Development (R&D)

One of the key issues in developing a domestic climate change policy will be the emphasis placed on potentially expanding the Federal R&D effort into technologies that reduce future greenhouse gas emissions and/or lower the cost of achieving a given greenhouse gas reduction target. Achieving greenhouse gas emission reductions that would stabilize atmospheric concentrations at "safe" levels will require major advances in technology in every sector of the economy. These goals will be difficult to achieve during a time of constrained federal spending and sharp reductions in long-term private sector R&D. Since 1978, federal investment in energy R&D has declined 75%. Investment by industry fell 33% from 1983 to 1993.

The President's Fiscal Year 1998 budget requests an increase of \$200 to \$300 million in relevant R&D over the current level of approximately \$1.3 billion. Such an increase was rejected by Congress last year, and achieving it may require raising the issue to a higher level in budget negotiations. In the Fiscal Year 1999 budget and beyond, further increases will be needed, as will a more coordinated effort to target the R&D on the biggest opportunities for CO2 mitigation.

Achieving greenhouse gas levels that are not harmful to humans or the environment will require major advances in technology as can be seen from the following equation:

$$\text{Emissions} = \text{Population} \times \text{Affluence (GDP/capita)} \times \text{Technology (Emissions/GDP)}$$

From 1990 to 2060, we may well see global population double and affluence increase by a factor of four. At the same time, the world may ultimately need to *lower* emissions from 1990 levels, requiring the average emissions-related technology to improve by more than a factor of ten during the next few decades and be rapidly deployed throughout the world. The benefits could be enormous, in part because of these technologies serve a number of other national goals, including reducing the emission of the criteria air pollutants and decreasing dependence on foreign oil. Edmunds has found that developing and deploying advanced technologies over the next 15 to 30 years could lower the present value cost to the global economy of stabilizing the atmosphere at 550 ppm CO2 from 1.5% of GDP to 0.12% of GDP.

Because of the high risk nature of R&D, a number of pathways need to be pursued simultaneously:

Clean Power

- The next generation of natural gas technologies, including gas turbines and fuel cells, could achieve energy conversion efficiencies of 70% or more by 2005.
- The next generation of high efficiency coal-fueled power plants, such as integrated gasification combined cycle perhaps combined with a fuel cell, could achieve efficiency exceeding 55%, with half the CO₂ emission of current plants.
- Zero CO₂ Renewable technologies—wind power, photovoltaics, biomass power, solar thermal, and geothermal—have seen sharp cost reductions in the past two decades, some by a factor of ten. Further R&D, coupled with expanded deployment to achieve economies of scale and improvements in manufacturing, would likely make one of more these technologies competitive with fossil fuels in the next two decades.
- Zero CO₂ Nuclear fission and fusion remain options that would benefit from further R&D.

ignores Transp. costs

Energy Efficiency

Transportation

The Partnership for a New Generation of Vehicles (PNGV) is a public-private partnership to design and build a triple-efficiency clean car by 2004. Multiple technology paths are being pursued to build a hybrid vehicle that has both an advanced engine (such as a clean diesel, Stirling or gas turbine) and an energy storage device (such as a battery, fly-wheel or ultracapacitor). Supporting R&D includes lightweight, super-strong materials such as composites; high-temperature ceramics; regenerative braking; and advanced power electronics. Proton-exchange membrane (PEM) fuel cells have perhaps the greatest long-term potential for reducing transportation CO₂.

Biofuels also lower transportation CO₂. Continued R&D in bio-engineered organisms and fast-growing crops is expected to produce ethanol from waste paper, crop waste, and dedicated crops for under 70 cents a gallon by 2005, competitive with oil at \$25 a barrel.

Industry

The seven most energy-intensive industries—steel, aluminum, petroleum refining, chemicals, pulp and paper products, glass, and metal casting—account for about 80% of the energy consumed in U.S. manufacturing and more than 90% of the hazardous waste. They

represent the largest opportunity for reducing industrial CO₂ emissions, and the Energy Department is partnering with them because they significantly underinvest in R&D compared to the industry average. Key areas that would benefit from expanded R&D include advanced materials development; separation technology; catalysis; bioprocessing, biocatalysis, and renewable feedstocks; sensors and controls; and industrial cogeneration of electricity and heat, which can achieve overall efficiencies of more than 80% and ultimately utilize biomass.

Buildings

The buildings sector consumes one-third of the nation's energy and two-thirds of its electricity. Key near-term R&D opportunities include improvements in lighting, windows, design software, high-efficiency appliances, gas heat pumps, insulation and duct systems, cooling including gas cooling, solar heating and cooling, daylighting, and urban heat island mitigation (reflective roofing and road materials). Longer term R&D needs include electrochromic glazings for windows, building-integrated PV systems, and PEM fuel cells.

Capture and Sequestration

If major reductions in CO₂ emissions are necessary, and global reliance on fossil fuels continues beyond the middle of the next century, then some form of CO₂ sequestration (i.e. capture and disposal) will be needed. A long-term R&D strategy would include demonstration of a number of sequestration options and research into their possible environmental impacts; converting CO₂ into industrial chemical feedstocks; selectively permeable membranes for CO₂ capture; processes for converting fossil fuels and biomass into CO₂ and hydrogen; development of hydrogen infrastructure technology, including transportation and storage; and PEM fuel cells. Capture and sequestration has received only limited funding to date.

Other Advanced Research

A number of areas of basic research could prove crucial to responding to climate change, including photosynthetic mechanisms, biotechnology, fermentation microbiology, combustion research, polymer and ceramic science, process engineering, supercritical CO₂, new materials synthesis, and nanotechnology. One essential area for expanded basic and applied R&D is superconductivity, which offers the possibility of nearly loss-less energy storage and transmission and of highly efficient superconducting motors.

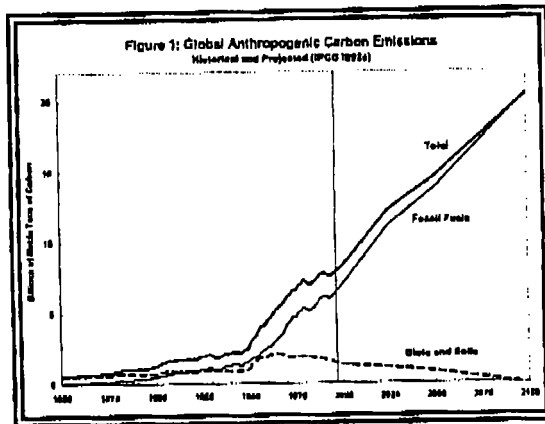
Conclusion

A number of mitigation options exist for controlling greenhouse gas emissions. In considering which are most appropriate, it is useful to consider the time scale in which they operate. In the near term, priority could be placed on diffusing currently underutilized energy efficiency technologies. This could be best accomplished through

programs to address current information and other market barriers. Both the programs of the current Climate Change Action Plan, current energy labeling programs, as well as DOE's appliance standards are targeted at this problem. In the medium term, new government infrastructure, either in the form of emissions trading or expanded regulatory programs could be put into place to limit greenhouse gas emissions. However, in the long run, it is only through the adoption of new, non-fossil technologies, that stabilization of atmospheric concentrations of greenhouse gases can be accomplished. Thus, it is important for any program to consider the incentives it provides for both private and government research and development.

Attachment 1: Global Trends in Emissions and Concentrations

Growing emissions of greenhouse gases (GHGs) from industrial activity and land-use changes are rapidly raising the concentrations of these gases in the atmosphere, making some degree of climate change virtually certain. Although greenhouse gases come from many sources, carbon dioxide (CO₂) from fossil fuel use is the source of



greatest concern because of its rapid historical and projected growth.¹

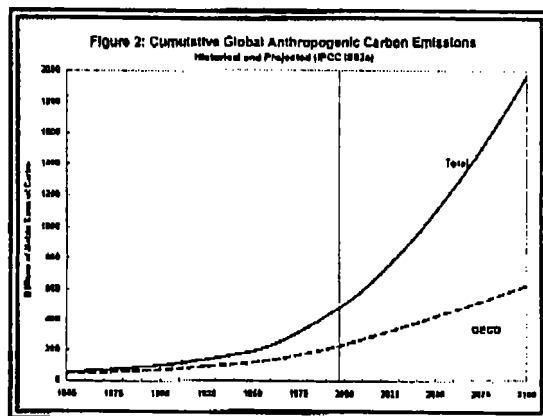
Atmospheric carbon concentrations are already over 30% higher than their pre-industrial levels and rising at about 4% per decade. The further potential for human activities to disrupt the natural balance is enormous because hundreds of years' worth of carbon (at current rates of use) are currently available in proved fossil fuel reserves that could be exploited under current economic and technological conditions – and even

larger “ultimately recoverable” reserves. In the absence of controls, emissions are projected to grow quickly as the developing countries experience rapid population growth and industrial development. These trends are expected to lead to ongoing atmospheric accumulation and climate change into the indefinite future, with a doubling of atmospheric carbon concentrations sometime during the second half of the next century and a resulting long-run increase in average global temperatures by an estimated 1.5° to 4.5°C. Even stabilizing global emissions at 1990 levels *permanently* will lead to a near doubling of atmospheric carbon concentrations by the end of the next century.

Climate change is truly a global problem in the sense that emissions from anywhere will affect everyone everywhere. As a consequence, concerted international action will be needed to induce all countries to cooperate in reducing emissions. Nevertheless, cooperation will be hampered by the uneven distribution of past and future emissions. Simply put, the developed industrial nations have relatively high levels of per capita emissions and are largely responsible for past emissions, while the developing

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

nations, whose per capita emissions are currently very low, will be responsible for the bulk of emissions in the future.² Since the developed countries have high levels of emissions now and have already used up a substantial portion of the overall "GHG budget," the developing countries will be reluctant to undertake any emissions reductions at all in the absence of significant emission controls on the part of the developed countries. (The issue becomes more complex when all GHG emissions and sequestration from land-use changes are taken into account, but the basic point holds.) Sharing the burden of control among countries will thus be a very serious and difficult issue.



At the same time, it is clear that actions taken by the developed countries alone are likely to have little effect on cumulative global emissions or on atmospheric concentrations. Based on the projections shown in Figures 1 and 2, stabilization of Annex I country³ emissions at 1990 levels from 2000 through 2100 would reduce cumulative carbon emissions by around 8%, and would reduce atmospheric CO₂ concentrations in 2100 by less than 5%. In other words, Annex I

emissions stabilization will still lead to well more than a doubling of atmospheric CO₂ concentrations by 2100. Even stabilizing total global emissions – which, given anticipated population growth, would require dramatic reductions in global per capita emissions – will not lead to stabilized concentrations. *Stabilization of concentrations requires global emissions to fall well below current levels, and ultimately to decline to zero.*

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

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

³ The OECD nations plus the former Soviet Bloc.

Researchers have examined in some detail the emissions paths – and various distributions of emissions between developed and developing countries – required to meet atmospheric carbon concentration targets of 450 to 750 ppm, representing increases of 63% to 173%% over preindustrial concentrations.⁴ All of these targets require

Table 1: Alternative Carbon Targets and Budgets		
Target	Carbon Budget 1991-2100 (GtC)	Reduction from 1500 GtC
450 ppm	630 - 650	-57% to -58%
550 ppm	870 - 890	-34% to -42%
650 ppm	1030 - 1190	-21% to -31%
750 ppm	1200 - 1300	-13% to -20%

significant reductions in global carbon emissions from the roughly 1500 MMTC projected over the period 1991 to 2100 in the absence of controls, as shown in Table 1.

Furthermore, these budgets must be distributed both across countries and across time. And while emissions can increase in

the near term, higher growth in emissions in the near term must be offset by increasingly dramatic reductions later on.

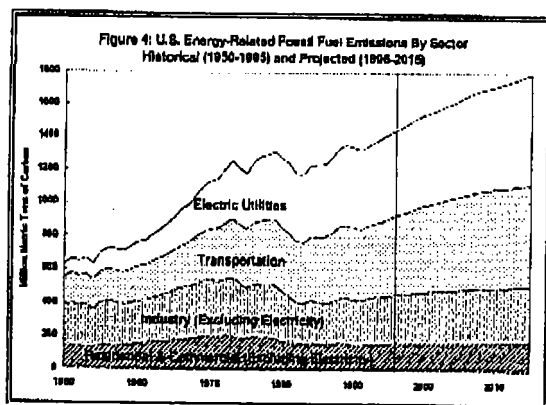
⁴ The lower target would limit the projected average global temperature increase to roughly between 0.6° to 1.75°C; the higher target would limit the increase to between 1.4° to 3.5°C.

Attachment 2: U.S. Emission Trends

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

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

The electric utility sector's share has grown from 12% in 1950 to 35% in 1996 (500 MMTC), as the American economy has steadily increased its use of electricity. Over 85% of electric utility sector carbon emissions come from burning coal. Similarly, the transportation sector's share of fossil-related carbon emissions has grown from 28% in 1950 to 33% in 1996 (470 MMTC),

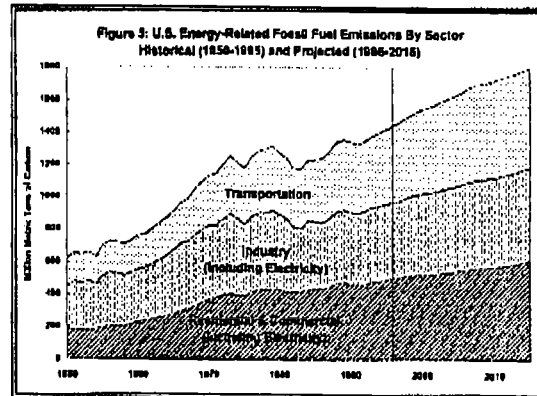


with oil accounting for practically all of the fuel use in the transportation sector. Thus, the transportation and utility sectors together currently account for 68% of U.S. fossil-related carbon emissions.

In contrast, carbon emissions from the residential and commercial sectors' direct energy use have fallen from 22% of the total in 1950 to 12% in 1996; while emissions from industrial direct energy use

have fallen from 38% to 20%. However, if electricity-related carbon emissions are attributed to the sectors that consume the electricity (rather than to the utility sector which produces it), the residential and commercial sectors' share has risen from 28% in 1950 to 35% in 1996. In contrast, the industrial sector's share has fallen from 44% in 1950 to 32% in 1996, as industry's share of economic activity has declined and services' share has risen.

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



Attachment 3: Summary of the "Car Talk" Process

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

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

Fuel Economy Measures

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

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

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

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

Alternative Fuels Measures

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

VMT Measures

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

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

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

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

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

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

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EXECUTIVE OFFICE OF THE PRESIDENT
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cc: JAF
JS
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February 4, 1997

To: Assistant Secretaries Group

From: Rosina Bierbaum

RE: Revised paper on Emissions / Concentrations / Stabilization

Here is a slightly revised version of "The Longer-term View: The Relationship of Emissions to Atmospheric concentrations". All of the correct graphics are in this version and I tried to make the text a bit clearer.

Please e-mail any comments to me at RBIERBAU@OSTP.EOP.GOV or fax them to me at 202-456-6025.

Number of pages (including cover): 11

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

Most discussions have focused on what steps might be taken in the medium term (2010-2020) to reduce emissions of greenhouse gases. Such actions represent only an initial step and, by themselves, would fall far short of significantly reducing the risks of climate change. Much more long-term planning will be necessary to achieve the goal of the Framework Convention on Climate Change:

"stabilization of greenhouse gas concentrations . . . at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should . . . allow ecosystems to adapt naturally to climate change; ensure that food production is not threatened; and enable economic development to proceed in a sustainable matter."

This paper describes emissions paths that would be necessary to achieve various longer-term goals of stabilizing atmospheric concentrations of greenhouse gases. It also explores the implications that a longer term goal has for shaping near-term policy decisions.

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

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

I. GLOBAL EMISSIONS AND ATMOSPHERIC CONCENTRATIONS

In the absence of any actions specifically to limit carbon dioxide emissions, the Intergovernmental Panel on Climate Change (IPCC), as shown in Figure 1, estimated that current emissions (as shown by the 2 upper lines) of 6 billion tons of carbon per year could grow to between 15-25 billion tons of carbon by 2050 and continue to increase through the end of the

next century.

Global CO₂ Emissions & Concentrations

Emissions

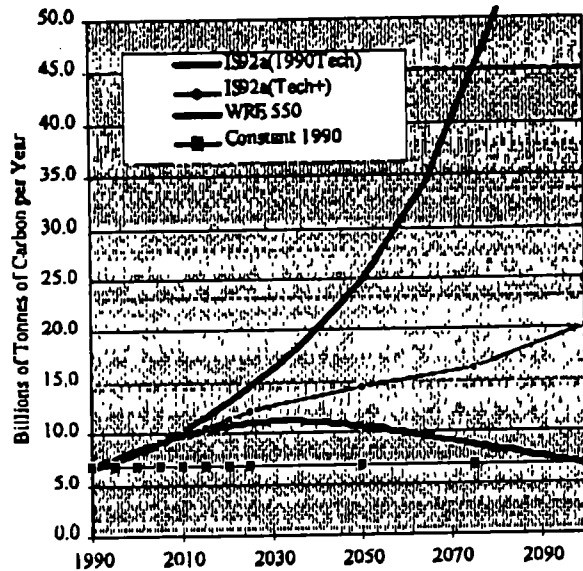


Figure 1

Concentrations

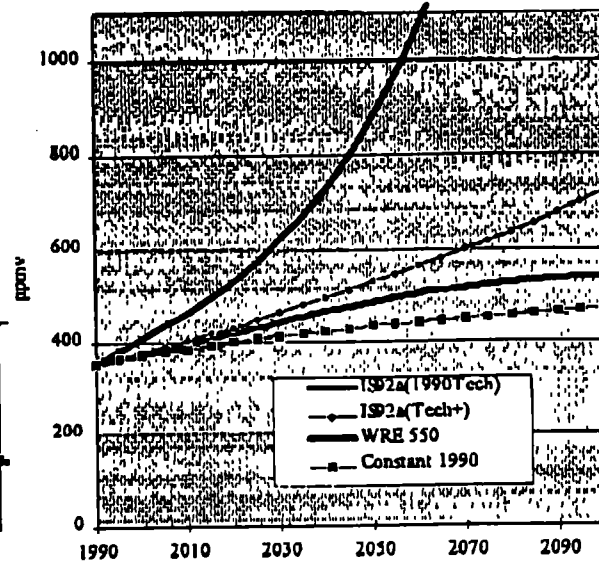


Figure 2

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

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

Figure 3 shows the projected long-term atmospheric concentrations if emissions were stabilized at different levels. The figure shows that if emissions were stabilized at current levels (6 Pg C/yr), atmospheric concentrations would grow to almost 500 ppm by 2100, but continue increasing thereafter. It also shows that if emissions are stabilized at 10 PgC/yr, roughly 33 percent higher than today's level, then atmospheric concentrations would increase to more than a doubling from pre-industrial levels by 2100, while also continuing to increase thereafter.

CO₂ Concentrations Associated with IS92a(Tech+) and Alternative Energy Related Emissions Stabilization Levels

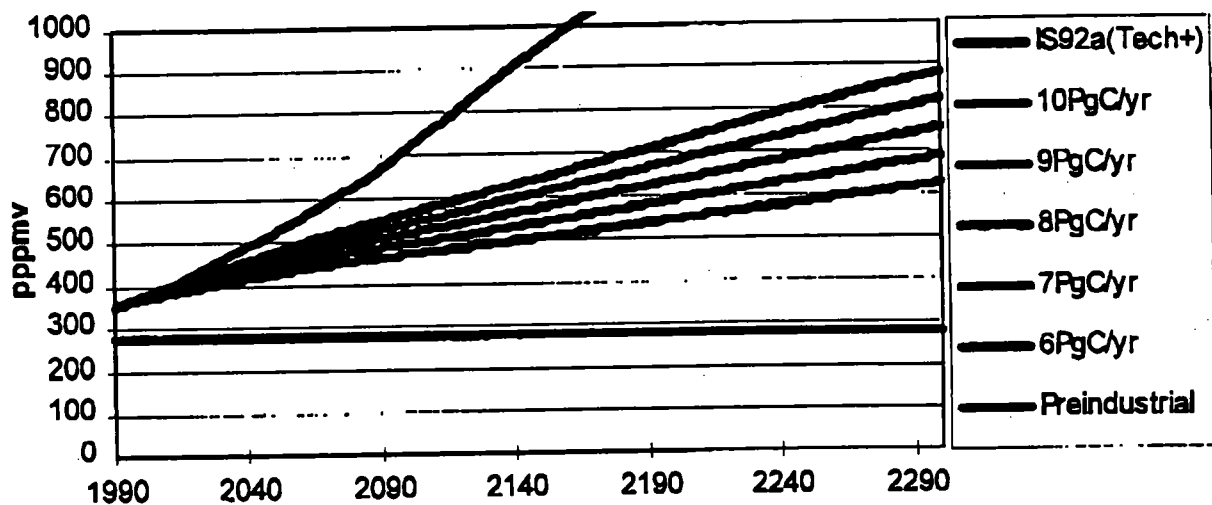


Figure 3

Table 1 shows how various concentration targets relate to emissions pathways. For example, to meet a 550 ppmv concentration goal, global emissions must begin to deflect from the business-as-usual curve by 2013. In this scenario, emissions would peak at 9.7 PgC/yr in 2033 and drop rapidly thereafter.

**The Relationship Between CO₂ Concentration Ceilings,
Maximum Emissions, and the Subsequent Rate of Emissions Decline: WRE Cases**

Deflection Date IS92a (Tech+) ^a	2001	2007	2013	2018	2023
Growth Rate to Maximum Date ^b	0.3%	0.3%	0.5%	0.5%	0.4%
IS92a (Tech+) Growth Rate ^c	0.8%	0.7%	0.9%	0.9%	0.7%
Maximum Date	2005	2011	2033	2049	2062
Maximum Emission ^d	6.0	8.0	9.7	11.4	12.5
Rate of Decline ^e	1.0%	1.0%	0.8%	0.6%	0.5%

^aThe deflection date is the year in which emissions in the emissions stabilization trajectory first fall below IS92a emissions by more than 0.1 PgC/yr.

^bAverage annual rate of growth (%/yr) of WRE fossil fuel carbon emissions between the "Deflection Date" and the "Maximum Date."

^cThe rate of growth (%/yr) of fossil fuel carbon emissions between the "Deflection Date" and the "Maximum Date."

^dPgC/yr fossil fuel carbon emissions on the date of maximum total anthropogenic carbon emissions.

^eRate of decline in fossil fuel carbon emissions, in percent per year, over the first 75 years following the date of maximum emissions. Note 350 ppmv not defined as it requires a negative net emission.

Table 1

II. DEVELOPED AND DEVELOPING COUNTRY EMISSION TRENDS

Figure 4 presents current and projected emissions of carbon dioxide for developed and developing countries. Of the current emissions of roughly 6 billion tons, approximately two-thirds are from developed and one-third from developing countries. The U.S. is currently the largest emitter of carbon dioxide, with China the second largest source. However, on a per capita basis, the U.S. emits about 5 tons of carbon per capita, compared to an average of approximately 4 tons per capita in Japan and Western Europe, and 0.4 tons per capita for developing countries. While per capita differences remain large over time, by the middle of the next century, developing countries would become a source for more than half of total global emissions.

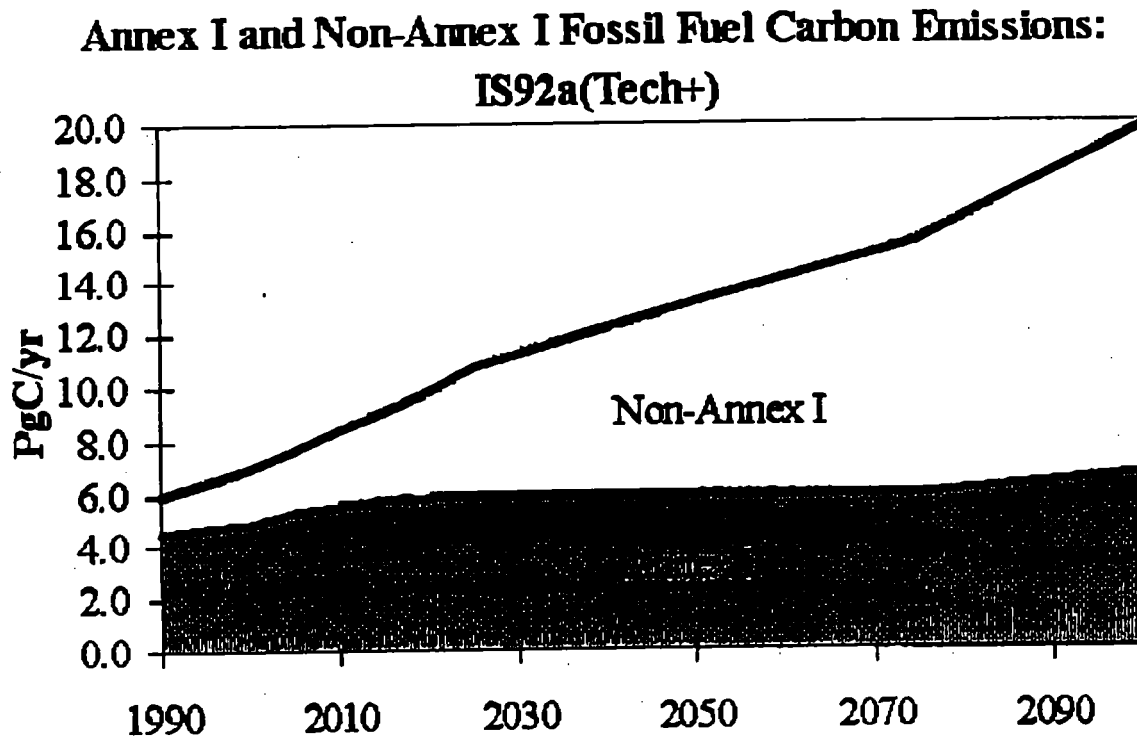


Figure 4

III. ILLUSTRATIVE EMISSION REDUCTION SCENARIOS

Limited mid-term actions to reduce emissions by developed countries alone have little impact on

shifting the atmospheric concentrations curve. Figure 5 shows the small change in concentrations if Annex I (developed countries) freeze emissions at 1990 levels in the year 2010.

Stabilizing US Emissions Reduces 2100 CO₂ Concentrations 12 ppmv & Stabilizing Annex I Emissions Reduces CO₂ 45 ppmv

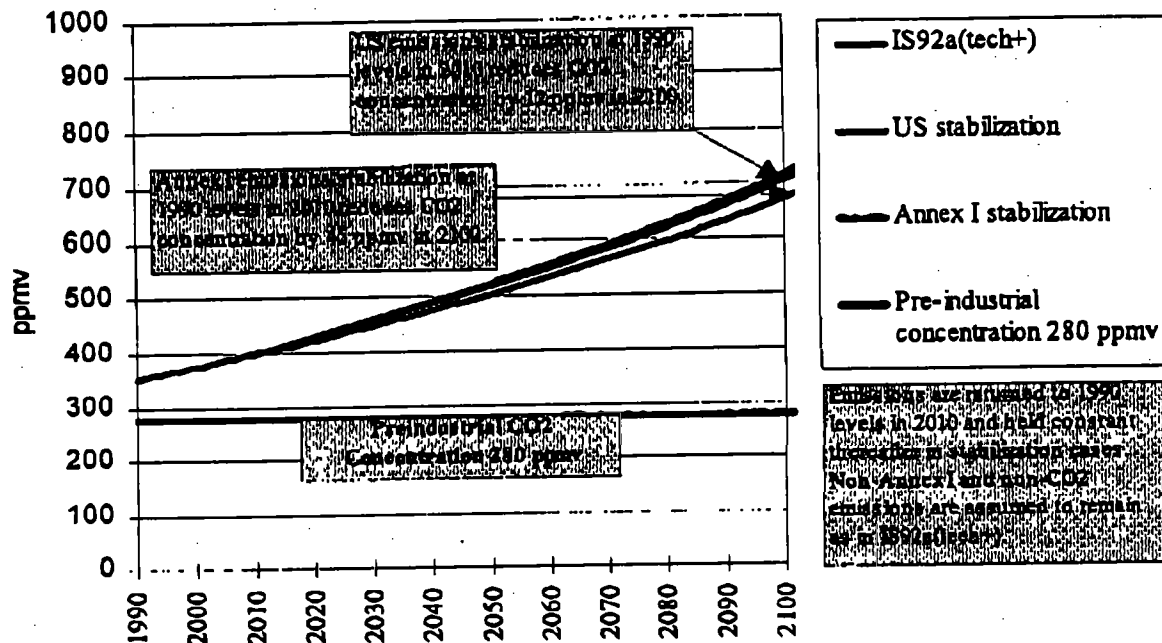


Figure 5

Annex I Fossil Fuel Carbon Emissions: IS92a(Tech+), and 2.5%/Decade, & 7.5%/Decade Reductions

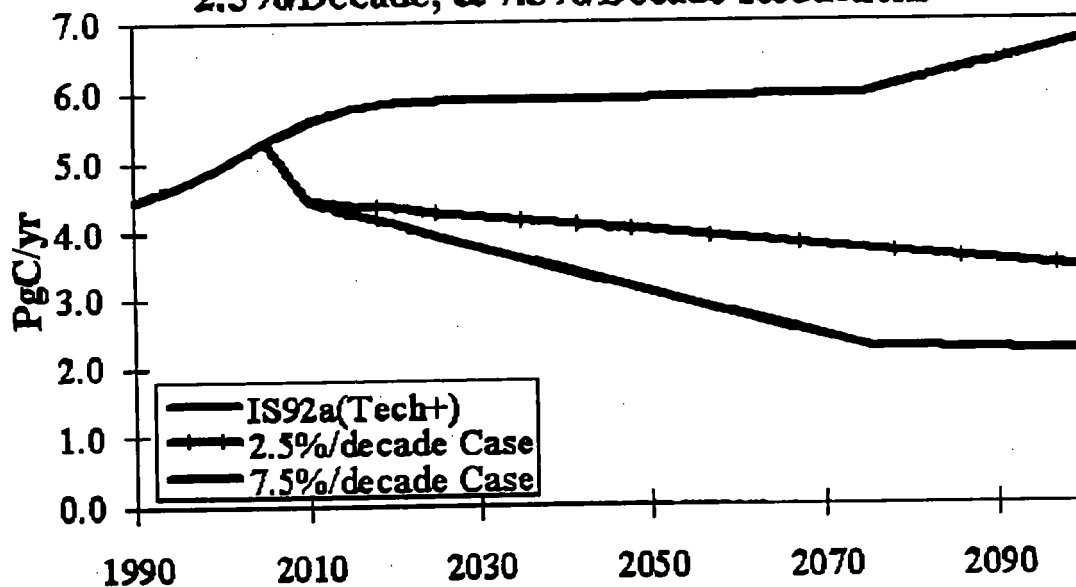


Figure 6

Figure 6 illustrates two possible emissions profiles for developed (Annex I) countries. Both scenarios assume a freeze in emissions at 1990 levels in 2010. On the hatched line, emissions are then reduced by 2.5% per decade and in the lower line they are reduced at 7.5% per decade. The highest line is the business-as-usual (TECH+) scenario from the IPCC. (To put these reductions in perspective, the U.S. has achieved annual efficiency improvements of 2.5 percent per year during the energy crises.)

Figures 7 and 8 are based on each of the Annex I pathways described in Figure 6. They show the pathway developing countries would need to follow to stabilize concentrations at 450 ppm, 550 ppm and 650 ppm. These figures show that to achieve stabilization at 550, developing countries would be able to emit on their currently projected path until about 2020 before significant reductions would be required. Figure 8 illustrates a similar case but assumes that developed countries freeze at 2010 at 1990 emissions but then reduce at 7.5% per decade.

Figures 9 and 10 show the per capita emissions for both developed and developing countries that result from the scenarios described in the previous two figures. They show that under these scenarios, developed country emissions stay substantially greater than those in developing countries (which rise to 1 TC/person only in the 650 ppm case).

Allowable Non-Annex I Emissions

Annex I 2.5%/decade Emissions Reduction Case, Using WRE Global Emissions Paths for 450 ppmv, 550 ppmv & 650 ppmv CO₂ Ceilings

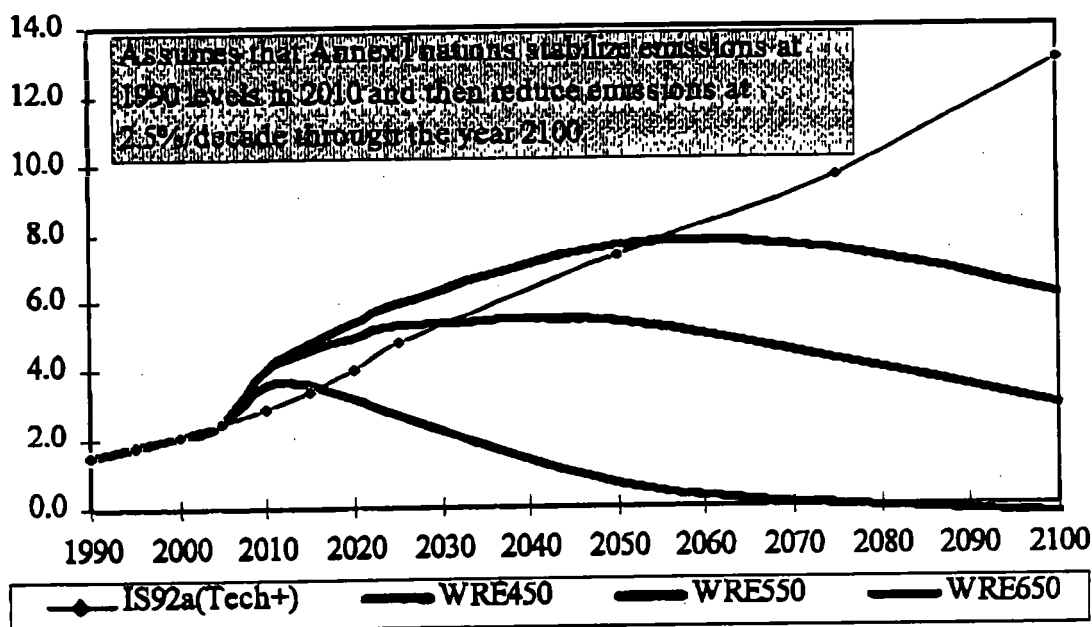


Figure 7

Allowable Non-Annex I Emissions

Annex I 7.5%/decade Emissions Reduction Case, Using WRE Global Emissions Paths for 450 ppmv, 550 ppmv & 650 ppmv CO₂ Ceilings

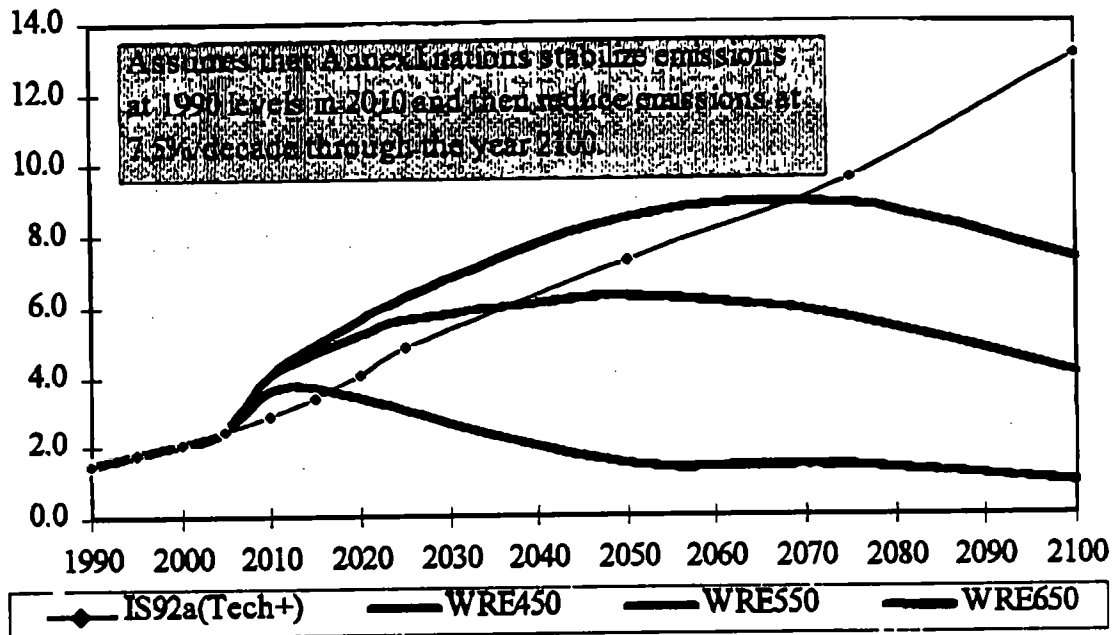


Figure 8

Per Capita Emissions

Various CO₂ Concentration Ceilings--Annex I 2.5%/Decade Emissions Reductions

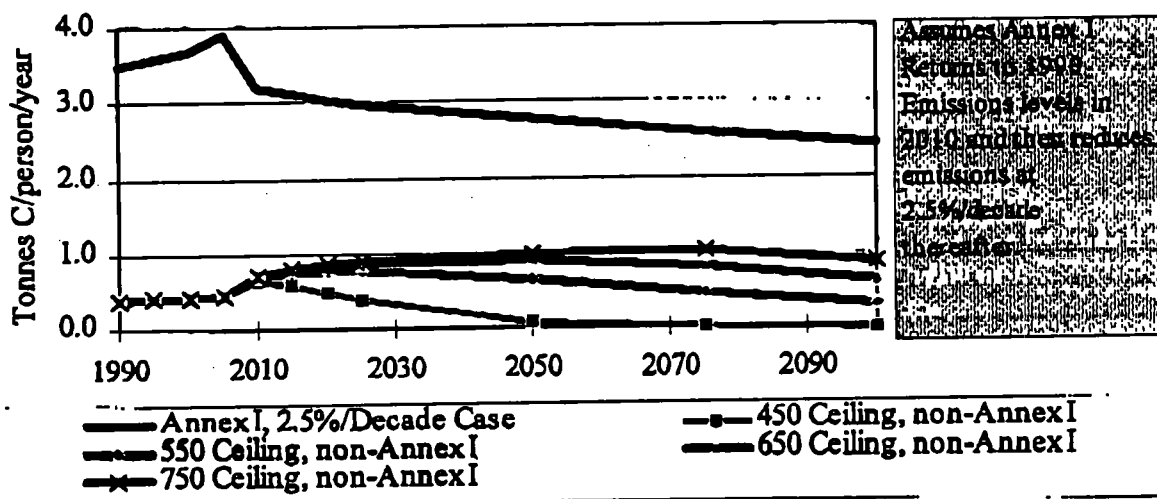


Figure 9

Per Capita Emissions Various CO₂ Concentration Ceilings—Annex I 7.5%/Decade Emissions Reductions

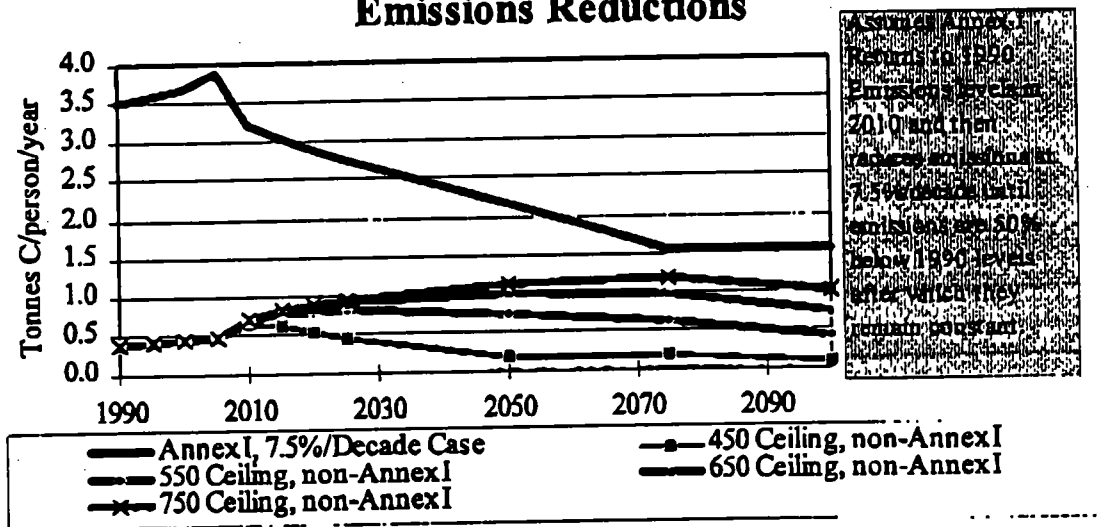


Figure 10

IV. THE ROLE OF TECHNOLOGY AND IMPACTS ON COSTS

As suggested in Figure 1, the rate of technological change can play a very important role in determining the level at which atmospheric concentrations can be stabilized. Figure 11 looks specifically at the costs associated with different technology cases. It looks at three specific cases:

- 1990 tech: assumes no technological change from 1990
- 1990 tech +: assumes significant improvements in reducing the costs of alternative fuels and in improving efficiency;
- Advanced tech: assumes even further advances and cost savings.

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

Figure 11 shows for each of these technology cases, the total costs associated with achieving three different levels of atmospheric concentrations: 550, 650 and 750 ppm. The estimated costs under the assumption that no technological progress is possible were found to be about \$12 trillion or 1.2% of total world GDP, compared to \$1 trillion or 0.12% of GDP assuming substantial progress in reduction technologies. In the advanced technology case, which assumes very substantial non-fossil alternatives will be available by 2020, the cost virtually disappear. However, the assumed cost and performance of the alternative technologies would only become achievable with significant increases in research and development investments.

What costs?
Where does it come from?

The Relationship Between Technology and Minimum Cost of Stabilizing the Atmosphere Below Various Ceilings

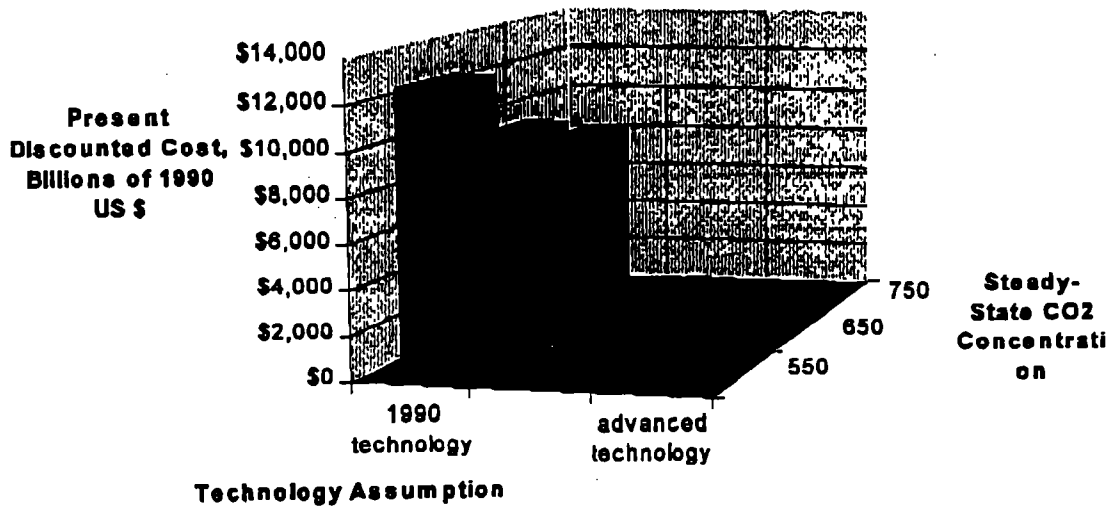


Figure 11

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

APPENDIX

Key Assumptions about Technology Scenarios:

IS92a (Tech+)

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

Advanced Energy Technology

- Advanced solar/wind/fusion
 - The cost of solar/wind power reaches a busbar cost of \$0.04/kWh by 2020 and
 - the cost decreases at 0.5 %/year thereafter.
- Low cost biomass
 - By the year 2020, 20% of the biomass resource is available at \$1.40/GJ and
 - 80% is available at \$2.40
- Advanced liquefied hydrogen fuel cells for transport