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In West, U.S. Stands Alone on Warming Issue

Europeans Display Unity on Stabilizing Gases

By Michael Weisskopf
and William Booth
Washington Post Staff Writers

AS

Preparing for a major international climate conference now meeting in Geneva, the World Meteorological Organization circulated a draft declaration reflecting the commitment of European governments to stabilize the production of gases believed to cause global warming.

The United States responded with a series of caveats and weakening amendments as long as the declaration itself.

While virtually every Western industrialized nation has committed itself to specific timetables for stabilizing or reducing the gases that cause the greenhouse effect, the Bush administration remains skeptical that global warming is scientifically valid and refuses to take any direct action that threatens the way the United States generates energy and runs its economy.

Emphasizing the wait-and-see policy, White House Science Adviser D. Allan Bromley noted the administration has budgeted \$500 million for research into climate change and said more conclusive evidence is necessary before the nation restricts use of critical fossil fuels—oil, coal and gas—that produce carbon dioxide when burned.

"I think the taxpayers would want that," he said in an interview.

As head of a White House task force on global warming, Bromley has played a key role in the administration's efforts to develop a cohesive policy on global warming. The group meets every six weeks and reports to the domestic policy council and White House Chief of Staff John H. Sununu, the leading skeptic of global warming.

Environmental Protection Agency Administrator William K. Reilly is the strongest advocate of direct action on global warming within the administration, but has fought an uphill battle against economic conservatives led by Sununu. And he lost a key ally when Secretary of State James A. Baker III, who has sided with Reilly on key policy disputes with Sununu, including last February's decision by Sununu to water down a speech Bush delivered to an international conference here, recused himself from policy debates that could influence his oil and gas interests.

Anticipating how isolated the United States will be in Geneva, Reilly, sources said, warned John Knauss, director of the National Oceanic and Atmospheric Administration, the administration's representative at the conference: "Roll up your sleeves and give blood, John. We're just going to get beaten up."

The administration's caution on the issue has been a disappointment to environmentalists, given President Bush's pledge during his 1988 campaign to use the "White House effect" to combat the "greenhouse effect," the popular term for describing the effect of gases that blanket the Earth and trap solar heat. The buildup of those gases has led to fears that the planet will warm significantly.

European governments, with popular environmental movements to placate, have created pressure for Bush by moving faster with concrete targets for stabilizing emissions of greenhouse gases by the turn of the century. But the administration defends its go-slow approach by noting the economic and political differences from Europe, where nuclear energy and high energy taxes are accepted alterna-

tives. The United States also has further to go to combat per capita emissions of carbon dioxide, which more than double those of Japan and France.

In place of targeted cuts, officials such as Bromley point to research programs and the incidental carbon dioxide reductions achieved by other environmental policies. Still, carbon dioxide emissions are expected to grow 15 percent by the year 2000.

"They don't want to think about the tough decisions they would have to make if they admitted the problem is real," said Sen. Albert Gore Jr. (D-Tenn.), a leading critic of the administration's global warming position.

A year ago, Bromley said the administration would await the outcome of a U.N.-sponsored assessment of global warming before formulating remedial policies. But when the report in late September concluded that the planet will warm 5 degrees by the end of next century, Bromley said it raised as many questions as it did answers.

"Before we commit ourselves to massive mitigation schemes, we want to be sure of what the costs and what the effects will be, particularly on a regional basis," Bromley said.

Bromley said, for example, that of the six major climate models, three predict that the American midwest will be hotter and drier in the coming century, while three predict cooler, wetter weather. He has repeatedly said that the climate models are not accurate enough to base public policy.

For the present, many members of the scientific community support a "no regrets" policy, in which the United States and other governments would attempt to limit the production of carbon dioxide and other gases for reasons that made sense even if there is no significant warming trend in the world climate.

CONTINUED

The administration supports such "an insurance policy," said Bromley, even as it remains skeptical over the prospect of global warming. Passage of the Clean Air Act, he said, will limit any possibility of warming, he said, since it will foster more efficient use of energy. The United States is also committed to phasing out chlorofluorocarbons (CFCs), another important warming gas.

But more ambitious plans to cut carbon dioxide run into the hard realities of an economy dependent on fossil fuels as its energy staple. Economic models to predict the cost of mitigating global warming are still in their infancy. While some analyses make the cost seem almost negligible, others project huge costs, which have been a major cause of concern for Sununu and other administration officials.

An interagency group formed by the Energy Department recently put the costs at \$50 billion a year—or 1 percent of the nation's annual Gross National Product—to stabilize global warming emissions by the year 2005.

"You're talking about major changes in the structure of economic activity," said Richard Schmalensee, a member off the White House Council of Economic Advisers. "There is the brute fact we use a lot of energy. If you're going to cut down carbon dioxide, you're going to have to figure out how to use less coal. History gives us no reason to think it will be cheap."

According to the Energy Department, the price for stabilizing global warming emissions by 2005 would be a tax of \$100 on each ton of carbon contained in fossil fuels. That would nearly triple the price of coal and double the price of oil.

"If you impose unnecessarily high taxes or punitive measures on one sector of the economy, you might penalize economic growth," said Mark Kerrigan, associate deputy undersecretary of energy.

At yesterday's meeting in Geneva, the United States appeared to prevail in its efforts to water down the conference declaration to be issued on the final session Wednesday.

While the preliminary text had proposed specific targets to stabilize emissions by industrialized nations, the latest draft "welcomes" the European commitments but omits any reference to responsibilities of other countries.

Jessica Mathews

The ^{K27} Greenhouse Holdout

The surprise announcement this week that Europe had committed itself to putting a lid on emissions of the global warming gas carbon dioxide completes the diplomatic isolation of the United States on greenhouse policy.

Between them, the European Community and the European Free Trade Association represent all 17 countries of Western Europe (except Malta). Their decision means that members will aim to hold their emissions of carbon dioxide in the year 2000 to the same level as in 1990, but does not interfere with more ambitious targets set by Germany, Denmark, the Netherlands and others, which call for cuts ranging up to 25 percent.

In the Pacific, New Zealand also plans a 25 percent CO2 cut. Within the past few weeks Australia (which, like the United States, is large, thinly populated and heavily reliant on coal), set a goal of a 20 percent cut, and Japan abandoned its prior support for the U.S. position. Japan's goal holds per-capita emissions steady, but allows for expected population growth.

Canada also plans to stabilize its emissions. This leaves the United States as the only developed country arguing that it is too soon to begin slowing these emissions. In stark contrast to the others, its yearly CO2 outputs will likely grow by about 15 percent by 2000, unless policies change.

The split between the United States and the rest of the developed world has nothing to do with science. The just-completed World Climate Conference issued another in a long string of international consensus documents on the scientific aspects of greenhouse warming. American scientists have played the leading role in all of them.

Rather, it lies in the chancy leap from science to policy. In this disorienting twilight zone, it is revealed that the best scientists, being mortal, rely on hunch and intuition like the rest of us, and policy makers effortlessly cloak their ideological, political or personal predilections in the folds of scientific uncertainty.

Administration officials are more than a little patronizing in their dismissal of other countries' greenhouse control targets. The goals, they say, are unsupported by serious analysis showing how they will be achieved and at what cost. On alternate days of the week they say the goals are cheap rhetoric and that these countries are actually secretly relying on the United States to hold the line and save them from themselves. All of these apparently grown-up countries, in this view, either don't know what they're talking about or don't believe what they are saying.

But how accurate the studies are—whether Germany ultimately cuts its emissions by 25 percent or half of that—is not what matters. The goals are meaningful for precisely the reason the administration opposes them: they shape policy, they commit a government to try.

Nor can domestic political pressure explain why so many countries would adopt phony goals. Many of these countries harbor vocal and growing Green parties, but in no case is greenhouse warming such a priority public issue as to drive governments to adopt challenging policies they don't believe in. Quite the contrary, governments are ahead of public opinion on this issue.

Why, then, would governments choose—as the administration sees it—self-inflicted economic wounds? Here is the nub. They don't share the United States' assessment that there will be a high economic cost. Many, including Japan, Germany and the Netherlands, are saying that they expect a net profit from energy efficiency gains and through eventual market dominance of innovative high-efficiency technologies and alternative energy sources. Interestingly, the most ambitious CO2 targets have been adopted by countries that are already among the most energy efficient (measured either by energy use per person or per dollar of GNP). This would not be the first time those who are first to explore a technological frontier are the first to see its full potential.

With a government hamstrung between two political parties, each of them internally divided, and a public fearful of recession and scornful of its government, the United States right now is poorly equipped to contemplate, much less embrace, change. Wholesale cuts in CO2 emissions may well yield net economic benefits, but every step in that direction will hurt someone. When whale oil gave way to kerosene, the economy saw the change as a big plus. Not so the whaling industry. In modern terms, those who could be hurt are powerful industries with friends at both ends of Pennsylvania Avenue.

But the real key to the U.S. position is White House Chief of Staff John Sununu. He has a simple version of the climate models that run on supercomputers at places like the National Center for Atmospheric Research set up in his office, as if in his spare time he could uncover some flaw in the scientists' reasoning. His fierce personal interest and opposition to dealing with the energy-related greenhouse gases has cleared the field of potential opposing voices in the Cabinet. Secretary of State James Baker has gone so far as to have a formal legal recusal drafted, removing himself from the debate on the grounds it could affect his oil and gas holdings. (Whereas managing the Mideast crisis does not?)

Being a minority of one does not make the U.S. position wrong. But, given the lineup of governments taking the opposite view, it should give us pause. There's reason to be questioning not their analysis but our own.

Getting Warmer

THIS YEAR, so far, has been the warmest since scientists began keeping records more than a century ago. It wasn't noticeable here in the United States, where the past summer was only a little hotter than normal. The most dramatically unusual weather was in Asia, particularly in Siberia and particularly last March. The 1980s were the warmest decade on record, and now another decade has begun with this unprecedentedly warm year.

That doesn't amount to proof that the world has entered a warming trend that will continue. Nor does it prove that it's being caused by people burning fuel to generate energy. But the evidence is certainly consistent with those possibilities, and this year's temperatures strengthen them.

The White House keeps arguing that the science of global warming is still unclear. True, no one knows whether man-made carbon dioxide has yet begun to make the world hotter or what the consequences might be. But by the time warming becomes provable under the rigorous standards of science, the process will have developed a gigantic momentum, and the world will require decades even to slow it down.

Since the consequences are unpredictable, it doesn't seem very smart to drift headlong into them with as little thought as this country is giving to them.

Some of the effects of warming would be benign. Certainly the Soviets, with their economy failing, were grateful for an early spring, much rain and the unusually large harvests that followed. But other impacts may be less welcome. As the people at the White House say, nobody knows.

Most of the world's governments met in Geneva this week to try to work out a joint strategy for cutting down the production of greenhouse gases. The United States was conspicuous in its refusal to commit itself to any reduction or even to accept the need for one. Without the United States, nothing serious is likely to happen worldwide.

The Bush administration fears that any attempt to diminish the emissions of carbon dioxide—the inevitable result of burning oil, or coal or any fossil fuel—would be intolerably disruptive and expensive. But not necessarily. There's a lot the United States ought to be doing to reduce its dependence on imported oil, to protect the economy from Middle Eastern oil shocks, to encourage conservation generally and to raise efficiency. By doing that, the country would also reduce the risk of drastic change in the climate. By refusing to deal with the steady rise in carbon dioxide emissions, the Bush administration is ignoring dangers that are literally incalculable.

Baker Sitting Out Global Warming Debate

By Michael Weisskopf
Washington Post Staff Writer

A25

In his first speech after taking office, Secretary of State James A. Baker III called for immediate steps to combat the threat of global warming, noting that even though scientific questions remain, "Time will not make the problem go away."

His call to action in January 1989 cast Baker against the grain of Bush administration policy—a skeptical, go-slow approach to the problem. Still, he stuck to his guns in internal debates, siding with environmental officials and pushing for stronger U.S. leadership on an increasingly important diplomatic issue.

Now as support builds in Europe for a treaty to cut warming gases, the top U.S. foreign policy officer has taken himself out of the debate, further isolating environmentalists in the administration.

According to administration officials, Baker has formally recused himself because of oil and gas holdings that create the potential for conflict of interest. When burned by cars or factories, oil produces the primary warming gas. Every plan to curb global warming includes measures to discourage or cut oil use.

In a statement filed Feb. 5, Baker listed his oil interests and said that he would abstain from "any particular matter that has a direct and predictable effect upon the price of domestic oil and gas."

The statement does not specifically rule out participation in global warming decisions, and a State Department spokesman refused to clarify how the recusal works in practice. But administration officials say that Baker has not been involved in the issue for months and indicated last summer he would remain uninvolved.

His recusal leaves Environmental Protection Agency Administrator William K. Reilly among Bush's top advisers as the lone advocate of aggressive policy measures to head off what many scientists predict will be significant warming of the Earth's surface by the middle of the next century. Eighteen European nations are committed to freezes or cuts in emissions of carbon dioxide—the principal warming gas—by 2005.

Reilly has enjoyed Baker's support at key junctures of administration debates, forming an alliance against White House Chief of Staff John H. Sununu and Office of Management and Budget Director Richard G. Darman. They belittle global warming as scientifically un-

proven and too costly to combat in an economy that runs on coal, oil and gas.

Last February, Sununu ordered major revisions in a presidential speech endorsed by Reilly and Baker that was designed to underline the seriousness of the problem and burnish Bush's reputation as the world leader most dedicated to its solution.

Baker, officials said, also played a key role in persuading Bush to host the first negotiating session for a framework convention on global warming to be held here this February.

Since Baker dropped out of the debate, the administration has moved even further from U.S. allies and leading trading partners. At an international conference this week, the United States refused to join the Western European nations, Japan and Australia in setting targets limiting the emission of carbon dioxide.

The February meeting is expected to measure the impact of Baker's recusal. With European nations likely to press for protocols committing participants to stabilization policies, administration conservatives would prefer to scuttle negotiations rather than accept global warming targets, officials said.

"When it comes to facing down Sununu and Darman, there's no substitute for Baker," one official said. The official did not rule out intervention by Baker if he considered it politically beneficial to Bush.

Environmentalists who had been counting on Baker as an ally question why his involvement in global warming would pose any more of a conflict than the Persian Gulf policy.

Bush addressed such potential conflicts of interest on Aug. 8 when he directed the White House counsel to review the financial interests of several Cabinet officers, including Baker, involved in the Iraq crisis.

Price of cleaner air set at \$50 billion plus jobs, businesses

By Ronald A. Taylor
THE WASHINGTON TIMES

A7

The revised Clean Air Act will add \$50 billion to the annual price of cleaning up the nation's air, cost 600,000 jobs and force many small businesses to shut down, an industry watchdog group claims.

William Fay, administrator of the Clean Air Working Group, said his organization supports the Clean Air Act now awaiting President Bush's signature. But he noted it will exact a dear price from industry, small business and labor.

According to his organization's economic analysis, the new law will add \$50 billion a year to the \$32 billion the nation currently spends to meet existing federal and state clean air laws.

The costs "will be passed on to consumers in the form of higher prices of almost all consumer products," he said.

"You add that much to the cost of doing something, and you're going to pinch something," he said.

The Clean Air Working Group is an ad hoc organization composed of representatives from the manufacturing, auto and steel industries. It was formed to lobby Congress during passage of the new Clean Air Act. Yesterday's briefing was described as its last.

If the 700 pages of pending revisions are enacted, the Clean Air Act will have evolved from a broad statute that set ambitious, but imprecise clean air goals in 1970 to a law surpassed in complexity only by the Internal Revenue Code.

Despite substantial clean air gains since the 1970 law was enacted, high smog, carbon monoxide and particulate levels regularly ex-

pose half the nation's population to unhealthy air pollution levels.

The pending revisions would impose a tough new round of emissions controls on industry to control acid rain. It also would set strict limits on emissions of 190 toxic chemicals and require motor vehicle tailpipe control in 1994 models to reduce emissions by 98 percent over 1970 models.

Achieving those goals will be costly and, in some cases, impossible, Mr. Fay said.

Some of the hardest-hit segments of the economy will be small businesses, he said. The new law targets dry cleaners, bakeries, brewers, printing and painting shops, auto repair and service stations for tough new permit requirements in addition to socking them with strict emissions controls.

Such new costs on enterprises that commonly earn \$100,000 a year in after-tax revenues "must be eaten somewhere," Mr. Fay said. "They don't just evaporate into the air."

Smokestack emission control equipment to control acid-rain forming emissions from the dirtiest 111 electric power generating plants may not be available in time to meet the 1993 deadline set in the compromise measure.

The schedule for marketing cleaner-burning reformulated gasoline in the nine cities with the worst smog problems will be tough to meet, he said. The petroleum industry will not be able to retool refineries fast enough to make the new fuel available by the 1995 deadline.

The president is expected to sign the bill despite objections within the administration, especially from Council on Economic Advisers chief Michael Boskin.

THE DENVER POST

CU environmental alpine lab keeps eye on global warming

But marmots chewing at foundation of research site

By Bruce Finley
Denver Post Staff Writer

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NIWOT RIDGE — Marmots are not taking kindly to a high-tech environmental laboratory being built here on their 11,565-foot habitat west of Boulder.

But the results of research conducted at the University of Colorado alpine lab — one of the world's premier sites for monitoring global change — are expected to outweigh the intrusion.

Monitoring of air, precipitation, plants and animals in the protected alpine habitat already has provided some of the best clues about how human activity may be changing Earth's climate.

"We're going to be able to see the first signs of us screwing up the Earth," said CU researcher David Yamaguchi, one of the international cadre of scientists conducting alpine studies at the site.

"A place like this can start providing computer models predicting global warming with real data."

The \$110,000 lab, funded by CU and the National Science Foundation, is 60-foot-long half cylinder that resembles one of the Quonset buildings used for temporary housing after World War II.

It will replace a weather-beaten shack used to house scientific equipment at the site, which has been designated a "Biosphere Reserve" by the United Nations.

In the past, scientists on skis have risked their lives amid 160 mph winter winds to collect data from instruments erected on Niwot Ridge. The new lab will offer a comfortable shelter.

"Working up here, I love it more than any work I've done in my lifetime," says Hans-Uwe Schuetz, 30, a landscape ecologist from Germany's University of Meuns-

ter, who expects to work long hours in the lab.

Construction crews are hauling 120-pound slabs of rubber and foam to insulate the building from wind-chill temperatures as low as minus 100 degrees.

Nearly invisible

Solar panels and a wind turbine provide power. A gravel exterior helps the lab blend into the gray, granite terrain, making it nearly invisible from surrounding peaks along the Continental Divide.

A similar hut may be built in the Arctic if this lab proves successful, said Jim Price, supervisor of construction.

The CU building should be completed within two weeks.

Research in progress on Niwot Ridge includes collection of air samples used by the National Oceanic and Atmospheric Administration to measure global levels of pollutants such as chlorofluorocarbons that erode the atmosphere.

CU researchers this year documented the earliest snow melt on record on the ridge — evidence suggesting global warming could be at work.

Other studies focus on changes in vegetation, behavior of gophers and habits of Mexican hummingbirds who come to the Rockies every year to mate.

But marmots gnawing persistently at foundations of the lab are not the subject of any study.

Construction workers have tried repeatedly to get rid of the bristly beasts with dog repellent and by setting salt licks away from the site.

But workers find new chunks of wood missing every morning.

"This was the work of a marmot," Price lamented yesterday, running his fingers over fresh marmot teeth marks.

He planned to erect wire fences to protect the foundation.

On marmots' side

Meanwhile, some environmental scientists are siding with the marmots.

They want to establish a policy to protect Niwot Ridge from research-related litter and restrict walking to designated paths — so as not to disrupt marmot lifestyles.

Chewing "is their nature," Schuetz said. "And we have to live with that."

Gas prices steep on Western Slope

Aspen service station tops off at \$1.94 a gallon

By Julie Stafford
Special to The Denver Post

Gas prices aren't going downhill on Colorado's Western Slope, where unleaded fuel was selling yesterday for \$1.51 a gallon in some resort towns.

Gas prices dipped a bit nationally, but that trend was bucked in resorts like Vail and Aspen.

The West Vail Texaco and the Vail Conoco stations both reported unleaded gas selling for \$1.51 a gallon. Super unleaded was at \$1.61.

Most stations have reported stable gas prices since Tuesday. Rick Dilling, manager of the West Vail Texaco, said his prices dropped 4 cents a gallon yesterday.

Frisco Amoco reported the lowest price for unleaded gasoline at \$1.32 a gallon. Bob's Downtown Conoco in Steamboat Springs had the second-lowest price, \$1.389, and the Keystone Texaco was at \$1.39.

Unleaded gasoline at the Old Snowmass Conoco in Basalt cost \$1.49 a gallon. "We haven't been changing our prices until the load of gas is in the ground," said Bill Welcher, co-owner of the station. Welcher said his price jumped about 10 cents yesterday after a more costly shipment of gas arrived.

The American Automobile Association reported yesterday that self-service, no-lead gas prices

across the country averaged \$1.25 a gallon, down 3 cents from Thursday. However, an informal survey by The Denver Post showed that prices in Colorado averaged \$1.42 — 17 cents higher than AAA figures.

Colorado gas prices have shot up almost 20 cents since Iraq invaded Kuwait 10 days ago.

Nowhere is the trend more in evidence than the Western Slope.

Conner's Aspen Amoco reportedly listed one of the highest full-service premium prices in the country — \$1.949 a gallon. The station's owner, Claude Conner, would not give out prices over the telephone, but did say he believes his self-service prices are competitive in the area.

Conner also said he may discontinue the full-service option. "We're considering it very strongly," he said. "It's going to be too bad. We're the only full-serve in Aspen."

Alpine Standard in Vail, reportedly at \$1.799 for full-service premium earlier this week, already has discontinued full service.

"The price got out of hand," said Doug Sterkel, president of Alpine Ventures.

Sterkel said his self-service prices were "the cheapest in town." Unleaded was at \$1.439 a gallon and premium unleaded was selling for \$1.559.

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The administration's caution on the issue has been a disappointment to environmentalists, given President Bush's pledge during his 1988 campaign to use the "White House effect" to combat the "greenhouse effect," the popular term for describing the effect of gases that blanket the Earth and trap solar heat. The buildup of those gases has led to fears that the planet will warm significantly.

European governments, with popular environmental movements to placate, have created pressure for Bush by moving faster with concrete targets for stabilizing emissions of greenhouse gases by the turn of the century. But the administration defends its go-slow approach by noting the economic and political differences from Europe, where nuclear energy and high energy taxes are accepted alternatives. The United States also has further to go to combat per capita emissions of carbon dioxide, which more than double those of Japan and France.

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"You're talking about changes in the structure of economic activity," said Richard S. See, a member of the White House Council of Economic Advisors. "There is the brute fact of energy. If you're going to burn down carbon dioxide, you have to figure out how to get it. History gives us no choice. It will be cheap."

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come of a U.N.-sponsored assessment of global warming before formulating remedial policies. But when the report in late September concluded that the planet will warm 5 degrees by the end of next century, Bromley said it raised as many questions as it did answers.

"Before we commit ourselves to massive mitigation schemes, we want to be sure of what the costs and what the effects will be, particularly on a regional basis," Bromley said.

Bromley said, for example, that three of the six major climate models, the American Midwest will be hotter and drier in the coming century, while three predict cooler, wetter weather. He has repeatedly said that the climate models are not accurate enough to base public policy.

For the present, many members of the scientific community support a "no regrets" policy, in which the United States and other governments would attempt to limit the production of carbon dioxide and other gases for reasons that make sense even if there is no significant warming trend in the world climate.

The administration supports such "an insurance policy," said Bromley, even as it remains skeptical over the prospect of global warming. Passage of the Clean Air Act, he said, will limit any possibility of warming, he said, since it will foster more efficient use of energy. The United States is also committed to phasing out chlorofluorocarbons (CFCs), another important warming gas.

But more ambitious plans to cut carbon dioxide run into the hard realities of an economy dependent on fossil fuels as its energy staple. Economic models to predict the cost of mitigating global warming

... advocates action against warming

are still in their infancy. While some analyses make the cost seem almost negligible, others project huge costs, which have been a major cause of concern for Sununu and other administration officials.

An interagency group formed by the Energy Department recently put the costs at \$50 billion a year—or 1 percent of the nation's annual Gross National Product—to stabilize global warming emissions by the year 2005.

"You're talking about major changes in the structure of economic activity," said Richard Schmalensee, a member of the White House Council of Economic Advisers. "There is the brute fact we use a lot of energy. If you're going to cut down carbon dioxide, you're going to have to figure out how to use less coal. History gives us no reason to think it will be cheap."

According to the Energy Department, the price for stabilizing global warming emissions by 2005 would be a tax of \$100 on each ton of carbon contained in fossil fuels. That would nearly triple the price of coal and double the price of oil.

"If you impose unnecessarily high taxes or punitive measures on one sector of the economy, you might penalize economic growth," said Mark Kerrigan, associate deputy undersecretary of energy.

At yesterday's meeting in Geneva, the United States appeared to prevail in its efforts to water down the conference declaration to be issued on the final session Wednesday.

While the preliminary text had proposed specific targets to stabilize emissions by industrialized nations, the latest draft "welcomes" the European commitments but omits any reference to responsibilities of other countries.

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Major Policy Issues
Second World Climate Conference
Ministerial Declaration

1. Targets and timetables for reducing greenhouse gas emissions
2. Stipulating the nature and content of a convention on climate change
3. Financial Assistance
4. Statement concerning the scientific understandings associated with climate change
5. Precautionary Principle

-2-

1. Targets and timetables for reducing greenhouse gas emissions

Ministerial Declaration:

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

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

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

USG position:

We should not agree to specific targets and timetables. We should take a comprehensive approach that includes all sources and sinks of greenhouse gases and, in the short-term, take those actions which are justified for reasons other than climate change. USG proposed language for paras. 20 and 21 follows on page 3; para 22 should be deleted.

Houston Summit Communique:

"We are committed to undertake common efforts to limit emissions of greenhouse gases, such as carbon dioxide.... The Second World Climate Conference provides the opportunity for all countries to consider the adoption of strategies and measures for limiting or stabilizing greenhouse gas emissions, and to discuss an effective international response."

21. We recognize that the most effective response strategies, especially in the short-term, are those which are:
- ┆ Justified for reasons other than climate change and also provide beneficial influence on potential climate change;
 - ┆ Economically efficient and cost effective,;
 - ┆ Able to serve multiple social, economic, and environmental purposes:
 - ┆ Easily modified to respond to increased scientific and economic understanding of climate change;
 - ┆ Compatible with the concept of a comprehensive approach addressing all sources and sinks of greenhouse gases;
 - ┆ Compatible with the concept of sustainable economic growth and development;
 - ┆ Administratively practical and effective in terms of application, monitoring, and enforcement;
 - ┆ Inclusive of obligations by both industrialized and developing countries.
22. We recommend that limitation and adaptation strategies be considered as an integrated package that complement each other to minimize net costs. These strategies should include measures which limit emissions from greenhouse gas sources as well as those which increase the ability of natural systems to utilize greenhouse gases. A comprehensive approach is needed which considers the costs of options for reducing emissions of different greenhouse gases and the effects of those reductions on potential

-4-

2. Stipulating the nature and content of a convention on climate change

Ministerial Declaration:

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

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

- (i) the enhancement of research and systematic observation of climate
- (ii) the control of greenhouse gas emissions
- (iii) the adaptation to the adverse effects of climate change in coastal areas
- (iv) the needs of developing countries for financial assistance in their development efforts and transfer of technology
- (v) appropriate institutional and decision-making procedures.

USG position:

The declaration should not prejudge the negotiations. We support the negotiation of a framework convention; at a minimum, the declaration should be general and should advocate a comprehensive approach that includes sources and sinks of all greenhouse gases. USG would propose deleting para. 23; new USG version of para. 40 follows on page 5.

Houston Summit Communique:

"We reiterate our support for the negotiation of a framework convention on climate changes;...implementing protocols...should consider all sources and sinks."

-5-

35. We recommend that such negotiations consider the possible elements compiled by the IPCC, and that the Framework Convention be framed in such a way as to gain the support of the largest possible number of states. We recommend that the Framework Convention contain, at a minimum, general principles and obligations, and that it advocate a comprehensive approach that includes sources and sinks of all greenhouse gases.

-6-

3. Financial Assistance

Ministerial Declaration:

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

USG position:

We will not commit to providing new and additional funding which increases the overall budget. We are already giving the environment a higher priority in our assistance funding, both bilateral and multilateral, and believe that existing resources and mechanisms must be fully utilized before new monies can be considered. It will also be necessary to quantify the costs associated with any actions in this area before consideration of new funds can be justified. We will also note that the provisions of the Montreal Protocol are not a precedent for other environmental issues.

We understand that other countries may try to strengthen this paragraph, calling for explicit reference to "new and additional funding". USG proposes that para. 27 be deleted.

Houston Summit Communique:

"We recognize that developing countries will benefit from increased financial and technological assistance to help them resolve environmental problems..."

-7-

4. Statements concerning the scientific understandings of climate change.

Ministerial Declaration:

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

8. Global warming poses environmental threat of a magnitude the world has never known. Human activities which have lead to the emissions of greenhouse gases into the atmosphere have so far committed the Global Commons to an irreversible warming so far.... It is therefore important that emissions of greenhouse gases, especially carbon dioxide and other long lived greenhouse gases, be reduced as soon as possible.... The long lived gases (CO2 and N2O) would require at least 60% reductions in emissions, and methane 15-20% reduction in emissions in order to stabilize their concentration in atmosphere at today's level.

USG position:

The declaration must accurately describe the scientific context and uncertainties associated with potential climate change. USG proposed language follows on page 8.

Houston Communique:

Does not address the scientific underpinnings.

-5-

4. Climate has varied significantly in the past; however, the potential change in global mean temperatures over the next century associated with human activities is predicted to be larger and more rapid than those seen in the last 10,000 years. The magnitude, timing, rate and regional distribution of these predicted climate changes are uncertain because of limitations in our present scientific understanding of climate processes and in our ability to model the behavior of climate systems and components. The human-caused emissions of greenhouse gases, while significant, are much smaller than the exchange between the atmosphere and natural systems. Stabilization of atmospheric concentrations of long-lived gases at today's levels, for example, would require either a 60 to 80% decrease in anthropogenic emissions or a 2 to 3% increase in absorption by natural systems.
8. The potentially serious consequences of human-induced climate change, however, give sufficient reasons to begin adopting response strategies that are fully justified for other reasons, even in the face of significant uncertainties. These strategies could include: improved energy efficiency, use of lower greenhouse gas-emitting sources; improved forest management; development of comprehensive coastal management plans; use of practices to recycle and reuse CFC gases and their substitutes; and improved agricultural practices.

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5. Precautionary Principle

Ministerial Declaration:

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

USG position:

This definition was agreed to in the Bergen Declaration. We expect other countries to reopen this language, at which time we will seek to have the definition include a reference to the no-regrets strategy. USG proposed language follows on page 10.

Houston Summit Communique:

"We agree that in the face of threats of irreversible environmental damage, lack of full scientific certainty is no excuse to postpone actions which are justified in their own right."

-10-

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

Meg Greenfield A23

The Word's Too Big

As I write this I am aware that by the time it is printed, environmentalism will be last week's news, a.k.a. history. That is part of the problem: our national penchant for skipping from issue to issue, pausing only long enough to dub each a crisis more momentous than any other. But having the attention span of a snail darter is only part of it. We are also prisoners of our overblown terminology. The big tent word "environment" attempts to cover too much, and by its very nature contributes to the muddle of our conversation.

This happens with lots of issues in our public life. The political efficiency experts start trying to nudge all the related or seemingly related subjects into one general category. The "crime" issue is an example, combining, as it does, problems and phenomena that have almost nothing to do with each other. I remember when this happened with the environment issue in the Nixon administration. We got lots of advance briefing that the Nixon White House was going to create this issue and make it a very big deal and, at least for a while, it did. Environmentalism became the chic subject of worry and of columnizing.

Before that the subject had consisted mostly of its separate parts known primarily as "pollution" and "conservation." It had been largely the preserve of separate political entities. There were the Republican dukes and duchesses trying to keep the neon signs out of their line of vision at the country place; there were the conspiracy theorists of the left (nuclear fallout, pesticides) and right (fluoridation) who believed they were being secretly poisoned (we now know some of them were); and there were the tiny minority of health-food nuts, as we then called them before we all became health-food nuts, and there were the well-born human friends of animals.

This was not exactly a promising potential constituency, but the people who invented the environmental rubric were on to something: the growing irritation of large numbers of voters

All sides in the environmental debate have credibility problems.

with the perceptible degradation of their surroundings and the fact that there were urgent questions, primarily to do with health, standards of living and the management of natural resources that needed to be addressed. The trouble with herding all this (and more) into one tent was that the sane and the crazy, as well as the important and the trivial all got mixed up together. As an unfortunate result you could oppose something crazy and trivial and be denounced as an enemy of life on the planet. Or, if you *were* a foe of the sane and important projects that needed to

be undertaken you could do a lot to discredit them by running them all together with the flakier stuff and denouncing the whole works. This is the equivalent of harping on "bra burners" any time a serious feminist issue comes up.

Not surprisingly, therefore, a pervasive credibility problem dogs all sides in the environmental debate. We have just seen the Earth Day special version of this problem with the two sides debating whether there even is an environmental crisis of the magnitude portrayed in most of the public observances—at least with the crime issue, we aren't debating whether horrendous crime exists. The environmentalists (how easily one falls into the deplored lingo) have suffered a loss of credibility because so many of them have issued melodramatic, wildly overstated end-of-the-world bulletins every hour on the hour for the last 20 years. This hurts most the people on their side who are trying to get the country to buy the realistic assessment of the dangers—and they are very great—that exist.

Not that those who dispute the environmentalists' critique and try to reassure us that each troublesome situation

is under control are believable either. Far from it. The credibility problem on this side of the debate has to do with the unfortunate and humiliating fact that it sometimes seems, on this issue, as if we are living in the middle of a nonstop "60 Minutes" exposé. Again and again and again do we discover that the supposed regulation is not being enforced, that the monitoring never took place, that the statistics concerning the lethal hazard were merely shuffled around somebody's office and filed, or, that the folks who run the company or the agency or city hall are lying. Be honest: between the repeatedly demonstrated incompetence and/or dissembling of the authorities responsible for these things, would you anymore take at face value a reassurance that this leakage or that seepage or the other stinking exhaust wasn't dangerous at all and was, in any event, being constantly checked for risk?

Finally, there is the fact that disputes over scientific questions concerning the environment, like all such scientific-political disputes, only deepen the public suspicion that someone, if not in fact everyone, is lying. This is because it is almost never understood that what the two sides are arguing about is rarely a set of facts, but rather a set of conclusions based on facts. The arguers are often merely trading hypotheses about the meaning of data they actually agree on, saying how they think some uncertainty or other will play out. The rest of us laymen immediately sign on to the scientific side whose theory we prefer. I don't mean to say there is no better or worse, righter or wronger side in these matters—only that most of us don't have a clue about them, except to believe the other side is cooking the data.

CONTINUED

To my mind, the irony in all this is that there is a huge political constituency out there concerned with daily-living questions that could probably qualify as environmental, but which somehow exist outside the high-strung realm of the environmental argument. These are people tangling with traffic, development, zoning and pollution issues that profoundly affect their well-being and which they care desperately about, but which often seem to get lost in the big-picture argument. Often, too, they are victimized by the debate between absolutists, the stop-everything-no-change crowd versus the mow-it-all-down-and-pave-it boys, contests that seem to rule out sensible planning and intelligent compromise solutions.

Here you reach the final paradox. I believe there is a deep and widespread anxiety in the country about what could properly be called environmental questions, but that we have created environmentalism as an issue that somehow doesn't reach them.

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Italian business chief calls for world environment standard

By Karen Riley
THE WASHINGTON TIMES

Business has traditionally complained that U.S. environmental regulations hurt its bottom line and make it difficult for it to compete against foreign companies that face less stringent rules.

But some multinational corporations have begun to advocate a single global environmental standard that would put all companies on a level playing field.

Italian businessman Raul Gardini, chairman of the agribusiness and chemical giant Ferruzzi Group, is one of the leading proponents of

this approach.

"There can't be just an American Clean Air Act. It is necessary to have a World Clean Air Act," Mr. Gardini said in an interview after an American Enterprise Institute conference on environmental policies and business earlier this week. The conference was sponsored by the Ferruzzi Group.

Environmental standards, which typically vary from country to country and even from state to state, can influence production costs and prices, the location of facilities and commercial policies, he said.

"In any instance where the methods used to protect the environment influence prices, there is a risk of creating potential competitive distortions," said Mr. Ferruzzi.

European and American environmental standards are rife with differences on such issues as atmospheric emissions, the use of water resources, chemical substances permitted for agricultural use, noise levels, and on the taxes levied on certain chemical and energy products.

The Ferruzzi Group is the leading Italian investor in the United States with 54 plants, 13 warehouses and nine research and development centers that together take in \$5.5 billion in net sales a year.

The only government-to-gov-

ernment effort to develop international environmental rules has been the so-called Montreal Protocol on Substances that Deplete the Ozone Layer, which prescribed a 10-year phaseout for chlorofluorocarbons that degrade the ozone layer.

Mr. Gardini believes environmental issues should be incorporated into the General Agreement on Tariffs and Trade, the world's free trading rules embraced by 97 nations.

"It is anachronistic to discuss liberalizing international trade at the GATT negotiations without taking into account the new environmental phenomenon," he said. For example, in Italy, a change in the structure for pricing soybeans now before GATT would mean eliminating the most important purifier from Italian farmlands and cause a 20 percent increase in the consumption of potentially damaging nitrogenous fertilizers.

Ferruzzi, with \$40 billion in sales and 300 plants worldwide, recently developed a strategy for reducing its environmental impact over time.

One element of its strategy is an environmental balance sheet, which will provide complete data about the company's use of energy and raw materials as well as the quantity and quality of its solid, liquid and gaseous emissions.

It will allow the company to monitor reductions in energy use, determine the amount of pollutants created per unit of production and unit of sales and help set new goals for additional reductions.

Mr. Ferruzzi urges all major companies to adopt a similar accounting system to avoid calamitous errors in forming environmental policies.

For example, many European governments impose penalties on the use of plastics.

"But a proper system of energy accounting would reveal that a plastic bottle adds . . . much less [carbon dioxide, which contributes to global warming] than a glass bottle of the same size," he said.

Tanker spill heads for Texas beaches

A3

GALVESTON, Texas (Reuters) — A growing oil spill in the Gulf of Mexico crept toward Texas beaches yesterday as a burning Norwegian tanker continued to leak its cargo.

The Coast Guard said that 3 million gallons of crude oil have leaked from the 853-foot Mega Borg since it exploded Saturday and that more will pour from its shattered cargo hold.

The ship still has 35 million gallons of Angolan crude oil on board, but Coast Guard Capt. Thomas Greene, federal on-site coordinator, said he believes oil is leaking from only one of 16 cargo tanks.

That tank, apparently punctured by one of the explosions that have rocked the Mega Borg, had 6 million gallons of oil before the accident, he said.

A growing slick of brown oil crept toward the state's beaches, pushed on by rising winds and waves.

"Tar balls could begin to reach land as early as Friday or Saturday," Capt. Greene told reporters.

A slick of thick oil 12 miles long and 5 miles wide extended from the Mega Borg, but a sheen of oil stretched 30 miles across the gulf.

The Mega Borg is anchored 57 miles southeast of this coastal city, but wind and currents were expected to carry the oil to the west. Landfall was expected to take place somewhere along a 180-mile section between Freeport and Corpus Christi.

The area includes Aransas National Wildlife Refuge, winter home of the endangered whooping crane. Local officials were readying equipment to keep oil off the beaches and out of estuaries.

Capt. Greene said that C-130 cargo planes continue to bombard the floating oil with chemical dispersants and that a new technology called "bioremediation," in which oil-eating bacteria are dumped on the oil, may be used.

He estimated that only 12,000 to 40,000 gallons of the 3 million gallons that have leaked remain in the water.

"We're assuming the rest has incinerated or evaporated," Capt. Greene said.

The nation's worst oil spill took place March 24, 1989, when the Exxon Valdez spilled 11 million gallons of crude oil off the Alaskan coast.

A flotilla of 60 vessels, including eight oil-skimming boats, is in the gulf attempting to contain the growing spill, said Jim O'Brien, president of Oops Inc.

Gretna, La.-based Oops was hired by the private contractor — Smit American Salvage Inc. — in charge of putting out the fire aboard the Mega Borg and cleaning up the spill.

Mr. O'Brien said 31,000 gallons of oil have picked up by skimming boats, but winds that kicked up to 25 mph and waves of 4 to 6 feet were making the task difficult.

"Certainly some of the oil is escaping," he said.

Three more skimmers, including two from the United Kingdom and one from Mexico, were expected to arrive later yesterday, Mr. O'Brien said.

Robert Klawetter, an attorney representing ship owner K/S Mega Borg II, told reporters the company has \$700 million in pollution insurance to pay for the cleanup.

He defended the company's choice of Smit, a Dutch-owned firm, by calling the firm "the best in the world" at fighting these types of fires.

The company has been criticized because of delays in getting equipment to Texas to fight the fire.

The Coast Guard said the fire aboard the Mega Borg was under control.

To Skeptics on Global Warming

By Al Gore Jr.

WASHINGTON environmental and financial experts from around the world gathered in Washington this week for a White House-sponsored conference on global warming, they expected a serious discussion. Instead, they were surprised and angered to hear President Bush wholeheartedly endorse delay and inaction.

Global climate change is real. It is the single most serious manifestation of a larger problem: the collision course between industrial civilization and the ecological system that supports life as we know it.

The purpose of Earth Day is to alert people around the world to that impending collision. And yet the Bush Administration, according to a leaked memo, is advising its policymakers that "a better approach is to raise the many uncertainties," and argue with other skeptics that nothing should be done until unresolved questions are definitively answered.

What are the skeptics' questions? Here are several of the most prominent. None of them stands up under scrutiny.

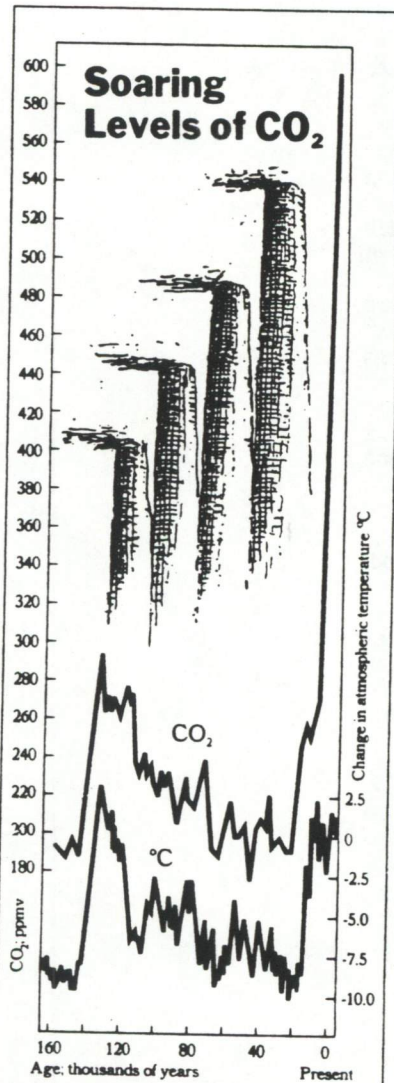
Q: Aren't the dire predictions about global warming based on unreliable computer models? How do we know that there is any correlation between increased levels of carbon dioxide in the atmosphere and changes in temperature?

A: The most compelling evidence comes from careful studies of tiny air bubbles in Antarctic ice. These show what has actually happened to the Earth's climate during the last 160,000 years. As illustrated by the accompanying graph, carbon dioxide and temperature have gone up and down in lockstep for as far back as scientists can measure.

Through the last two ice ages and the period of great warming in between, levels of carbon dioxide have fluctuated between 200 and 300 parts per million. Even the skeptics agree that concentrations of carbon dioxide will be pushed to levels of 600 parts per million within the next 35 to 45 years. It is irresponsible to assume that after moving in tandem with carbon dioxide for 160,000 years, temperatures will not be affected by those dramatic increases.

Q: Do we know enough to act? Shouldn't we study the problem until

Al Gore Jr., a Democrat, is a Senator from Tennessee.



The New York Times; Illustration by Janusz Kapusta

we eliminate the uncertainties?

A: That was the Administration's excuse last year, when it asked a distinguished United Nations-sponsored group of scientists to answer that question. A draft of the scientists' long-awaited report, leaked to the press this week, concludes that we must act now. The scientists say there's still a chance that the problem won't be as bad as they fear, but there's an equal chance that it will be much worse than predicted.

Q: Come on, isn't this really a little far-fetched? After all, the Earth is a big place and probably has some kind of natural "thermostat" to maintain the present climate. Don't some scientists say that clouds or the oceans or sunspots will offset any effect caused by human activity?

A: While the Earth is indeed vast in size, the atmosphere surrounding it is less than one one-thousandth the

PUBLIC & PRIVATE | Anna Quindlen

thickness of the Earth's diameter, a thin blue line around the crust of the Earth. Unprecedented population growth and new technologies for burning fuels, clearing forests and manufacturing chemicals have given humankind the ability to alter the composition of the atmosphere.

Everywhere on Earth, for example, each lungful of air now contains 600 percent more chlorine atoms than it did 40 years ago — or 3 billion years ago, for that matter. That chlorine is responsible for burning a hole in the stratospheric ozone layer. Similar increases in methane, nitrous oxide and other polluting gases add to the seriousness of global warming.

Q: But how can we trust scientists on this issue when some of them say global climate change is real and some of them say it's not?

A: Five hundred years ago, most scientists said the world was flat. Most people believed them because the Earth did indeed look flat. The new "model" of a round Earth was based on mathematical calculations that they could neither touch nor understand. Similarly, Galileo was punished for his then-novel view that the Earth orbited the sun, instead of the other way around.

In the last 20 years, eminent scientists continued to ridicule the theory of continental drift. The theory of global climate change used to be ridiculed, too. But in the last few years, the overwhelming majority of scientists who have examined the evidence have agreed that the problem is real.

Q: Didn't NASA just report that new measurements of the Earth's temperature in the last 10 years showed no evidence of warming?

A: That was the impression some people got. What NASA actually reported was that "nothing could be said" about a warming trend one way or another "due to the relatively short satellite data record." Temperatures naturally fluctuate so much from year to year that a single decade is not a long enough yardstick for a long-term trend. The decade as a whole, according to several other studies, was the hottest since temperatures have been recorded. The six hottest years on record occurred in the 1980's.

Q: O.K., suppose temperatures do rise by a few degrees. So what?

A: Even small changes in the average global temperature can have dramatic consequences. The last time there was a change as big as the one

cont'd

USA TODAY • MONDAY, APRIL 23, 1990 • 1D

Stars' examples get down to earth

By Valerie Helmbreck
USA TODAY

WASHINGTON — At first glance, it looked like Tom Cruise had recycled himself.

When the dimpled darling of the big screen showed up for a VIP Earth Day breakfast Sunday, his entourage included two Cruise look-alikes used as fan decoys. The duo watched as he preached environmental purity and "dolphin-safe tuna."

Any doubt about Cruise's dominance in the weekend's celeb pecking order was sealed by his Sheraton-Carlton room assignment: Hotel spokeswoman Kathleen Keenan said Cruise and girlfriend Nicole Kidman got the suite recently used by Elizabeth Taylor.

Not all Earth Day celebs were so anxiously attended, or overdressed. (Cruise chose a double-breasted suit). Most were in jeans; all talked of their efforts to save the Earth:

► Kevin Bacon and Kyra Sedgwick brought cloth-diaper-clad son Travis, 11 months. The couple shuns disposables, even on the road. "We try to find a diaper service wherever

we are," Bacon said.

► Olivia Newton-John is embarrassed she didn't use cloth diapers on daughter Chloe, now 4. The singer plans to ditch her Mercedes for a car that guzzles less gas.

She says a suit by Malibu neighbors, charging construction of her new house harms the beach, has been blown out of proportion. "When you build a house, you have to move dirt. Other neighbors have done much worse."

► Richard Gere, holding hands with model/girlfriend Cindy Crawford, offered a laid-back lecture on changing the inner self. Does he recycle? "No, I just keep everything. It's a problem, you should see my office." Crawford buys "environmentally safe" cleaning supplies.

► Cruise's efforts include distributing a booklet on environmental activism on the set of his *Days of Thunder*. Why do a film glorifying gas-greedy auto racing? "That's the wrong why!" he retorted. "You're only talking about 35 cars."

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JAPANESE LETTERS
ON STABILIZATION

CABINET
MEETING
OUTCOME

Since the press has already started reporting on (the "Action Program to Arrest Global Warming"), I would like to inform you of the background of one of the key issues of the Program, i.e. targets for CO₂ emissions stabilization. I hope that this will facilitate your eventual response to inquiries from the press and other quarters. An excerpt of the relevant text is attached for reference.

First, it is our common understanding that actions taken by a single country will not have a significant impact on greenhouse gas emissions. This has been well recognized in the IPCC process. We have a common interest to encourage other countries, especially those industrialized countries which have not started developing their response strategies, to join us in making serious efforts to meet the common challenge. Therefore, our target is made on the basis of common efforts by other key industrialized countries. This view is stated in the introduction of the text in question. This does not, of course, mean that our Action Program is being qualified by "similar actions" and the like.

Second, we view these stabilization targets as realistic guide posts for maximum efforts encompassing both the public and private sectors. At the same time, the specific circumstances of individual countries would yield differing greenhouse gas emissions potentials reflecting their past energy conservation performance, available energy options and other conditions. In the case of Japan, even if technically and economically feasible options were fully pursued, emission increases reflecting population growth could not be offset in the coming decade. This is consistent with the earlier recommendations from the Advisory Committee for Energy to our Minister of International Trade and Industry. This is why we are taking per capita emissions as a yardstick. This is reflected in the first part of the targets.

Third, despite the stringence of the afore-mentioned target, we do not preclude the possibility of stabilizing total emissions at the 1990 level by the year 2000 reflecting currently unforeseen events, such as the introduction earlier and on a larger scale than is predicted of innovative technologies such as photovoltaics, hydrogen and other energy-related technologies and CO₂ fixation. The second part of the targets indicates such an eventuality.

Neither of these targets can be realised automatically. We expect very serious and systematic efforts to be made in both the public and private sectors. We also believe that efforts of other countries will greatly enhance the effectiveness of our undertaking. The Second Climate Conference will certainly provide us with a good opportunity in intensifying our common endeavors.

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Action Program to Arrest Global Warming (excerpt)

III. Targets Under the Action Program

The targets for the limitation of greenhouse gases emissions shall be set as follows.

(1) The Government of Japan, based on the common efforts of the major industrialized countries to limit CO₂ emissions, establishes the following targets for the stabilization of Japan's CO₂ emissions.

a. The emissions of CO₂ should be stabilized on a per capita basis in the year 2000 and beyond at about the same level as in 1990, by steadily implementing a wide range of measures under this Action Program, as they become feasible, through the utmost efforts by both the government and private sectors.

b. Efforts should also be made, along with the measures above, to stabilize the total amount of CO₂ emission in the year 2000 and beyond at about the same level as in 1990, through progress in the development of innovative technologies, etc., including those related to solar, hydrogen and other new energies as well as fixation of CO₂ at a pace and scale greater than currently predicted.

(2) The emission of methane gas should not exceed the present level. To the extent possible, nitrous oxide and other greenhouse gases should not be increased.

With respect to sinks of carbon dioxide, efforts should be made to work for the conservation and development of forests, greenery in urban areas and so forth in Japan and also to take steps to conserve and expand forests on a global scale, among others.

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THE WHITE HOUSE
WASHINGTON

May 31, 1990

MEMORANDUM FOR GOVERNOR SUNUNU

FROM: D. ALLAN BROMLEY *AB*
DAVID Q. BATES *DQB*

SUBJECT: Global Climate Change Convention Negotiations

I. BACKGROUND

On June 8 Mostafa Tolba, the Executive Director of the United Nations Environment Programme (UNEP), will host a bureau meeting of UNEP and the World Meteorological Organization (WMO) in Geneva. One of the main objectives of the meeting will be to discuss when and how negotiations on a global climate change convention might be conducted. The President has previously indicated the U.S.'s willingness to host the first negotiating sessions for such a convention, and his comments alluded to an initial negotiating session late this year or early in 1991. It is now generally assumed by other countries that U.S.-hosted negotiations will begin at that time, although the U.S. invitation has not been formally accepted. If the U.S. is to influence the timing of negotiations, it is felt that our representatives at the UNEP/WMO meeting should have the authority to make a more definitive statement of the U.S. position on the issue. On May 30 a strategy task force of the Global Change Working Group met to discuss the U.S. position on the timing of negotiations for a climate change convention and the structure of the convention.

II. TIMING OF NEGOTIATIONS

The issue of timing is twofold, involving decisions both on the beginning date for formal negotiations and the date of a preparatory experts working group meeting (generally referred to as a "prepcom"). Tolba strongly supports the idea of a prepcom, probably in Geneva, which would serve as an organizational session and would likely be attended by lower-level technical personnel.

Several options were presented and discussed:

- o September prepcom and October negotiations
- o October prepcom and December negotiations

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By MM NARA, Date 2/22/2018
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- o October prepcom and February 1991 negotiations
- o February 1991 prepcom and April 1991 negotiations

It was the consensus of the Global Change task force that the third option -- negotiations beginning in February 1991, perhaps during the first week of that month, preceded by an October prepcom -- is the preferred course.

Advantages of Option

- o An October prepcom would provide grounds for deflecting anticipated efforts in the United Nations General Assembly and the Second World Climate Conference (in early November) to influence the negotiation process. It also provides sufficient time to prepare and appears to be widely supported by other countries.
- o February 1991 negotiations provide the U.S. with more lead time for site selection and other organizational and financial matters and avoid the seasonal difficulties posed by December negotiations.
- o Delaying until later in 1991 opens the U.S. to accusations of "stalling" and could allow the U.N. General Assembly and the Second World Climate Conference to make specific recommendations for negotiations or implement a separate formal process under their control.

Disadvantages of Option

- o Earlier negotiations in October or December could give greater assurance of deflecting any possible direction from the U.N. General Assembly or the Second World Climate Conference.
- o Some drafts of the resolutions to be taken up at the June 8 UNEP/WMO meeting present the option of December negotiations hosted by the U.S., so expectations may already have been created.
- o There are arguments that placing the negotiations within the U.N. General Assembly, which would likely result in a very protracted process, has advantages, and that allowing this to occur through inaction should be the U.S. position.

Once a position is determined, a second question of the method by which it will be announced must be considered. The announcement could come simply within the context of the June 8 meeting. Alternatively, a Presidential announcement, perhaps concurrently with an announcement in Geneva, could heighten the profile of the decision.

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III. STRUCTURE OF CONVENTION

The Global Change task force also discussed the structure of the convention -- the type of convention and protocols, if any -- but not the details of the negotiating process or the elements or ultimate content of a convention. The President spelled out the current U.S. position on this issue in his closing address to the White House Conference on Science and Economics Research Related to Global Change when he stated "we would encourage a framework convention as a part of a comprehensive approach to address the system, sources and sinks as a whole if a decision is made that environmental action is needed to reduce net emissions."

The issue of the structure of the convention may be discussed at the June 8 UNEP/WMO meeting. It has previously been dealt with in the Response Strategies Working Group (RSWG) of the IPCC (which will be meeting in Geneva beginning on June 5). RSWG has developed a paper, which will be addressed next week, that lays out the issues associated with the structure of a framework convention and presents a number of options. The paper carefully protects the U.S. position supporting a comprehensive approach but does not make any recommendations or preclude any future options. Because the U.S. will in the future be compelled to develop a position on the issue and a negotiating strategy, it is appropriate to begin to focus on it now.

There is general agreement that any convention will contain elements dealing with:

- general principles of cooperation;
- research and monitoring obligations, with support for the latter being strongly pushed to show our seriousness about the obligations being undertaken;
- obligations for exchanges of information; and
- establishment of appropriate institutions.

Although it does not represent a consensus position, there is support for advocating a program that would allow trading of emissions, at least on a voluntary basis, as a basic principle of a convention.

The Global Change task force considered five options:

- o (1) A "bare bones" framework convention that is without prejudice as to how protocols will be addressed.
- o (2) A framework convention that provides that any protocol (but which does not commit to the need for protocols) should address the sources and sinks of greenhouse gases comprehensively and commits the

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parties through the IPCC to study means to develop such a protocol.

- o (3) A framework convention that directs the parties to develop a comprehensive protocol; if agreement on a comprehensive protocol could not be reached, the effect would be to cause the framework convention to fail.
- o (4) A framework convention that either provides for a possible comprehensive protocol after further study or requires such a protocol, but with the first element of such a protocol being forestry. It was agreed that a separate forestry protocol standing alone could also be considered an option.
- o (5) A comprehensive convention.

Option 1 -- a framework convention that is without prejudice as to how protocols will be addressed -- is considered the only U.S. position articulated to date. There was consensus that it is time to move beyond that position, however. The task force agreed that Option 2 -- which makes clear the U.S. commitment to a comprehensive greenhouse gas index as the basis for a framework convention and any associated protocol, without obligating the parties to pursue it -- is now appropriate:

- o This position should be perceived as a step forward for the U.S.
- o Its emphasis on a comprehensive approach, assuming further study shows such action is appropriate and is consistent with statements of the President at the White House Conference on Science and Economics Research Related to Global Change, is the direction in which the U.S. should continue to push.
- o It is consistent with the U.S. position that negotiations for targets and timetables is premature.
- o U.S. unwillingness to commit to the need for some protocol may weaken our ability to push for a comprehensive protocol, however.

Option 5 was eliminated as premature. It was agreed that Options 3 and 4 should be considered further after the June 8 UNEP/WMO meeting and (assuming negotiations on the schedule outlined above go forward) the October prepcom meeting. It was noted that other countries are likely to push for Option 3 requiring a comprehensive protocol or at least for commitments to some protocol. It was also noted that Option 4, incorporating negotiations on forestry as the first element of a comprehensive protocol or an independent forestry protocol, could put the U.S.

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on a "slippery slope" leading quickly to specific discussions of reductions in carbon dioxide emissions that could go beyond forestry.

Variations of the position presented above would be to allow U.S. representatives to announce Option 2 as our position, but authorize them to move further to Option 3 or Option 4 depending on the tone of the discussions and the extent of pressure on the U.S. A second alternative would be not to go beyond the current U.S. position (Option 1), but wait on later meetings to obtain better intelligence on other countries' positions.

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JACK ANDERSON and DALE VAN ATTA

The Cloudy Politics of Clearing the Air

Rep. John D. Dingell (D-Mich.) is one of the pit bulls of Congress, and he likes nothing better than chewing on the leg of William Reilly.

Reilly, the head of the Environmental Protection Agency, is tailor-made to whet Dingell's appetite—a career environmentalist, driven to clean up the air. Dingell is a career politician, driven to protect his constituents, the auto makers and auto workers in Detroit.

Ever since George Bush declared himself to be the "environmental president," Dingell has had his hands full. It isn't that Bush has turned out to be a defender of the environment. It's simply that Bush stumbled upon an EPA director who is.

For years, Dingell has harped on the EPA for its lax protection of nearly every element of the environment, except the air. Dingell's favorite target has been EPA's failure to clean up hazardous waste. But when it comes to air pollution, the congressman sings a different tune.

In past years, Dingell has fought efforts to put more pollution controls on cars because it would cost the car makers big money. But when changes to the Clean Air Act were introduced in Congress, Dingell looked up from chewing on Reilly's leg and saw that public sentiment was not going his way. It was time to compromise.

Dingell met halfway with the leading pollution fighter in the House, Rep. Henry A. Waxman (D-Calif.). They worked out a compromise and passed tough revisions to the clean air laws last month.

Dingell's fellow Democrats were breathing hot on his neck. They remembered how Bush stole the "environmentalist" label from Michael S. Dukakis

by focusing on Dukakis's failure to clean up Boston Harbor. The last thing the Democrats needed was one of their own standing in the way of cleaner air.

It was Dingell who caved in, but now Reilly is watching his ankles. The chilly relationship between the two men turned to ice in the clean air debate, sources told our associates Scott Sleek and Tim Warner. Dingell even confronted Reilly at a Washington party and gave him a tongue-lashing. In a speech to the American Public Power Association in January, Dingell implied that Reilly was a dilettante who didn't care if workers in Detroit lost their jobs.

During the clean air hearings, Dingell made Reilly pay for every concession he got. The congressman drilled Reilly like a prosecutor badgering the star defense witness. After Dingell had agreed to sponsor the bill, he demanded minute details about how the new emissions standards would affect car makers, he complained about the cost of cleaner fuels, and he carped about the increased power Reilly would have.

The exchange was so cold Waxman had to break the ice: "Mr. Reilly, I think you're fortunate Mr. Dingell is the lead sponsor of your legislation. Otherwise, I think he would be critical of it."

Reilly will continue to pay the price of victory. Dingell would like to blame Reilly for the EPA's failure to issue new guidelines for the industrial and military cleanup of hazardous waste dumps. But as we reported earlier, the Office and Management and Budget has derailed those guidelines.

Rather than pick on Budget Director Richard G. Darman, Dingell has nagged Reilly about the rules.

An administration source summed up the nagging: "This is just clean air politics."

DAVID WARSH *B3*

Game Theory Suggests Quick Action on Greenhouse Effect Is Remote

George Bush routinely gets beaten up by environmentalists because they think he should be leading the charge to do something about the greenhouse effect. In fact, among the economists who study the problem, the opposition to quick action runs fairly deep—aside from uncertainty over the climatological models.

Typical is Thomas C. Schelling, a thinker who is senior enough to be serving as president of the American Economic Association and who is leaving Harvard for the University of Maryland this week after a 30-year span. A look at the 69-year-old Schelling's career illuminates a good bit of the origins of present-day thinking about the greenhouse effect.

In the 1960s, no academic figure exemplified the romance of Harvard in Washington better than Schelling. It was said that Robert McNamara was influenced by his thinking, more than by any other. The son of a naval officer and veteran of a long Marshall Plan stint after World War II, Schelling wrote a book on algebraic economics in his spare time during the late 1940s and turned it in for a Harvard Ph.D. Then, after a stint at the Rand Corp., he took up thinking about nuclear war, earning a reputation as a tough-minded peacenik in the strenuous top-secret campaign against the Air Force plan to establish a testing treaty.

Schelling published "The Strategy of Conflict" in 1959 (sample chapter: "Bargaining, communication and limited war") But it was in John Kennedy's Camelot that Schelling really burst upon the Washington scene, commuting for his day-a-week consulting job on Friday. During Lyndon Johnson's years the economist-cum-strategist was everywhere, advising the best and the brightest in the Defense Department and the National Security Council.

But in the wake of the U.S. decision to spread the Vietnam War to Cambodia in April 1970, Schelling led a delegation of 12 Harvard professors to Washington to call on old friend Henry Kissinger, who was then national security adviser.

"We took turns speaking," Schelling recalls. "We told him that we had thought of the executive branch as our friend, of Congress as our enemy. From now on we would reverse it. Henry went gray in the face, he slumped in his chair. I thought at the time that he suffered serious depression. But there was no sign that it ever had any effect." For Schelling, the vow to perform no more work for the executive branch was an especially momentous pledge. It cost him both his audience and his information.

After a laborious intellectual retooling, there followed a trickle, then an outpouring of work on human behavior, energy and climate. There was still the garment bag on the shoulder at the airport on Thursday evenings, but now Schelling's clients included Congress, the National Academy of Science and various foundations. The issues were fossil fuels, racial discrimination, sexual politics, drug addiction, the cigarette habit, medical ethics, climate change, even wearing mittens in your sleep to keep from scratching poison ivy. ("Treating your sometime self as though it were somebody else is a ubiquitous and familiar technique of self-management.")

At the heart of it all was game theory. Today, of course, the systematic taking account of other people's actions in your theorizing is all the rage in economics. In fact, probably nothing is being talked about more frequently among teachers of economics than David Kreps's new graduate microeconomics textbook, which incorporates game theory for the first time in the deep-down architecture of the field. But when Schelling began writing about strategy in the 1950s, it was news to most economists—so much so that his "theory of interdependent decision" was all but ignored by them.

In Schelling's hands, the most mundane choices are illuminated for their strategic considerations. Christmas savings clubs are seen as a way of binding oneself to save even in the face of temptation. Protective hockey helmets become an intricate exercise in collective choice, for nobody wears them voluntarily, while everybody benefits if they are mandated. It turns out to be easy to decide where to meet in New York City without making plans if you just think for a while about what places the other guy knows. (In another era, it would have been the Biltmore clock, of course.)

As Richard Zeckhauser says, "Those who read Schelling and participate in his games learn a general principle: In any interactive situation, it is vitally important to look at matters from the side of the other party. . . . The other-people's-shoes approach is often recommended by softhearted promoters of compromise. The core principle, however, is that by understanding the other party's perspective, you will improve your comprehension of the situation dramatically and will come out better yourself. This is an important lesson for hard hearts as well."

CONTINUED

As Global-Warming Meeting Ends, US, Heels Planted, Is Pulled Along

By Peter Grier

Staff writer of The Christian Science Monitor

WASHINGTON

P.7

THIS week's White House conference on global climate change only served to emphasize the division between the United States and many other industrialized nations on the global warming problem.

From President Bush on down, US speakers stood in front of a backdrop depicting the earth from space and talked about caution, and what we do not know. Before committing to expensive cleanup programs we should "sort out the science on this complex issue," Mr. Bush said.

Delegates from other nations agreed that there is still much uncertainty about the scope and pace of global warming. But in closed working groups they told the US the stakes are so high that sweeping pollution reductions need to be taken, just in case.

In particular, a number of delegates at the conference said their countries were setting deadlines for freezing emissions of carbon dioxide, a gas implicated in the greenhouse effect. "We do not have the right to carry out experiments on a planetary scale," said Environment Minister Hans Alders of the Netherlands.

The Dutch were perhaps the most outspoken global-warming insurgents, but far from the only ones. At the 18-nation conference, the West German environment minister announced his country would reduce emissions of carbon dioxide 25 percent by the year 2005. The Norwegian Environment Minister Kristin Hille Valla said "doubt should not be used as a reason for postponing measures to prevent environmental degradation."

Ireland, France, and Italy were to some degree critical of what they felt was US foot-dragging. Japan and the Soviet Union, among others, were more supportive of the US.

The purpose of the conference, according to US officials, was to inject economic thinking into the international environmental debate. They say this means more than just figuring what pollution controls might cost. D. Allan Bromley, science adviser to the president, used the example of a recent study of the US economy which projected that by the year 2050 it would be producing anywhere from 1.5 to 12 times as much carbon dioxide as today. This is hardly the refined research needed to design and implement a carbon dioxide control strategy, Dr. Bromley said.

The US tried to highlight actions it is taking to curb other pollutants besides carbon dioxide. Bromley and others talked up the US commitment to banning chlorofluorocarbons (CFCs), as well as a new long-range energy conservation strategy under development at the Department of Energy.

But most of the other nations wanted to talk about carbon dioxide just the same. At an environmental conference in the Netherlands last November the US agreed to freeze its carbon dioxide emissions at some point. Now activist nations are pushing for a timetable — the Dutch, for instance, say they will freeze carbon dioxide emissions by 1995.

Since this week's conference was the White House's party, there was little public discussion of such a timetable. But some nations served notice it would be on their agenda at July's economic summit in Houston and the second World Climate Conference, scheduled for October in Geneva.

"Major decisions must be taken this year. At these meetings the world is expecting leadership from the USA," said minister Alders of the Netherlands.

It is not the cost that is stopping the US, charged dissident conferees, but the lack of political will. If that is true, the Dutch program for freezing carbon dioxide emissions shows why. It contains many items that would be controversial if any president tried to implement them in the US:

- Stabilization of car use by increased gas taxes and, possibly, a system of road tolls that varies according to time of day and day of week. Tax breaks for workers who commute by car will be cut.

- A doubling of investment in public transport systems. Zoning changes will encourage development near public transport facilities.

- Widespread recycling programs, including "collection of biogas from waste and manure and the gasification of wood and nonusable paper," says a Dutch environment ministry report.

In closing the conference, President Bush said his commitment to research was not a cover for doing nothing. The administration has "never considered research a substitute for action," he said. Delegates appeared to be warmed by this assertion.

"We've found common ground — that research and action are inseparable," said Pdraig Flynn, Irish environment minister.

Chicago Tribune

U.S. rebuffed at talks on global warming

Foreign delegates reject conclusions

By Terry Atlas
Chicago Tribune

P: 11

WASHINGTON—In an embarrassing setback for the White House, foreign delegates to the U.S.-sponsored conference on global warming Wednesday strongly rejected a document drafted by the administration that did not stress an urgent need for action to counter the climate threat.

U.S. officials quickly withdrew the document, saying it was mistakenly presented to the delegates. However, many foreign delegates were outraged at what they considered a clumsy American effort to steamroller them into endorsing the disputed conclusions sought by the White House.

The document, a proposed charter for research cooperation, said in part, "Gaps in scientific and economic understanding substantially limit the abilities of nations to gauge" the consequences of policies designed to counter global warming.

"We've disavowed it. It has no status," said William Reilly, head of the Environmental Protection Agency and one of the conference delegates.

It was just one of many U.S. missteps at the two-day conference, which foreign delegates and environmentalists viewed as a missed opportunity for President Bush to

shore up his claim to be an environmentalist president.

In concluding remarks to the conference Wednesday, Bush attempted to undo some of the damage, abruptly shifting ground to endorse international action against global warming.

Just 24 hours earlier he had stressed before the same group that more research was needed to resolve scientific uncertainties before making commitments to costly programs to counter what many consider the biggest environmental threat to mankind.

"There is one area where we will allow for no uncertainty, and that is our commitment to action to sound analyses and to sound policies," he said, using the word "action" half a dozen times in a 20-minute speech.

The administration has called for a complete phaseout of chlorofluorocarbons, a "greenhouse gas" that is eroding the Earth's protective ozone layer.

The administration also has supported a United Nations-sponsored program leading to negotiations toward a treaty to address global warming.

"We have never considered research a substitute for action," Bush said.

Administration officials said the president was aware of the criticism of his earlier remarks, in which he seemed to ignore the growing scientific consensus that the buildup of carbon dioxide and other greenhouse gases may cause a potentially catastrophic warming of the Earth.

"His commitment is a lot more informed as a result of what has happened," said Reilly.

But White House officials denied that Bush was directly responding to the criticism of his remarks Tuesday.

The conference succeeded in its narrowest mission—to bring together experts and policymakers in the areas of science, economics and the environment to discuss global warming.

But the White House failed in its attempt to produce an outcome that administration officials could interpret as an international endorsement of a go-slow approach to the climate danger.

On the contrary, delegates said, an important consensus was reached during informal, closed-door discussions favoring international goals and timetables to reduce emissions of carbon dioxide and other gases which are produced by burning fossil fuels such as gasoline and coal.

The administration has been divided over the seriousness of global warming, with Reilly favoring specific goals to reduce carbon dioxide and White House chief of staff John Sununu doubtful about the danger of climate change.

In planning the conference, which fulfills a Bush campaign promise, Sununu tried to structure the session in a way to produce an outcome to his liking, a White House agenda that many visiting ministers and other high-level delegates complained from the start was heavy-handed and biased. For instance, the two public sessions were monopolized by administration officials who, not unexpectedly, all echoed the president's views.

High-level delegates publicly complained that the White House seemed to be stressing the scientific uncertainties as an excuse to postpone action.

Some White House Effect p22

"Not beneficial to discuss whether there is or is not warming. . . . In the eyes of the public we will lose this debate." So warned the White House in a briefing paper for Cabinet officials attending the international conference on the greenhouse effect that President Bush convened this week.

Mr. Bush, for one, took the warning to heart. He didn't even mention the words "greenhouse effect" or "global warming." His foreign guests, under the impression they had been invited to discuss these subjects, were disappointed at the White House's decision to focus on uncertainties and not action to avert the feared greenhouse warming.

"Don't get into an advocacy position of the merits of various policy proposals," advised the briefing paper. "Don't use specific numbers i.e., degrees, dollars, rates, etc."

Specific numbers, of course, are the coin of serious discussion. So why hold a conference at all if serious discussion is to be avoided? Because in a campaign speech on Aug. 31, 1988, Mr. Bush promised to hold one. "Those who think we are powerless to do anything about the 'greenhouse effect' are forgetting about the 'White House effect,'" he said. "In my first year in office, I will convene a global conference on the environment at the White House. It will include the Soviets, the Chinese. . . . The agenda

will be clear. We will talk about global warming."

Such were candidate Bush's stirring promises. But President Bush disinvited the Chinese — a major producer of greenhouse gases — and manipulated the agenda to sidestep issues the White House wanted to avoid, declining even to utter the phrase "global warming."

That's a shameful surrender of substance to image, especially at a time when scientists in a major but so far unpublished United Nations study conclude that a rise of 3 to 8 degrees Fahrenheit can be expected within the next 60 years. What makes the surrender even stranger is that the White House's policy is not indefensible. Its skepticism of computer models of the climate, for example, is justified. So far the computers only show what might be, not what will be.

The Administration's stated policy is to pursue those actions against greenhouse warming that are worthwhile on their own merits. That policy, too, could be defended, even though the Administration's present list of actions is too short and omits the urgent remedy of an increased gasoline tax.

Had Mr. Bush's advisers got their act together, they would not have been trapped in the absurdity of holding a conference whose true purpose was to avoid debate.

Earth Day to Earth Day, and beyond

A.2

By now you may have heard or read more than you ever wanted to about Earth Day 1990, and the day has only just begun. Its coming has been embraced all over the nation, from newsrooms to classrooms to boardrooms, and before it ends an estimated 200 million people in 140 countries will have joined in some celebration, presentation, demonstration or protestation on behalf of this scuffed, wheezing planet.

That is one measure of a road greatly traveled since Earth Day 1970, the event more or less acknowledged as having sounded the gong for a new environmental awareness in the United States. Now, 20 years later, this anniversary Earth Day is being cast as the propellant for what will be the decade of the environment, and there is good reason to believe that thesis.

An extraordinary convergence of forces, some enthusiastically and some reluctantly, now crowd under the environmental umbrella. The zealots always have been there and always will be, and they have their place—at the risk sometimes of alienating the support they crave. The mainstream environmentalists carry on their yeoman work, nudging the system toward their ends. And in the system itself—in business, politics and government—have come the rumblings that have effected, and must effect, the greatest changes.

More than any factor, this gathering sentiment has been fueled by the will of the American people, who have shown in poll after poll that they want a cleaner, healthier environment and are willing to pay for it. In one of the most recent soundings, commissioned by the New York Times and CBS News, 84 percent of the respondents said pollution is a serious problem and getting worse. Seventy-four percent said protecting the environment is important enough to justify any standards at any cost; 71 percent would approve more government spending and higher taxes to that end; 56 percent would tolerate the loss of local jobs.

Politicians read very well, and this signal accounts for the astonishing transmutation of so many of them into environmentalists, knocking each other down in the rush for Earth Day podiums. Some may not yet realize that their feet will be held to the fire for their oratory, when the big environmental issues are called. But many, with or without conviction, will answer the call because it is good politics, and this will significantly influence the swing of the pendulum in the 1990s.

If the past 20 years are any guide, it will be a safe position, for the principal lesson since Earth Day 1970 is that it is possible to have a healthier environment and a healthy economy. Each time a major environmental initiative is proposed—as is the case now with the Clean Air Act before Congress—there are dire warnings from industry that it will bring catastrophe in the shuttering of businesses and the loss of thousands

of jobs. Yet despite the pile of environmental regulations approved in the past 20 years and their high cost—perhaps \$1 trillion—this has not happened. Jobs increased 50 percent and manufacturing productivity 45 percent, and whole new industries have been created in pollution control and recycling.

Still, there must be reason. As much as some environmentalists would prefer zero pollution tolerance, President Bush is correct: Environmental policies that ignore the economic factor are destined to fail.

Industry, though not always willing, is coming to understand that it has to be a participant in the quest for a cleaner, safer planet. This is partly out of resignation to inevitable regulation, partly out of genuine corporate conscience, and partly out of understanding that it is good business. It is not by coincidence that the advent of Earth Day brought announcement of an electric car, cleaner gasolines, a recyclable plastic ketchup bottle and dolphin-safe tuna. Even if not always acts of altruism, their results count just as much.

Government frequently is criticized for moving too slowly on environmental matters, and there is truth in that. Yet the past two decades brought new standards for clean air and water, pesticides, hazardous wastes, drinking water, endangered species, wild and scenic rivers and the creation of the Environmental Protection Agency. Many of the goals have not been reached and Congress has been too willing to grant extensions, but still there has been substantial progress.

The challenges ahead are daunting. More than 100 cities still violate federal clean air standards; millions of tons of toxic pollutants cloud the air; too many rivers and beachfronts still fail the fishable/swimmable test; wetlands are disappearing at an alarming rate; the number of endangered species has skyrocketed. There are cosmic problems not contemplated 20 years ago, which no single nation can solve: the threat of acid rain, the depletion of the Earth's ozone layer, trepidation over the effects of possible global warming.

And right at home, there is the problem of what to do with all our garbage, perceptively described by EPA administrator William Reilly as the nation's No. 1 environmental problem. On that one, the American public has had a lapse of conscience. Despite a growing fondness for recycling, people are producing more garbage than ever while becoming increasingly fierce in their opposition to landfills, incinerators and now even composting centers anywhere in their vicinity.

There is an object lesson in that, and a profound one as well. If Earth Day is a catalyst for anything, it ought to be to a look inward, to the choices we make, the lifestyles we favor and, yes, literally to the trees we plant. Each of us, one by one, fills this planet. Each of us, one by one, can work to make it a better place.

Bid to Slow Global Warming Could Cost U.S. \$200 Billion a Year, Bush Aide Says

By BOB DAVIS **B4**

Staff Reporter of THE WALL STREET JOURNAL

WASHINGTON—The chairman of the president's Council of Economic Advisers said that substantially reducing gases that some scientists believe will cause the Earth to warm catastrophically could cost the U.S. as much as \$200 billion a year and batter economies world-wide.

"The stakes are very high economically," said Michael Boskin, CEA chairman. "You'd likely wind up seeing a sharp reduction of economic growth" around the globe if the so-called greenhouse gases are to be reduced by 20% during the next 15 years.

Mr. Boskin's comments reflect an attempt by the Bush administration to refocus the debate over possible global warming from the effects on the environment to the potential costs of any clean-up. The president has invited 17 nations to a two-day conference on global warming that begins here tomorrow; the U.S. and Japan are expected during the meetings to emphasize the potentially staggering costs of reducing greenhouse gas emissions.

Environmentalists contend that the administration's tactic will slow any effort to combat global warming. "What they're doing is backing away from commitments already made," said Rafe Pomerance, a senior associate at the World Resources Institute, a Washington environmental research organization. "They have absolutely no plans to do anything about global warming."

Bush administration officials deny that. William Reilly, chief of the Environmental Protection Agency, said he expects the U.S. to begin preliminary negotiations on a global warming compact by the end of the

year. He called calculations of the economic effect of curbing greenhouse gases the "significant missing dimension" in international talks so far on the subject.

Climate scientists say the world may be heating because of the rapid increase in the atmosphere of carbon dioxide and other gases produced by human development. These gases trap heat in the atmosphere and block it from escaping into space. During the past century, the earth has warmed about 0.5 degree Celsius, according to White House Science Adviser Allan Bromley, but it isn't clear how much of that rise is due to human activity.

Mr. Boskin, one of the three co-chairmen of the global-change conference, played down the significance of the potential heating. A rise of a few degrees Celsius would be similar to the change from moving from Boston to Washington, and might even benefit U.S. agriculture, he said.

He also argued that people could use technology to adjust to the warmer weather. "For example, air conditioning has made previously less-hospitable climates much more hospitable," he said.

David Rind, a climate specialist at the National Aeronautics and Space Administration's Goddard Institute for Space Studies, said that computer models predict a rise of between about two degrees and six degrees Celsius if the amount of carbon dioxide in the atmosphere doubles, as expected, in the next century. Even a rise of two degrees would increase droughts in Florida and the southern-most parts of the U.S., Central America and large parts of Africa and South America. A four-degree rise would be a "disaster," leading to droughts in most of the U.S., he said.

The earth usually changes temperature exceptionally slowly. At the peak of the ice age 15,000 years ago, the earth was on average only four degrees Celsius colder than it is today. What makes global warming so menacing, he said, is that it would vastly accelerate the pace of environmental change.

Mr. Boskin said he and his staff hadn't done original research on the costs of greenhouse warming, but had reviewed a "substantial number" of U.S. computer models. Cutting emissions 20% by the year 2005, as has been suggested by countries in Western Europe, would cost the U.S. "trillions of dollars—\$100 billion to \$200 billion a year would be in the ballpark," he estimated.

"It would mean a period of substantially higher unemployment and lower economic growth," he said, because the U.S. would have to switch to "much more expensive forms of energy."

Even stabilizing carbon dioxide emissions would deal a big blow to the economy, Mr. Boskin predicted. The last time U.S. emissions of the gas didn't grow was after the Arab oil embargo quadrupled the cost of oil and the economy plummeted.

William Nordhaus, a Yale University economist who served on the CEA under President Carter, estimated the cost of stabilizing greenhouse gas emissions overall during the next 40 years at about \$50 billion a year for the U.S. and \$150 billion annually for the rest of the world. During the past year, Mr. Nordhaus conducted research into the costs of trying to limit global warming.

Slowing the increase of greenhouse gases so they grow at a rate 20% less than predicted would cost little, he said, and might "actually have benefits" economically.

Counter gas with clean air initiative

I thought it was ironic that just as the Senate passed the clean air bill, Saddam Hussein of Iraq announced that he had both the missiles and binary capability to rain nerve gas down on his enemies from afar.

Perhaps the Strategic Defense Initiative is our best investment in clean air.

BURMAN SKRABLE
Fairfax, Va.

CONTINUED

TALKING POINTS
APRIL 17, 1990

The U.S. is taking environmentally responsible actions that make sense on their own merits that also help deal with global change issues.

The U.S. Conference is working in complement to the IPCC.

The world community is making great strides towards understanding the science of global change, but many fundamental questions remain unanswered.

The economic impacts of potential global changes and possible responses are not well understood--more work is needed.

Science, economics and policy formulation need to be integrated, so we can deal responsibly with global change.

DEBATES TO AVOID

NOT BENEFICIAL TO DISCUSS WHETHER THERE IS OR IS NOT WARMING, OR HOW MUCH OR HOW LITTLE WARMING. IN THE EYES OF THE PUBLIC WE WILL LOSE THIS DEBATE. A BETTER APPROACH IS TO RAISE THE MANY UNCERTAINTIES THAT NEED TO BE BETTER UNDERSTOOD ON THIS ISSUE.

DON'T GET INTO AN ADVOCACY POSITION OF THE MERITS OF VARIOUS POLICY PROPOSALS.

DON'T LET REPORTERS POSITION THIS CONFERENCE AS AN ATTEMPT TO DELAY SERIOUS DECISIONS ON THIS ISSUE.

THIS CONFERENCE IS ACCELERATING THE INTERNATIONAL DISCUSSION AND UNDERSTANDING OF THESE ISSUES. (DON'T USE SPECIFIC NUMBERS IE., DEGREES, DOLLARS, RATES ETC.)

Global Warming Conference Illustrates Difficulty of Establishing World Policy

By BOB DAVIS **AW**

Staff Reporter of THE WALL STREET JOURNAL

WASHINGTON—President Bush, who invited 17 nations to find "common ground" on global warming issues at a two-day conference here, closed the meeting by ignoring the differences among them.

The conference illustrated the enormous difficulty of forging a global policy to head off a potential disastrous warming of the earth caused by a buildup of carbon dioxide and other so-called greenhouse gases.

The Dutch, West Germans and some other Europeans said they were ready to adopt strict limits on carbon-dioxide production. Apparently nobody else was. The U.S. and the Japanese said more study is needed, and the Japanese promoted a 100-year plan to solve warming through new technology. The Soviets said they need a new tax system. The Indonesians and the Poles said they are broke.

"Due to a difficult economic situation, we are not able at this moment to take up our obligations to reduce carbon dioxide emissions," said Jan Janowski, Poland's deputy prime minister, who spent much of his speech praising the U.S. and trashing totalitarianism.

President Bush said, "We have never considered research (on global warming) a substitute for action." Pdraig Flynn, the European Council's minister for the environment, along with a horde of environmentalists who hovered around the conference, pointed to that as a commitment by the U.S. to do something specific about global warming.

But the White House has said that for some time, while dodging proposals that would require the U.S. to reduce greenhouse emissions. The U.S. delegation to the conference was advised in two pages of "talking points" prepared by the White House to avoid discussions of whether warming is accelerating. "A better approach is to raise the many uncertainties that need to be better understood on this is-

sue," the paper advised.

The talking points were distributed to reporters by environmentalists, to whom they had been leaked.

After the president's speech, D. Allan Bromley, the president's science adviser, said the U.S. hadn't changed its global-warming policy "whatsoever" because of European criticism. He said the U.S. will be able to "respond" to specific proposals late this year, when the U.S. plans to host preliminary talks on a global warming treaty. But "that doesn't mean we'll have a particular percentage or particular timetable" regarding greenhouse gas stabilization or reduction in mind, he quickly added.

The only concrete proposals President Bush made were to build international institutes to study global change and computer networks to link researchers. But even those seemingly innocuous suggestions sparked controversy when they were circulated early yesterday. A number of delegates thought the U.S. was trying to ram the proposals past them without asking for their assent and that the wording of the proposals was designed to get them to admit that scientific knowledge about global warming is more uncertain than they believe it is. So the U.S. withdrew the proposals, and the president later characterized them as merely "ideas."

The sensitivity of the delegates and the apparent distrust of each other's motives was much in evidence. The U.S. repeatedly criticized a proposal by the Dutch and others to sharply reduce carbon dioxide emissions. The Americans said it failed to take into account the economic costs. But J.G.M. Alders, minister of the environment in the Netherlands, said his government had thoroughly studied the problem and found the costs negligible.

"Do you believe we could go home and take such measures without anybody saying, 'What are the economic effects?'" he asked.

Climate Meeting Ends in Controversy

Europeans Complain U.S. Used Conference to Push Its Position

By Michael Weisskopf
Washington Post Staff Writer **AP**

The White House conference on global warming ended in controversy yesterday after European participants complained that the United States seemed to be trying to engineer an endorsement of its go-slow approach to the problem.

Minutes after the European delegates protested a "Charter for Cooperation" that was drafted by the Bush administration and stressed the scientific uncertainty of global warming, U.S. officials withdrew it from the closed working session. Later they described its circulation as an unfortunate mistake.

"It was drafted several weeks ago and wasn't meant to be distributed," said Michael R. Deland, chairman of the White House Council on Environmental Quality. "Sometimes in the confusion of a conference, things get passed out that aren't supposed to be."

But some European participants, who contend the meeting was skewed to justify President Bush's position that further research is needed on global warming before any action is taken, did not accept the explanation.

"The United States publicly questioned the seriousness of the European Community, but it backfired," said Pier Vellinga, director of the Dutch National Climate Program. "We Europeans have become a major economic and political power, and it's naive to challenge the integrity of a major power. They haven't done their international diplomacy well."

Jorgen Henningsen of the Commission for European Communities said the document came as a "supreme surprise" to delegates and reflected the "one-sided approach" the administration applied to the conference.

From the start, European delegates criticized the two-day meeting for what they described as its patronizing tone, the near monopoly of speakers favoring the U.S. position and the failure to discuss in open sessions the plans of European

governments to curb industrial gases blamed for global warming.

The administration's strategy apparently was based on "Talking Points," a primer prepared by spokesmen for the U.S. delegation and circulated Tuesday to the Cabinet officials who were delegates.

Under the heading "Debates to Avoid," the paper advised delegates that it is "not beneficial to discuss whether there is or is not warming, or how much or how little warming. In the eyes of the public we will lose this debate. A better approach is to raise the many uncertainties that need to be better understood on this issue."

As for press strategy, the primer urged the following: "Don't let reporters position this conference as an attempt to delay serious decisions on this issue."

A copy of the paper was obtained by the Sierra Club and vouched for by administration officials.

The conference grew out of a campaign pledge by Bush designed to prove his concern over global warming, which is believed to occur when industrial gases cover the Earth's surface and trap solar heat. In office, however, Bush's emphasis on the uncertainty of global warm-

ing theories reflects the concerns of advisers over the economic consequences of curbing gases produced by the burning of coal and oil.

In closing remarks yesterday, Bush mildly scolded the delegates

from 17 nations, urging them to "forge solutions without the excessive heat of politics." But he also sought to quiet critics by stressing "our commitment to action, to sound analysis and sound policies."

CONTINUED

TONY SNOW *fs*

And now, Indoctro-tainment

Pope John Paul II had better hustle. He's about the only earthling who hasn't endorsed Earth Day. Time-Warner has sponsored a consciousness-raising comedy special. Network newscasts have provided schoolmarmish lectures about what to do with your toilet paper. Auto companies, oil companies and chemical manufacturers have wrapped themselves in the day's symbolism. Green capitalists have marketed T-shirts, paper bags, foodstuffs and even mutual funds to cash in on Mother Earth's new cachet.

Earth Day thus brings into focus a phenomenon that for several years has been emerging from a primordial electronic ooze, something I'll call Total (or, more accurately, Totalitarian) Entertainment. The institution began as celebrity philanthropy with the Live Aid and Farm Aid concerts, but soon grew into something larger and more encompassing.

Our entertainment community, and our mass media generally, no longer seems content to supply diversions. Increasingly it devotes itself to inculcating proper sentiments. With Earth Day this "educational" program seeks to promote feelings of obligation to the emerging ideology of environmentalism.

Like most 20th-century ideologies, environmentalism begins by trumpeting what philosopher Michael Oakeshott has called "felt needs." The term seems rather tame, considering that many environmentalist policies justify themselves as the one and only salvation from a horrible annihilation by cancer or famine or flooding or something (the something seems to change annually). Still, the adjective, "felt," is

crucial. Most of the dangers are more felt than experienced. Environmentalism in many cases presumes dangers that don't exist and poses solutions that don't work.

For example, some of the people who have helped with Live Aid, an effort to feed starving Africans, now support bans on development and pesticides. The development ban could help condemn underdeveloped nations to a sort of environmentally approved poverty, while the pesticide ban will reduce agricultural productivity (without improving public health), thereby consigning millions of people to hunger and want. Think of that the next time Meryl Streep talks about the great non-threat, Alar.

The felt need of imminent destruction in turn justifies quick "solutions." Hence, the righteous indignation this week at the conference on global warming, where participants have derided President Bush for daring to ask whether the phenomenon actually exists, and if so, how we might address it without throwing millions of people out of work and into the biggest environmental threat of all, poverty.

Former Sen. Gaylord Nelson, an Earth Day poohbah and president of the Wilderness Society, expressed this impatience on the "MacNeil/Lehrer NewsHour" the other night by noting, "The president has a golden opportunity to grasp this issue. . . . The president is the only one who can provide this kind of bold and critical leadership. That's what presidents are for." Sierra Club Chairman Michael McCloskey incredibly described the president's request for fact as "keeping anything substantive from happening." Barry Commoner, meanwhile, has called for nothing less than restructuring the ways in which we live, creating a New Environmental Man (my characterization, not his).

He told California audiences this week that the government shouldn't be in the business of abating pollution. It ought to prevent it.

The idea of re-creating man is nothing new, but it never can be accomplished without the use of absolute coercion, since people have this habit of following their own instincts. New Man projects never succeed and never produce anything other than hardship, pain and penury. Unfortunately, the people who control the symbolism of the Environment are ideologues, who consider the past failures of such things as communism as failures of rigor. If the leaders had only followed the rational course, they say, the programs would work. Environmentalism thus resists fact, experience and history. It creates its own dogma, and when reality doesn't support the dogma, it insists on re-creating reality.

The press, unfortunately, has donned blinders in reporting on environmentalism, and with notable exceptions such as Warren Brookes, has adopted the view and agenda of the professional environmentalist. Few reporters seem to understand that people, given an incentive to innovate, will. Few even dare entertain the notion that we can reach most of our environmental goals without having to give up disposable diapers and automobiles. By taking such a narrow and controversial line, reporters in many cases have crossed the line that separates merely dimwitted "Info-tainment" from "Indoctrainment."

Indoctrainment — Totalitarian Entertainment — gives dubious political content to such indisputably good symbols as that of a clean, healthy Earth. And with the political and commercial success of Earth Day, you can be sure that we again will be treated to the spectacle of watching Tom Cruise, Meg Ryan, Dan Rather or other notables embrace a nice symbol and assume the right to tell us precisely how we ought to live our lives.

Tony Snow is the editorial page editor of The Washington Times.

European Officials Dispute Bush Over Global Warming

B4

By PHILIP SHABECOFF
Special to The New York Times

WASHINGTON, April 17 — President Bush called today for more research into the scientific and economic ramifications of global warming linked to pollution, but several European officials attending a conference here argued for more concrete and prompt action as well.

The differences over how quickly to proceed highlighted the opening session of a two-day conference called by the White House to discuss research into the scientific and economic uncertainties surrounding the issue of a pollution-induced warming of the earth.

In his speech, Mr. Bush urged environmental ministers and other delegates from 18 nations to consider the economic consequences while drawing up policies to deal with the problem.

The delegates, Mr. Bush said, should "sort out the science on this complex issue" as well as explore "the links between our environmental well-being and our economic welfare."

'An Excuse' for Inaction

But West Germany's Minister for the Environment, Klaus Töpfer, said in a statement today, "Worldwide action against the climatic threat is urgently required, even if the complicated scientific interrelationships of climatic change have not all been fully understood." He added, "Gaps in knowledge must not be used as an excuse for worldwide inaction."

The disagreement comes at a potentially embarrassing time for the Administration as several nations, including the United States, focus on pollution and environmental issues in advance of Earth Day next Sunday.

In the last year, there has been considerable debate within the Bush Administration over how quickly to respond to potential global warming. William K. Reilly, the Administrator of the Environmental Protection Agency, had initially urged a specific commitment to reduce carbon dioxide, which is produced by the burning of fossil fuels and is thought to contribute to global warming.

But the White House chief of staff, John H. Sununu and other officials opposed such a move. At this point the entire Administration, including Mr. Reilly, appears to have closed ranks behind the more cautious response sought by Mr. Sununu.

Many scientists now predict that climate shifts will occur in the next century as the gases in the atmosphere retain radiation from the sun that would otherwise be reflected back into space. But in his speech to the conference, Mr. Bush made it plain that more research was necessary on the global warming issue and that actions to deal with the situation should be weighed against their economic consequences.

"Environmental policies that ignore the economic factor, the human factor, are bound to fail," Mr. Bush declared.

Several officials of major European nations attending the White House Conference on Science and Economics Research Related to Global Change, said the time had come for action aimed at reducing the pollution, mainly from carbon dioxide, that is expected to

cause the earth to warm in the next century.

West Germany, the Netherlands and France, disclosed their own plans for unilateral action to reduce their emissions of carbon dioxide.

Bert Bolin, the Swede who is chairman of the Intergovernmental Panel on Climate Change, said in an interview that "this conference avoided bringing up certain issues such as how do you get an effective decision-making process without too much delay."

Dr. Bolin said that while there was a need for research, "it must be in parallel with action."

In his remarks, Mr. Bush said the conference was intended to help speed the efforts of the Intergovernmental Panel on Climate Change, a panel of experts organized by the United Nations Environmental Program and the World Meteorological Organization. The panel has been given the task of assessing the state of science with regard to global warming and to recommend possible international responses.

Other Administration officials who addressed the plenary sessions held today, including Treasury Secretary Nicholas F. Brady; Michael J. Boskin, chairman of the Council of Economic

More research, says the President; action, say the visitors.

Advisers; D. Allan Bromley, Assistant to the President for Science and Technology; Michael R. Deland, chairman of the Council on Environmental Quality, and Mr. Reilly, the E.P.A. administrator, sounded similar themes.

Several of them noted that the United States had committed \$1 billion to research into global warming and the President has agreed to act as host to a meeting to plan a framework treaty for international cooperation to deal with the problem.

Dr. Töpfer of West Germany said he had prepared a proposal for his Government's cabinet that would reduce his country's emissions of carbon dioxide, by at least 25 percent by the year 2005. He said the cabinet would take up the issue before its summer recess.

Per Villinga, who is in charge of global warming issues in the Netherlands environmental ministry, said his country was planning to reduce its carbon dioxide emissions by 5 percent by the end of the decade.

Talking to reporters on Monday, Mr. Villinga said that his country believed this conference should discuss policy as well as research and said that the economic problems may be exaggerated.

A number of the delegates complained today that, except for the Deputy Prime Minister of Poland, Jan Janowski, only American officials were permitted to speak at the plenary sessions today.

A1 World-Wide

THE SOVIET UNION ORDERED cuts in natural-gas supplies to Lithuania.

Moving to enforce a threatened economic embargo to break the Baltic republic's independence bid, the Soviet government said that gas supplies would be "sharply reduced," and that oil and petroleum shipments may also be cut because of Lithuania's refusal to rescind secession-related laws. Lawmakers met in Vilnius to discuss the situation, but there wasn't any indication that the order had been implemented. In Washington, the U.S. was preparing to delay some dealings with Moscow, including economic talks, if Lithuania's energy supplies were reduced. (Stories on Page A19)

About 10,000 people demonstrated at the Kremlin in defense of two corruption investigators while Soviet legislators debated whether the pair violated rules in pursuit of high-ranking offenders.

Researchers have pinpointed a gene that appears to increase the risk of alcoholism, a condition that afflicts 18 million Americans. The scientists at UCLA and the University of Texas, San Antonio, caution that other genes probably predispose people to alcoholism and that the findings must be repeated in a larger study. (Story on Page B1)

Bush called for additional research "to sort out the science" of global warming. The president was criticized at a White House-sponsored conference by Europeans who argued for action. Bush also expressed hope that the parley, attended by delegates from 17 nations, would inject economic issues into the debate over the greenhouse effect.

A federal judge in Atlanta froze 684 U.S. bank accounts that allegedly once contained as much as \$400 million in illegal Colombian narcotics profits. The order came at the request of the Justice Department. The accounts are held in 173 banks in 22 states and the District of Columbia, with the biggest concentrations in New York and Miami.

The Supreme Court ruled that a state may make the hallucinogenic drug peyote illegal in all circumstances, including its use in a Native American religious rite. In a 6-3 decision, the justices upheld an Oregon law, saying the First Amendment guarantee of religious freedom doesn't excuse an individual from complying with criminal laws.

South Africa's de Klerk rejected black majority rule, but said apartheid must end. Speaking to Parliament in Cape Town, the president didn't announce any new measures to dismantle the racial-segregation system, and again insisted that the African National Congress renounce violence.

Street battles swept through Beirut, sparked by separate power struggles for control of Lebanon's Shiite Moslem and Maronite Christian communities. Clashes also erupted in the southern port of Sidon between the Israeli-backed South Lebanon Army and the leftist Nasserite militia.

A court in Jerusalem upheld an order to evict 150 Jewish settlers who rented buildings owned by the Greek Orthodox Church in the Christian quarter of the walled Old City. The settlement had prompted protests by Palestinian Christians, and the Israeli government sent a cabinet minister to the area in an attempt to calm rising tensions.

A delegation of Contra rebels arrived in Managua and agreed to sign a truce with the Sandinista army as a first step toward demobilization, according to a senior aide to President-elect Violeta Chamorro. In Washington, a U.S. official said it was doubtful that all the rebels will surrender their arms by the time Ortega steps down April 25.

Jury selection began in Boston in the case of a Christian Science couple charged with manslaughter for praying for their son instead of seeking medical help. The two-year-old boy died in 1986 of a bowel obstruction. The case is being watched by the Christian Science Church, which contends its doctrine of spiritual healing is under attack.

Secretary of State Baker said in a report to Congress that the U.S. won't renew its membership in Unesco because the educational, scientific and cultural organization continues to be mismanaged and shows political bias against Israel. The U.S. withdrew from the international body in 1984.

Died: Ralph David Abernathy, 64, a Baptist minister who was a top aide to the Rev. Martin Luther King Jr. during the civil-rights movement of the 1960s and president emeritus of the Southern Christian Leadership Conference, in Atlanta.

Research Goal: Solar-Powered 21st Century

*Concerns about conventional sources of energy
spur efforts to find cost-efficient, environmentally safer alternatives*

By **Rushworth M. Kidder**
Staff writer of The Christian Science Monitor

GOLDEN, COLO.

WILL sunlight be a central source of United States energy for the 21st century?

Here at the sprawling, low-rise campus of the Solar Energy Research Institute (SERI), the answer is a resounding "Yes."

Politically, the answer may be coming just in time. Conventional sources of power generation — coal, oil, and natural gas — are coming under increasing fire from an environmentally conscious public concerned about global warming, acid rain, and air pollution. Also of concern: The national security implications of dependence on oil, nearly 40 percent of which is imported.

But nuclear energy, once touted as an environmentally clean alternative, is suffering from continuing revelations following the explosion of a Soviet nuclear reactor at the Chernobyl power station in 1986. The political difficulties surrounding the start up of the Seabrook Nuclear Power Plant in New Hampshire are seen by many as a portent of greater challenges facing nuclear installations in the future.

Can sunlight fill the gap?

"The progress in the last decade has been truly remarkable," says Robert Stokes, deputy director of research for SERI, a 13-year-old research facility owned by the United States Department of Energy. SERI is currently budgeted at \$100 million a year. "We believe that the government is now set up on a course that will gradually increase the research and development investment in renewable energy to the point that many of these technologies will become cost-effective," Mr. Stokes says.

Researchers at SERI, taking an expanded view of the word "solar," use it to cover any of the alternative energy resources that ultimately derive their energy from the sun — including wind power, combustion of organic (biomass) products, wave- and tidal-power, thermal gradients in the ocean, and a number of other technologies.

Already, say researchers, some of these technologies are cost-effective for certain applications. "We're very much closer today than we were eight or 10 years ago to eventual economic parity with a variety of other energy technologies," says Tom Bath, manager of SERI's Analysis and Evaluation Office. Among the cost-effective technologies:

- Photovoltaics (PV), the direct conversion of sunlight into electricity using solid-state "photo-cells," has been powering satellites since Vanguard 1 was launched in 1958. It is already the technology of choice for small applications far from conventional power grids — rural water pumps, communication relay stations, vaccine refrigerators in third-world nations — and is even competitive for some remote homes in the United States. "If you are more than a third of a mile from the grid," Dr. Bath says, "it pays you to buy PV and batteries today rather than try to hook up."

- Solar thermal power plants like the Luz International plant at Kramer Junction, Calif., use acres of trough-shaped mirrors to focus the sun's rays on vacuum-insulated tubes of oil. Heated to 735 degrees F, the oil is used to generate superheated steam that drives a turbine generator. At a cost of less than 8 cents per kilowatt hour, say plant officials, their power is already cheaper than nuclear power and is becoming competitive with oil and coal. Now producing 274 mega-

watts of power in southern California, Luz will reach almost 680 megawatts by 1994 — enough to meet the residential needs of a city the size of San Francisco or Phoenix.

- Wind power, typically generated at windmill farms located in high mountain passes in the West, is already a viable industry. In California alone, nearly 16,000 wind turbines generate nearly 2 billion kilowatt hours each year — as much energy as a medium-sized nuclear plant. Because they are nonpolluting, says Paul Gipe of

the American Wind Energy Association in Tehachapi, Calif., these turbines alone offset 1.8 billion pounds of greenhouse gases that would otherwise pour into the atmosphere from conventional power plants.

- Biomass conversion takes many forms, some of which are already cost-effective. Wood-burning and municipal solid-waste conversion, already supplying 3 to 5 percent of the nation's energy needs, have a potential of about 12 percent. More complex technologies — including the biological conversion of energy crops into alcohol fuels and biogas, the cultivation of microalgae and oilseed crops to produce diesel fuel, and the thermal conversion of biomass into synthetic gas — are already in limited operation. Taken together, they could ultimately produce as much as 20 percent of the nation's energy needs.

- Hydrogen, a gas that produces only water vapor when it burns and produces no greenhouse gases or air pollution, is increasingly being considered as a transportation fuel and as a means to store energy. Easily made by an electrolysis process

that uses direct current to split water molecules into hydrogen and oxygen atoms, it needs only a cheap source of electricity to be economically attractive. Hydrogen-powered automobile prototypes are already in existence. A recent report from the World Resources Institute in Washington notes that by the turn of the

CONTINUED

century, as the cost of producing photovoltaic electricity falls to between 2 and 3.5 cents per kilowatt hour in the sunnier regions of the nation, hydrogen could become a cost-competitive fuel.

The "bottom line" for all these alternative sources, Bath says, depends on whether the nation's research and development (R&D) investment remains

constant or increases. "With a business-as-usual kind of R&D by the United States," he says, "renewable goes from about 8 percent of the US energy mix to around 13 by 2030. If you intensify R&D, we can get up to 28 percent of the energy mix by 2030." The 28 percent figure, he says, is "roughly equivalent to what coal or gas-and-nuclear do today."

Researchers at SERI acknowledge that the 1980s were a quiet period in the history of solar energy. The flurry of public interest following the 1973-74 Arab oil embargo led to an upsurge in research into alternative energy sources. As oil prices fell, however, the urgency to develop solar resources also declined - leaving alternative energy with the reputation of a kind of idealistic crusade.

Over the last decade, however, steady progress has been made on a number of fronts. In photovoltaics, for example, solar cells are now available that are more than 27 percent efficient in converting the sun's energy. By contrast, nature's solar conversion process, known as photosynthesis, is "on the order of 1/2 of 1 percent," says Dr. Stokes.

"The long-term horizon for PV has barely been scratched," says Kenneth Zweibel of SERI's Photovoltaic Program. "The potential is there for 30, 40, 50, 60 percent efficiency as the technology matures."

In fact, it is that very maturing of the technology that drives the success of solar programs. "In contrast to conventional energy systems, these technologies are generally not resource-limited - they're technology-limited," Bath says. He adds, however, that "the resource in many cases is diffuse, and it's erratic. Those two factors provide the source of the technological challenge."

For these reasons, some technologies work well only in certain regions. Diffuse sunlight, of the sort usually available under cloud cover in the nation's Northeast, is an adequate source of PV energy, but it will not power today's solar thermal plants, which need to be located in the Southwest.

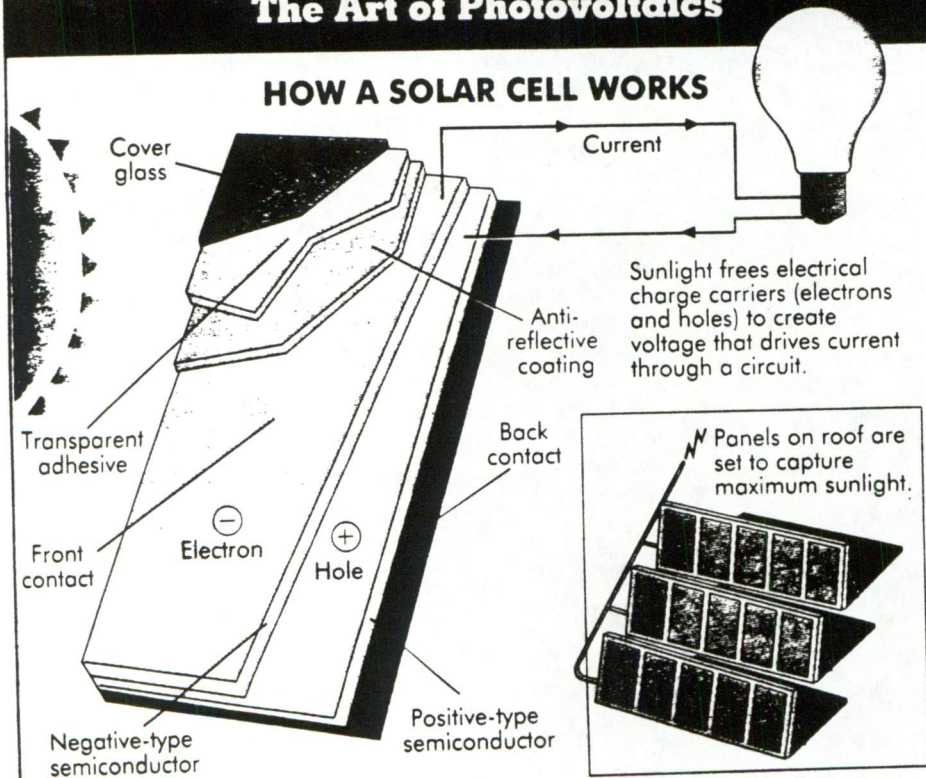
And wind power, which is erratic, will benefit greatly from continuing research into energy storage systems such as hydrogen conversion, new batteries, and superconducting rings.

Watching the rate of progress in solar technologies, however, Mr. Zweibel is optimistic. "Solar," he says flatly, "can meet the global-warming crisis."

GUY STUART - STAFF

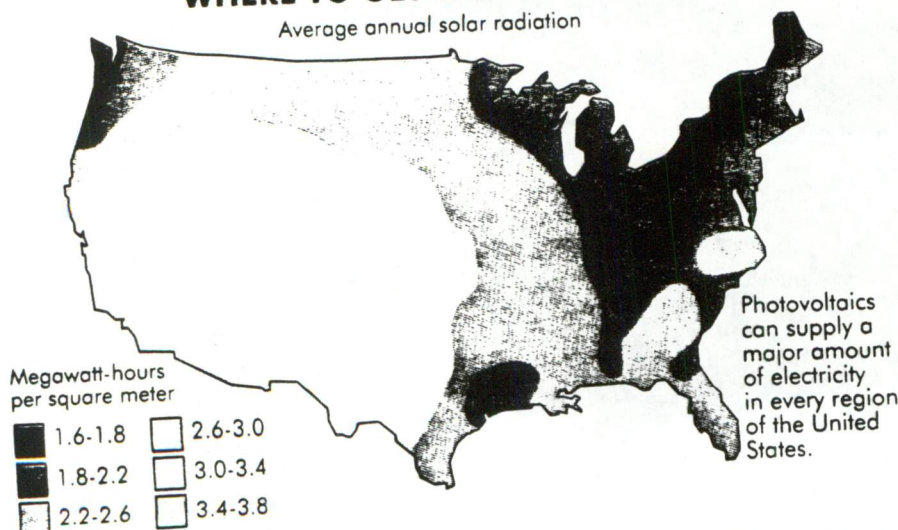
The Art of Photovoltaics

HOW A SOLAR CELL WORKS



WHERE TO GET THE MOST SUN

Average annual solar radiation



Source: SERI S&T In Review, 1988

Photovoltaics can supply a major amount of electricity in every region of the United States.

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(adv 6 pm edt)

WASHINGTON (UPI) _ Natural gas appears to be less harmful than other fossil fuels when it comes to aggravating the greenhouse effect, a Swedish researcher reported Thursday.

In a study published in the journal Science, Henning Rodhe of Stockholm University calculated the greenhouse impact of carbon dioxide, methane and other gases emitted from the burning of coal, petroleum and natural gas.

"A rough analysis ... shows that natural gas is preferable to other fossil fuels in consideration of the greenhouse effect as long as its leakage can be limited to 3 to 6 percent," Rhode wrote.

Spillage, however, has been one of the major problems plaguing the natural gas industry.

The so-called greenhouse gases act like the glass windows of a greenhouse to trap heat in Earth's atmosphere and prevent it from escaping back into space. Many scientists think increased human production of greenhouse gases, from such sources as automobile exhausts and forest burning, will aggravate the greenhouse effect and cause global warming.

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Table 2
Emissions Standards for Combustion Facilities
(Milligrams per Normal Cubic Meter, Mg/Nm¹)

Country	New Plants		Existing Plants	
	SO ₂	NO _x	SO ₂	NO _x
United States				
Solid	1240	475-620	None prior to 1971	
Liquid	920	350-570		
Gas	1135	285		
Canada				
Solid	615	615	None	None
Liquid	700	350		
Gas	850	287		
France	Plants evaluated on a case-by-case basis.			
Italy				
Solid	400	650	1200	1200
Japan				
Solid	223	411	644	200-400
Liquid	223	267	644	130-180
Gas	223	123	644	60-130
United Kingdom	"Best practicable means"			
West Germany				
Solid	400	200	400	200
Liquid	400	150	400	150
Gas	35	100	NA	NA

**Energy Consumption by Fuel of G-7 Countries, 1989
(Percent Share)**

	US	Can	Fr	It	Jap	UK	WG
Oil	41	30	42	59	58	38	43
N Gas	22	21	12	23	10	23	17
Coal	27	13	9	9	18	31	28
Hydro	3	28	7	9	4	1	1
Nuclear	6	8	30	0	10	7	12

**Conservation R&D Expenditures Among G-7 Countries, 1988
(Million \$ US)**

US	Canada	France	Italy	Japan	UK	W. Germany
165	33	NA	61	63	37	14

**Aggregate End-Use Energy Prices Among G-7 Countries, 1988
(\$ US per Barrel)**

US	Canada	France	Italy	Japan	UK	W. Germany
49.33	53.33	94.05	89.11	159.19	77.85	76.65

Table 1
G-7 Fuel Specifications

Country	<u>Sulfer</u>		<u>Lead</u>
	Percent Diesel	Percent Fuel Oil	Grams per Liter Gasoline
United States	0.50	0.25-1.5	0.26
Canada	NA	NA	0.29
France	0.30	0.30-4.0	0.25
Italy	0.30	0.30-3.0	0.30
Japan	0.50	0.50-1.2	NA ¹
United Kingdom	0.30	0.50-4.0	0.15
West Germany	0.20	0.15	0.15

¹ Essentially all gasoline is unleaded.

Let's Cool the Global-Warming Hype

p. 14

LET'S try an exercise in global environmental hype. Breathe in. Now breathe out. You have just added a breath of "dangerous, heat-trapping greenhouse" gas to Earth's atmosphere.

So what? You're not going to stop breathing just because the distinguished World Resources Institute in Washington hangs the epithet "dangerous" on carbon dioxide (CO₂) as it adds one more press release to the paper mountain of global-warming alarms.

Now before those environmentalists jump all over me, please note that I'm not out to bash the World Resources Institute or to trivialize the grave environmental challenge our late 20th century world faces. That challenge is well-documented in the "World Resources 1990-91 Guide to the Global Environment," just issued by the institute in collaboration with the United Nations Environment and Development Programs. It's published through Oxford University Press. With environmental and economic data on 146 countries plus focus essays on such major challenges as climate change or population and health, the report is a highly valuable resource for anyone concerned about our planet.

Yet scholarly as the report is, the press re-

leases that accompany it are not immune to the rhetoric of environmental hype. And, especially as regards possible dangers from pollution-driven global warming, such hype is counterproductive. We've had too much of it. It's become a turnoff for many policy-makers, who have to make tough economic decisions in dealing with environmental problems.

It's difficult for such hardened officials to consider CO₂ "dangerous" when animals exhale it and plants use it as an essential nutrient. Use of such an epithet makes environmentalists seem prone to exaggeration and devalues the very serious environmental problems they are trying to publicize.

In fact, the methane gas emitted by the digestive processes of humans and other mammals is a more efficient heat-trapper than CO₂. And the increasing release of methane from cattle, sheep, and goats and from bacteria in rice paddies is as important a contributor to possible global warming as is the increasing release of CO₂ from the use of fossil fuels.

Curbing the emissions of just these two greenhouse gases alone will involve major

economic restructuring all around the world. It will involve a new approach to agriculture to feed burgeoning population. And it will involve new approaches to industrialization. This can only be done through a truly global cooperative effort in which rich nations help poorer countries find practical alternatives to traditional

means of economic growth. It can only be done when industrialized nations themselves act to implement the costly waste management, energy saving, and other conservation measures needed to preserve the environment.

The scope of the problem is immense, as the new World Resources report shows. While population grows, useful water

resources shrink, forests disappear at a rate of 40 to 50 million acres a year (faster than previously estimated), and hundreds of other local and regional environmental assaults add up to an impending global tragedy. The cold hard facts of a reference like this can persuade decisionmakers to begin to act.

But environmentalists should tone down the alarmist rhetoric.

ROBERT C.
COWEN

The Advantages of Nuclear Energy p. 20

Regarding the opinion-page column "Efficiency Trumps Nuclear Power," May 23: We Americans have been prodigal in our use of energy - especially electricity. Per-household use of electricity has declined slightly in the wake of the Arab oil embargoes. But in recent times the trend has gone the other way. The most powerful influence toward conservation will be economic.

The author observes that provision of more nuclear power would increase the dangers of nuclear accidents. True, but no deaths have occurred in US electricity-generating power plants. Three Mile Island proved only that the safety systems work.

And people lose their lives in mines, manufacturing, and transportation accidents.

A typical coal-fired generating plant emits about 2,800,000 pounds - 35,000,000 cubic feet - of carbon-dioxide every hour. A nuclear plant emits none.

The author asserts that nuclear energy "cannot substantially alleviate global warming." But the French generate over 70 percent of their electricity by nuclear power, and their air-quality improvements have been spectacular.

We must increase our electricity-generating capacity, and given economic and environmental considerations, the only viable source is nuclear.

Much has been said and written about solar. Luz International, the predominant firm in this field, plans to have some 680 megawatts in operation in southern California by 1994. This is about one-half of the capacity of *one* large nuclear plant.

We need improvements in transportation, and again, nuclear generation well may be an answer. The big car manufacturers are developing electric vehicles. These cars will call for vast megawatts of electricity to charge their batteries. This power can only come from nuclear generation.

Earl E. Eigabroadt **Port Orchard, Wash.**
(Ret.) Capt., Army of the United States

This column states that "the practice of giving our public trust and dollars . . . to the technology with the best lobbyists must stop . . ."

There are dozens of anti-nuclear lobbyists for every pro-nuclear lobbyist. Democrats and Republicans support the Nuclear Regulatory Commission (NRC) in order to please coal miners, auto workers, and petroleum refiners. Many of

these people fear the economic "fall-out" of nuclear power plants producing cheap electricity.

Who will pay for increasing foreign auto and oil imports? Coal exports? The American public generally votes 3 to 2 in favor of nuclear power. The safety record of over 100 US nuclear power plants in operation supplying 20 percent of our electricity speaks louder than the NRC's regulation predicting nuclear doom.

Walston Chubb

Murrysville, Pa.

A Sizzling Scientific Debate

Skeptics claim that the evidence for global warming is not so hot

By CHARLES P. ALEXANDER



Environmentalists staged Earth Day to dramatize a simple message: The planet is threatened by a host of man-made ills, from toxic landfills to ozone depletion. But at least one part of the message—the theory that

the buildup of carbon dioxide and other greenhouse gases in the atmosphere will cause global warming—has come under considerable attack. A small but vocal group of scientists contends that the case for warming is sketchy and based on inadequate computer models.

Forces within the White House, led by chief of staff John Sununu, have seized upon the debate and persuaded President Bush to take a cautious approach to the problem. While not dismissing the greenhouse threat, the President has emphasized the need for more scientific research to help determine the proper policy response. This go-slow approach has irritated government officials in several other countries, especially in Western Europe. As the Europeans point out, many scientists still fear that global warming could take place unless strong action is taken to prevent it.

Last week representatives from 18 nations gathered in Washington for a global-warming conference set up by the White House. The Administration had hoped to get a debate going on the uncertainties of the greenhouse effect. Instead, most of the delegates appeared to agree that the global-warming threat is real and potentially serious. In the face of this strong sentiment, President Bush denied that he was taking global warming too lightly. The President reconfirmed a U.S. pledge to cooperate in a United Nations effort to forge an international agreement on dealing with climate change.

The greenhouse dilemma illustrates the difficulty of setting policy based on uncertain projections of the

future. Scientists generally agree that an unchecked accumulation of greenhouse gases will eventually lead to warming, but no one knows when it will start, how much will take place or how rapidly it will occur. The most widely accepted estimate is a rise in the earth's average temperature of 1.5° C to 4.5° C (3° F to 8° F) as early as 2050. An increase in the upper part of that range could produce disastrous climatic effects, including rising sea levels and severe droughts in some areas.

But the computer models that make the projections may not accurately reflect such factors as the role of clouds and the heat-absorbing capacity of the oceans. As these phenomena are better understood, warming projections will undoubtedly be revised in one direction or another.

Evidence that greenhouse warming has already started is at best tenuous. Even though some scientists believe the concentration of CO₂ in the air has shot up 25% since the early 1800s, the average global temperature has risen by no more than

0.5° C (1.1° F), and even that measurement is suspect. Moreover, the rise has been uneven. From about 1940 to 1970, a cooling period inspired some forecasters to predict a return of the ice ages.

Despite the uncertainties, there is a broad consensus that nations should slow down the rate at which they are changing the atmosphere. Said West German Environment Minister Klaus Töpfer at the Washington conference: "Worldwide action against the climatic threat is urgently required, even if the complicated scientific interrelationships of climatic change have not been fully understood."

To his credit, Bush has already taken several steps that will help combat global warming. Among other things, the White House has 1) earmarked \$1 billion for global climate research next year; 2) committed the U.S. to phasing out production of chlorofluorocarbons, potent greenhouse gases, by the year 2000; and 3) vowed to plant a billion trees, which would absorb CO₂ from the air. But Administration officials admit that Bush advanced most of the measures for reasons other than reducing global warming. And environmentalists argue that the Government should do much more to discourage the burning of fossil fuels. Among the

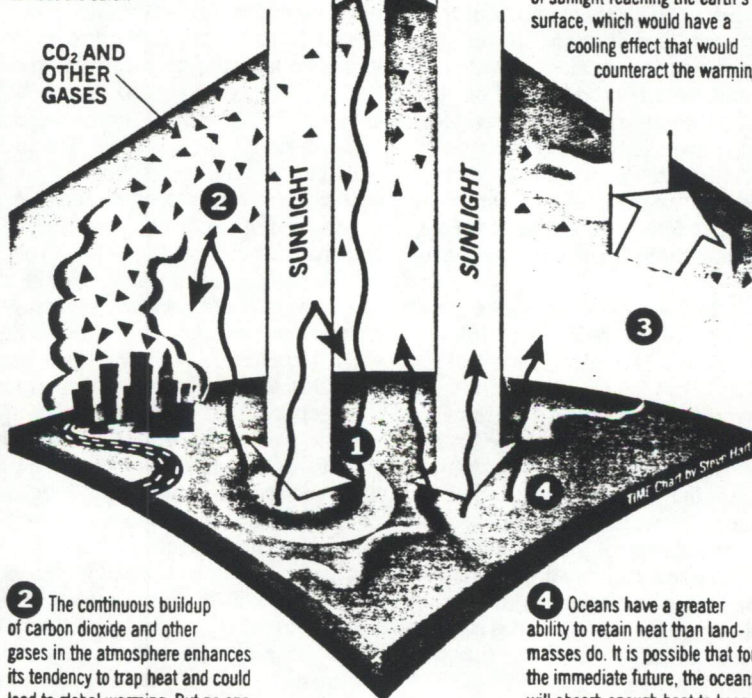
possibilities: raise the gasoline tax or use financial incentives to encourage people to buy smaller, more efficient cars.

The White House, however, worries about the economic consequences of forcing sudden, drastic curbs in fossil-fuel use. From the Administration's point of view, draconian action seems highly debatable so long as the scientific evidence for the greenhouse effect is sketchy. "We are not at the point where we can bet the economy," says a Sununu aide.

That may be so. The Administration is wise to consider the possible economic damage before committing itself to a major reduction in carbon dioxide emissions. But surely the Government can safely do much more than it has already done to spur energy conservation. It is possible to buy a great deal of insurance against global warming without sabotaging the economy. —Reported by Michael Duffy and Glenn Garelik/Washington

THE THEORY . . .

1 Energy from sunlight heats the earth's surface. At the same time, the earth cools itself by giving off infrared radiation. Some of this radiation escapes into space, but some is trapped by the atmosphere and continues to heat the earth.



2 The continuous buildup of carbon dioxide and other gases in the atmosphere enhances its tendency to trap heat and could lead to global warming. But no one knows how rapidly the warming will occur, and other factors may offset it.

. . . SOME UNCERTAINTIES

3 One uncertainty involves the role of clouds. A warming trend could cause more water to evaporate and increase the earth's cloud cover. That, in turn, could reduce the amount of sunlight reaching the earth's surface, which would have a cooling effect that would counteract the warming.

4 Oceans have a greater ability to retain heat than landmasses do. It is possible that for the immediate future, the oceans will absorb enough heat to keep the atmosphere from warming substantially.

L.A.'s High-Watt Highway

Electric cars get a boost in the capital of smog

P. 96

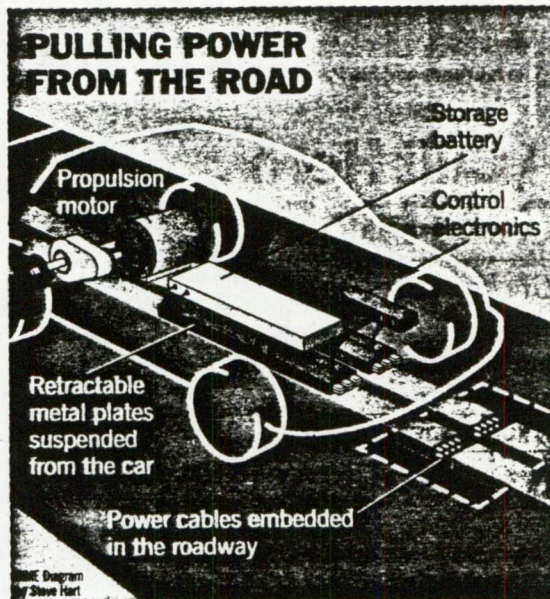
Battery-powered autos are clean, quiet and remarkably energy efficient—but they have a huge problem. Once they get on the road, even the most advanced models can travel only 190 km (120 miles) or so before they run out of wattage, and then they need to be plugged into an outlet for about six hours to get fully recharged. Now the city of Los Angeles and a California power company have proposed a radical solution to the problem of powering electric cars: electrify the roads. Last week they announced a \$2 million demonstration project in which electric cables will be run under 300 meters (1,000 ft.) of roadway in a west Los Angeles development called Playa Vista. Electricity from the cables would be used both to power electric cars and to recharge their batteries for travel on conventional roads.

"It's really very simple," says John Reeves, research manager at Southern California Edison, which is putting up half of the money (the rest is coming from the Los Angeles department of water and power). When electrical power passes through a wire, it creates a magnetic field. A metal plate moving through that field can, by a process known as induction, convert the magnetic force back into electricity. When such a metal plate is suspended from the bottom of a battery-run car, the vehicle can pick up power simply by moving down an electrified road. For maximum performance the plate needs to glide within 5 cm to 8 cm (2 in. to 3 in.) of the road's surface, which must therefore be unusually smooth.

Even if Los Angeles' limited experiment is successful, the technology will not necessarily be widely used. "This is real futuristic stuff," says Sean McAlinden, a researcher with the University of Michigan's Office for the Study of Automotive Transportation. "It's sort of a Star Wars fantasy." Even Southern California Edison officials concede it would take billions of dollars and decades of public works to electrify the streets of Los Angeles. There may never be electric roads in the snow-bound Midwest or in Eastern cities subject to the freeze-and-thaw cycles that turn the best-made highways into roller coasters of bumps and potholes.

Still, the electric-roadway project is

generating a lot of excitement in pollution-plagued Los Angeles. "I'm thrilled," says Jim Lents, executive officer of the South Coast Air Quality Management District, which voted last spring to require that all cars in Southern California operate on electricity or other clean fuel by the year 2007. "This is what we were hoping to stim-



ulate." Automakers have also been tinkering along these lines. Peugeot and Fiat have announced plans to sell electric vehicles in Europe within the next few years, and Ford is testing an electrified model of the Aerostar van. Not to be left behind, GM Chairman Roger Smith announced last week that his company will proceed with commercial production of its sleek battery-powered Impact, although experts say the sedan is not likely to reach dealer showrooms before 1995.

Electrifying even a few short stretches of roadway could increase the range and effectiveness of such voltswagens dramatically. Developers in Playa Vista hope to wire the subdivision's two-mile main artery and service the neighborhood with all-electric trucks and vans. Edison's Reeves dreams of extending the network until it crisscrosses the state. Electrifying one or two lanes of a freeway, he says, might be enough to keep fleets of buses and cars charged up. People wedded to gas-gulping cars could still drive on electrified highways, but they might get dirty looks from the new breed of battery-powered motorists.

—By Philip Elmer-DeWitt.

Reported by Sylvester Monroe/Los Angeles and Joe Szczesny/Detroit

THE WHITE HOUSE

WASHINGTON

June 22, 1990

MEMORANDUM FOR ROGER B. PORTER

FROM: EDWARD GOLDSTEIN
ADAM ISLES

This is.

SUBJECT: National Governors' Association Task
Force on Global Climate Change

Governors James Thompson (R-Illinois), Madeleine Kunin (D-Vermont), Buddy Roemer (D-Louisiana) and Terry Branstad (R-Iowa) will meet with the President Monday morning to present the final report of the National Governors' Association Task Force on Global Climate Change. This memorandum summarizes the recommendations of the report.

The report presents a balanced view of the global climate change issue.

The Governors' report calls for a serious response to potential global climate change while acknowledging "considerable uncertainty about the rate, magnitude, and effects of global climate change" and possible "substantial" costs of prevention which could have "serious effects on the economic well-being of the nation." The report states, "scientific uncertainty and the difficulty in accurately predicting climate change are compounded by the existing natural variability of meteorological and biological systems." Furthermore, it adds, "the social and economic costs of the measures that might reduce the threat are not yet well understood, and a comprehensive assessment of the available options has only recently begun. Mitigation and adaptation to climate change is an issue that can be effectively addressed only with the cooperation of all nations."

Some report recommendations reflect Administration policy.

The report calls for action on a number of fronts. Some of the reports' recommendations reflect Administration policy. They include: Promotion of cost-effective energy conservation and efficiency measures; support for the phase-out of chlorofluorocarbons; support for the development of alternative energy sources, including safe nuclear power; encouragement of tree planting through the President's tree planting initiative; and the funding of a comprehensive research program about the scientific and economic implications of potential global climate change.

Conversely, the report differs with current Administration policy in asserting that the U.S. should lead negotiations on an international framework convention that would result in specific commitments from all nations on greenhouse gas reductions, energy efficiency and population growth. The report also claims that the federal government bears a special responsibility to assist states or industries that may be adversely affected by economic transition in response to global climate change.

Report Findings.

1. Atmospheric concentrations of greenhouse gases are increasing due to human activities.
2. Broad scientific consensus has developed that increasing the concentration of carbon dioxide and other greenhouse gases will increase the atmosphere's heat-trapping ability and warm the climate to some degree.
3. Controlling emissions is central to reducing potential climate change. This should be done through energy policy, and measures to slow deforestation.
4. States have a key role to play because of authority over utilities, land-use, transportation, taxation etc.
5. An effective solution to global climate change must involve sustained action by the federal government and the international community, including developing nations.

Policy Recommendations.

1. **Develop an international agreement to protect the atmosphere.** The report calls for specific commitments from all nations on greenhouse gas emissions, energy efficiency and population growth.
2. **Utilize Cost-Effective Energy Conservation and Efficiency Measures to Stabilize U.S. Emissions of Carbon Dioxide.** The report proposes the local reform of electric utility regulation through the application of least cost planning and rate design reforms. The report also calls for improved energy efficiency standards for buildings, appliances, transportation (including an increase in the corporate average fuel economy standard) and state programs. Additionally, the governors endorse increased emphasis on telecommuting and ride sharing initiatives.

3. **Stop production of and recycle chlorofluorocarbons, and cost-effective strategies to stabilize or reduce other greenhouse gases.** The report calls for stabilization of U.S. emissions of methane, nitrous oxide, ozone, and other greenhouse gases and encourages methane recovery from waste and the production of more efficient and environmentally sensitive fertilizers.
4. **Develop and commercialize alternative energy systems, including clean fossil, renewable energy sources, and safe nuclear power.** Among the energy sources favored in the report were hydropower, clean coal, solar, wind and geothermal.
5. **Implement forestry programs to reduce the effects of global climate change.**
6. **Plan and act now to adapt to climate change.** The report calls for increased attention to water resource planning, the strengthening of coastal zone management programs, additional funding for climate research related to agriculture and forestry.
7. **Pursue an aggressive research program to reduce key uncertainties about global climate change.**

Finally, the report calls on the federal government to assist states or industries that may be adversely affected by a move to a less energy-and carbon-intensive economy: "The federal government must plan for and provide a transition so that our national goals do not become unreasonable limitations on the growth and development of particular states or industries."

TALKING POINTS FOR NGA TASK FORCE ON GLOBAL CLIMATE CHANGE

- * THANK YOU FOR COMING HERE TODAY TO PRESENT THIS REPORT AND THANK YOU FOR ALL YOUR HARD WORK.
- * I HAVEN'T READ THE REPORT YET SO I AM NOT IN A POSITION TO ENDORSE ITS FINDINGS.
- * HOWEVER, FROM WHAT YOU TELL ME YOUR REPORT IS A WELL-BALANCED AND CLEAR DISCUSSION OF THESE VERY COMPLEX ISSUES.
- * MADELEINE (KUNIN), I REMEMBER THAT YOU WERE HERE WITH US A YEAR AGO THIS MONTH WHEN WE ANNOUNCED THE COMPONENTS OF OUR CLEAN AIR BILL.
- * A LOT HAS HAPPENED IN CONGRESS OVER THE PAST YEAR AND I BELIEVE WE ARE CLOSE TO GETTING A BILL WHICH BREAKS A DEADLOCK ON CLEAN AIR WHICH HAS EXISTED FOR FAR TOO MANY YEARS.
- * I TAKE VERY SERIOUSLY THE OBLIGATIONS OF ENVIRONMENTAL STEWARDSHIP. I BELIEVE WE CAN PROTECT THE ENVIRONMENT WITHOUT DESTROYING OUR COMPETITIVE ECONOMY.
- * AS GOVERNORS, YOU ARE TO BE COMMENDED FOR YOUR WORK IN RECOGNIZING THAT WE ALL HAVE A ROLE IN THIS WORK AND THAT INCLUDES STATE AND LOCAL GOVERNMENT.
- * THANK YOU FOR YOUR HARD WORK AND THANK YOU FOR YOUR LEADERSHIP.

TALKING POINTS FOR NGA TASK FORCE ON GLOBAL CLIMATE CHANGE

- * I understand that some of the report recommendations reflect the ongoing environmental policies of this administration. I am pleased that your report calls for energy conservation and efficiency measures, efforts to plant trees throughout our cities and countryside, the development of alternative energy sources including safe nuclear power and an aggressive research program on the science and economic aspects of climate change.

- * I understand that your report states that an overreaction to potential global climate change, could have "serious effects on the economic well-being of the nation." Given that there are real uncertainties about global climate change, we are reluctant at this time to agree to international resolutions which call for severe reductions in emissions.

Farmers, Environmentalists in Conservation Accord

House Agriculture Committee Drafts Package

to Save Wetlands, Improve Water Quality

By Guy Gugliotta
Washington Post Staff Writer

The House Agriculture Committee, buoyed by an unprecedented compromise between farm groups and environmentalists, yesterday approved an ambitious package of conservation measures designed to improve water quality and protect wetlands on the nation's farms.

The committee reached a compromise after several weeks of wrangling with environmental groups. Committee members and commodity groups, reflecting the interests of farmers worried about

draconian restrictions on land use, drafted an early version of the conservation provision that environmentalists found unacceptable.

But in a protracted series of working sessions, a compromise was worked out on key provisions that lobbyists on both sides agreed they would not challenge later.

Committee Chairman E "Kika" de la Garza (D-Tex.) called the final product "probably the most ambitious effort we have ever had in the history of farm legislation. It's a good package for farmers and for the environment."

The session also completed com-

mittee debate on the entire farm bill, expected to move to the House floor for consideration after the July 4th recess. The Senate committee still has not completed work on its version of the bill.

The package includes the first provision in a farm bill for a water quality program aimed at controlling the quantity and types of chemicals leaching into local water supplies as a result of pesticide and fertilizer runoff.

Environmentalists had wanted a mandatory program, but settled for a voluntary plan monitored and implemented by the Department of

Agriculture. Congressmen had made it clear they would not vote for a mandatory program.

"We wanted a beginning," said Maureen Hinkle of the National Audubon Society. "We think farmers need to become part of the solution; with this legislation they have the opportunity to step forward and put their land into the program."

Another first for environmentalists was a program allowing farmers to receive a payment to stop growing crops on wetlands. The government will fund the restoration of the land to its natural state and pay farmers up to \$250,000 to

keep it permanently out of production.

The most bitter and long-running controversy, however, involved existing "swampbuster" legislation that takes subsidies away from farmers who drain and plant crops on wetlands.

The committee spent hours in closed and open session redefining "wetland" and modifying its application. "Providing this guidance," said Rep. E. Thomas Coleman (R-Mo.), "was the most important thing we did."

Under the legislation approved yesterday, farmers violating swampbuster will not have their program benefits terminated immediately, but instead will be required to pay a \$750 fine and restore the land.

Environmentalists also succeeded in changing the language of the measure so that farmers will be li-

able for fines not just for planting crops on wetlands but simply if they "alter the land."

Hinkle commended the committee for "deciding their own environmental future instead of having it happen to them," but noted that environmental groups had additional concerns that had not been addressed in committee. These, she said, would be raised on the floor of Congress if arrangements could not be worked out beforehand.

Committee members nonetheless remained optimistic: "These negotiations were as good as negotiations of this type can be," said Illinois Rep. Edward R. Madigan, the committee's ranking Republican. "I think we're moving in the right direction and I hope environmentalists will look at this as an opportunity for cooperation rather than to take advantage."

CLIPS LIST - Friday, June 15, 1990 B115

"Bush Says He'd Veto Owl-Job Legislation"
(Oregonian/Wire Stories - 6-14-90)

"House Committee Completes Farm Bill"
(Wall Street Journal - 6-15-90) (Wetlands)

"Astronomers Defend Their Own Rare Species"
(Albuquerque Tribune - 6-13-90)

Additional Stories: OCS/MMS Issues (Oil & Gas Journal 6-4-90) - Marine Sanctuary Program/MMS (Coastal Zone Management) - 6-10-90 - Huntington Beach Oil Spill - Subsistence - Mobil Oil/N.C. - Arco Awaiting Well Decision
Misc. stories on American Indians, Parks & other clips on DOI issues.

Greenhouse redesign

ENVIRONMENT ■ Shifting some blame to the Third World

A. 47

Next fall, when U.S. negotiators travel to Geneva to discuss prospects for an international climate-change treaty, they will be armed with many more bargaining chips than they brought to the first such conference. A new study conducted by the Washington-based World Resources Institute (WRI) upsets the longstanding assumption that rich, industrialized countries are the primary greenhouse culprits. In fact, the startling conclusion is that developing countries spew out almost as much in the way of heat-trapping gases as do wealthy nations.

Traditionally, when scientists have apportioned blame for what is an undisputed increase in greenhouse gases, they have relied on estimates of the carbon-dioxide gas generated by fossil-fuel combustion and cement manufacture. Reasoning that calculations based on just one of the three major greenhouse gases (the others being methane and chlorofluorocarbons, or CFC's) approximated the true picture fairly enough, they identified four out of the five top villains as First World nations. But WRI researchers finally did the calculations taking into consideration all three gases, all the major sources of those gases and each gas's potency as a heat trapper. The new index of the top five greenhouse villains includes three impoverished countries—Brazil, China and India.

Even with WRI's new and more equitable accounting system, the U.S. still tops the list of offenders, gushing out the equivalent of 1 billion metric tons of carbon into the atmosphere each year, almost one fifth of the world's total. The Soviet Union also remains a major offender, releasing the equivalent of almost three quarters of a billion metric tons of carbon. Fossil-fuel combustion is responsible for the bulk of both countries' emissions.

But under WRI's accounting scheme,

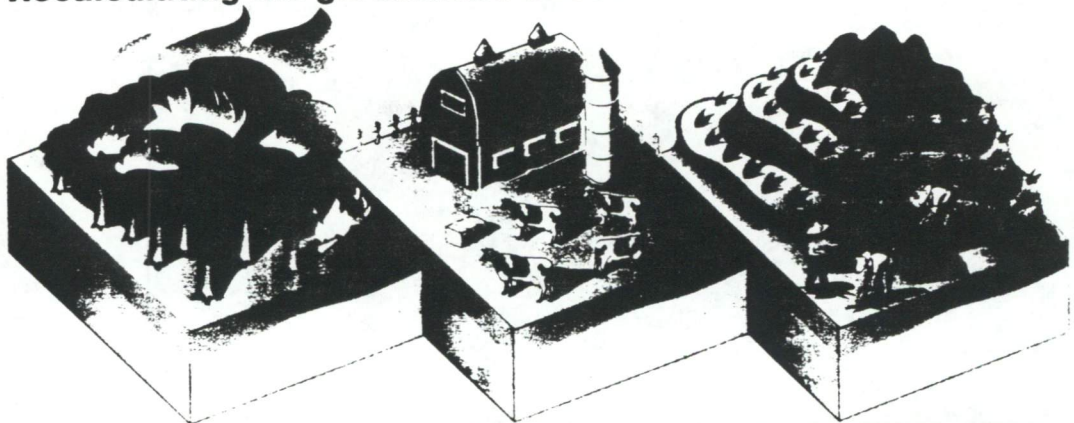
countries with far less industry must answer for their contributions to the accumulation of greenhouse gases. Brazil, for instance, is transformed from a petty criminal to a big-time felon, overwhelmingly because of the torching of its forests, which releases 24 times more greenhouse gases there than does fuel combustion.

a host of human activities. In particular, raising cattle and cultivating rice are the subcontinent's equivalent of heavy industry: Methane is formed by the decomposition of plant matter in the stomachs of cattle and released as flatulence, and by decaying vegetation in wet rice paddies.

But the quantity of gases released is

Recalculating the greenhouse effect

GARY VISGATIS—US&WR



DEFORESTATION

Every acre of forest burned spews about 50 tons of carbon into the atmosphere. In 1988, Brazil released the equivalent of 350 million tons of carbon.

BOVINE DIGESTION

Each year Bessie releases 77 pounds of methane into the atmosphere. Cow flatulence makes up more than 2 percent of worldwide additions to greenhouse gases.

RICE GROWING

Each acre of rice paddy releases 480 pounds of methane yearly, contributing 3.5 percent of the warming potential of greenhouse gases emitted.

Biggest greenhouse contributors

According to revised calculations, three of the five largest contributors of greenhouse gases are nonindustrialized countries

OLD INDEX	Percent of total	REVISED INDEX	Percent of total
U.S.	22%	U.S.	18%
U.S.S.R.	18%	U.S.S.R.	12%
China	11%	Brazil	11%
Japan	4%	China	7%
West Germany	3%	India	4%

US&WR—Basic data World Resources Institute Carbon Dioxide Information Analysis Center Oak Ridge National Laboratory

Taking into account other activities that give rise to greenhouse gases, such as rice farming and animal husbandry, also affects the lineup. India, for example, now ranks among the top five contributors of greenhouse gases, primarily because of its emissions of methane, a flammable, odorless gas associated with

only part of the reason for the reshuffling of greenhouse culprits. The gases themselves have different biological and chemical properties that make them more or less effective as heat trappers. Carbon dioxide, for instance, is absorbed constantly—by plants during photosynthesis and by organisms in oceans and soils. In fact, less than half of the carbon dioxide that is pumped into the air by factories and other man-made sources actually remains in the atmosphere to trap heat. Methane, on the other hand, traps heat 20 to 30 times more efficiently than carbon dioxide, although it decays more rapidly in the atmosphere.

The third major type of greenhouse gas, the CFC's, which are used as refrigerants and solvents, are the most potent heat grabbers of all. A CFC molecule holds 20,000 times more heat than does a carbon-dioxide molecule, meaning that even the relatively small emissions of

Keeping a Deadly Secret

The Feds knew the mines were radioactive

In the '50s and '60s, at the height of the cold war, Raymond Joe mined uranium to help meet the demands of the booming nuclear-weapons industry. For a total of 15 years the Navajo worked in the mines throughout the Southwest, at the outset earning as little as 90 cents an hour. Two years ago Joe was diagnosed with lung cancer, a victim, he believes, of the radiation in unventilated mine shafts. Doctors removed part of his right lung, but the cancer has recurred. At least 450 former uranium miners have already died of lung cancer, five times the expected average. And, as the miners and their families allege, for nearly 20 years the U.S. government knew the danger—and suppressed it. Says Joe, 57, who now lives in Shiprock, N.M., "We were never told that the work we did could affect our health."

About a quarter of a century—and a battery of lawsuits—later, Congress seems ready to make amends. After having reviewed documented testimony that the Atomic Energy Commission and the Public Health Service failed to reveal the hazards in uranium mines in New Mexico, Arizona, Utah and Colorado, the House passed the Radiation Exposure Compensation Act last week. The bill would establish a trust fund of \$100 million. Families of miners with radiation-induced illness would be eligible for a lump-sum payment of \$100,000, and "downwinders," certain cancer victims in Utah, Nevada and Arizona who

were exposed to fallout from nuclear testing, could receive \$50,000. Though the legislation's chances look good in the Senate, the White House's position is unclear.

The case against the federal government is damning. European studies in the '20s and '30s linked radioactivity in uranium mines to lung cancer, and found that mine-shaft ventilation could reduce the threat. In 1949 U.S. scientists discovered that cancer could be caused by inhaling particles produced by radon gas, a byproduct of uranium. But even after the Public Health Service privately recommended ventilation in 1952, the Atomic Energy Commission failed to pressure mine owners. "[The AEC's] position was that they had no legal responsibility for the mines," says Dr. Victor Archer, a former PHS official. "The safety of the miners sort of fell between the cracks." The evidence shows the AEC believed ventilators were too costly, despite the fact that processed uranium sold at an average rate of \$12 a pound. In 1954 alone the AEC bought more than 3 million pounds. The pressure to produce was so intense, says retired miner Harry Tsosie, 60, that the three shifts on which he worked were each expected to mine 80 tons of rock a day. (So far, Tsosie has escaped cancer.)

Why did the PHS fail to speak out? It was then a small agency with very little power. Also it was the McCarthy era, and anyone who criticized the nuclear-war effort risked being branded a communist. But the PHS may have committed a graver sin than keeping silent. From 1954 to 1960 the agency monitored the health of a test group of 4,138 uranium miners without telling the men why. Archer, who directed the study, says that by 1960 the miners already suffered high rates of lung cancer. "The PHS used the miners as guinea pigs to study the effects of radiation," says former secretary of the Interior Stewart Udall, 70, a lawyer who has filed five suits on behalf of the miners. "Some of us have difficulty morally distinguishing between this study and some of the stuff the Nazi doctors did."

Too late: Since 1979 Udall has crusaded to win compensation for the families of stricken miners. Union Carbide began ventilating some mines in the late '50s, but the federal government did not impose safety regulations on mining companies until 1967. By then it was too late for many of the 15,000 men—20 percent of them Navajos—who had mined uranium. Udall pursued four separate suits against mining companies, winning only a small settlement in Utah. He also tackled the U.S. government, but his suit was quashed

in 1985 when an appellate court ruled that the federal government was protected by sovereign immunity, which allows Washington to decide when it can be sued. But a judge recommended that the miners turn to Congress. With reparations now a possibility, Udall thinks the money is small consolation. "It may be that [a government] apology is worth more," he says.

What haunts the survivors most is the image of husbands and fathers working long hours, eating lunch and even drinking water from springs in the mines—totally unaware of the danger. Many Navajos were even more out of touch; they spoke no English and their language had no word for "radioactive." "It's an unfortunate instance of national-security interests being placed above the health of innocent people," says Elizabeth Arky, an attorney for the Navajo Nation in Washington. Medical experts believe that the number of lung-cancer deaths among former uranium miners will double soon. For most of the world, the cold war is over, but in some Navajo communities and small mining towns in the West, the body count is still climbing.

JAMES N. BAKER with PETER ANNIN in Shiprock, N.M., and MARY HAGER in Washington

ENVIRONMENT

Fighting the Greenhouse

And you don't have to freeze in the dark to do it

Of course you know what it will take to save the world from the greenhouse effect. To cut emissions of carbon dioxide—the gas released when coal, gas or oil burn and the one responsible for more than half of the impending global warming—you'll have to turn down the heater in winter and break out the long johns. In summer, don't even *think* of air conditioning. Chuck your 100-watt bulbs, screw in 40s. Trade in the dishwasher and clothes dryer for a dish drainer and laundry line.

But wait. Human nature being what it is, scientists realize that if we depend on a penchant for sacrifice to forestall the greenhouse effect, we might as well start building sea walls to hold back the waters that will rise along with the thermostat. Surveys show that only about one fifth of those questioned would keep their homes warmer in summer or chillier in winter to help the environment. Luckily, though, conservation 1990s style doesn't mean freezing in the dark. From superwindows that leak no heat to fridges that work like giant Thermos bottles, "there is a host of technological changes we can make that will let us keep the amenities we're used to," says Eric Hirst of Oak Ridge National Laboratory.

Last week the World Resources Institute announced new data that suggest the greenhouse threat is more serious than had been realized. Forty million to fifty million acres of tropical forests are disappearing each year, said WRI—50 percent faster than earlier satellite photos showed. Defor-

estation is second only to the burning of fossil fuels as a source of carbon dioxide (CO₂). Even without the new data, an international panel convened at the urging of the Bush administration, and 38 other countries concluded last month that global warming will raise sea levels enough to inundate the plains of Holland and Bangladesh and obliterate the Maldives, among other disasters. It called for a 60 percent cut in CO₂ emissions. Conservation is the cheapest and fastest way to do that, at least until solar and wind power, which emit no CO₂, are widely available. Efficiency alone, calculates Christopher Flavin of Worldwatch Institute, could cut global CO₂ emissions 3 billion tons a year by 2010, from today's 5.6 billion.

Nations might start with that symbol of energy profligacy, air conditioners. They use hydrochlorofluorocarbons (HCFCs) as the cooling fluid, and indirectly release CO₂ when electricity to run them is generated. HCFCs and CO₂ are greenhouse gases. But plug-in cooling needn't turn up the global thermostat. A model patented last year by Albers Technologies Corp. of Arizona cools air to 54 degrees Fahrenheit, dehumidifies it and removes contaminants. It uses water, not HCFCs, and draws half the electricity of conventional units. At \$2,000 for a unit big enough to cool a 1,500-square-foot house, it costs about the same as current models. No American makers have expressed an interest—they don't want to fiddle with their product unless the government bans

HCFCs. But last month a Saudi Arabian firm, Alessa Industries, agreed to turn out 25,000 every year beginning in 1992—and export 20,000 back to the United States.

Other breakthroughs are as close as the nearest window. During the winter, windows in the United States leak about as much heat as is provided by the oil flowing through the Alaskan pipeline every year. Researchers led by Stephen Selkowitz at the Lawrence Berkeley Laboratory in California can fix that with a "superwindow." It has three layers of glazing and two coatings of metal oxides that cut heat loss; the space between the panes is filled with krypton and argon gases. Result: the window collects more heat on a winter's day than it leaks at night. Superwindows today cost about 30 percent more than moderately efficient ones; even better versions are about to leave the lab. This week Libbey Owens Ford will introduce special glass coatings that allow sunlight to penetrate better than it can through plain glass, providing low-tech solar heating to a room. And LBL is working on a "smart window" that changes electronically from clear, which allows sunshine in on cold days, to reflective, which diverts rays on scorchers. Similar chameleonlike glass for car sun roofs can keep out enough sunshine to drastically cut the need for air conditioning, and should be in models next year.

Best bulbs: Researchers also have bright ideas for lighting, which accounts for almost 25 percent of U.S. electricity use. Replacing standard incandescents with the best bulbs, compact fluorescents, can cut electricity use by as much as two thirds. Last year Reno's Peppermill Hotel Casino installed about 1,000 fluorescents, and halved its lighting bill. Although fluorescents can cost 20 times as much as incandescents, they last 10 times longer, saving the consumer money, and emit light indistinguishable from incandescents. Since fluorescent bulbs draw less electricity, substituting one for an incandescent prevents the emission of up to 382 pounds of CO₂ that would otherwise be emitted from power plants (table). Other gizmos helped the

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two treaties, signed in the mid-1970s but not yet ratified, that would ban tests with an explosive power greater than 150 thousand tons of TNT (150 kilotons). President Bush and Soviet President Mikhail S. Gorbachev were due to clear the way for Senate action on the two treaties during their meetings May 31-June 3 by signing an addendum to the two treaties that tightens up the original verification provisions.

- Critics will try to prevent a rapid resumption of nuclear component production at Rocky Flats. For the longer run, they will try to pare the size of a proposed new production facility there.

First Signs of Danger

The first hint of a safety problem came in 1988, when mathematical analyses revealed an unforeseen problem with the W-79 warhead used in the Army's 8-inch nuclear artillery shells. The warhead's high explosives could be detonated if a shell was dropped by its handlers or struck by a stray bullet. If such an accident occurred while the shell was loaded in a gun, some analysts warned, it might conceivably result in a nuclear blast.

The hundreds of shells deployed in Europe and stored in U.S. depots were quickly modified to remove that risk. But the episode drew high-level attention within the Reagan and Bush administrations to two other previously recognized safety problems:

- Because the SRAM-A has very powerful fuel and a warhead with sensitive high explosive components, some have worried for years that an aircraft fire on the ground might trigger an explosion that would scatter plutonium for miles. The possibility had been underscored in 1980, when a B-52 loaded with SRAM-As burned at Grand Forks Air Force Base in North Dakota.

- In the late 1980s, designers of the Trident II deliberately accepted two risks. They designed the missile's W-88 warheads with old-fashioned high explosive components rather than a newer explosive that is much less prone to accidental detonation. Since the new "insensitive" explosive is heavier, it would have reduced the range of the warheads.

Also, to squeeze as much fuel into the missile as possible and still fit it into the hull of a submarine, the designers located one fuel tank in the missile's nose, ringed by the eight warheads. Because the fuel is extremely powerful, some analysts said a tank explosion would scatter plutonium from the war-

heads even if their explosive components did not go off. Although the data is highly classified, some sources speculated that a nuclear blast might occur.

"We're not just talking about plutonium scatter," says Zamora of the Federation of American Scientists. "We're talking about [nuclear] yield."

Political Fallout

The SRAM-A safety review, conducted jointly by the Air Force and Energy Department, was kicked off last November — at the Energy Department's recommendation — after a meeting of the Energy secretary, retired Adm. James D. Watkins, Defense Secretary Dick Cheney and top military brass. Meanwhile, the Air Force has initiated stringent safety precautions to prevent fires on SRAM-laden bombers.

House Speaker Thomas S. Foley, D-Wash., represents the district where Fairchild Air Force Base is home to SRAM-equipped B-52s. Foley asked

"There's not much support for building a new warhead to attack the Soviet Union, right now. But there is support for building a safer warhead."

—Tom Zamora, Federation of American Scientists

Cheney May 24 to consider the recommendation by the three weapons lab directors to shelve the missile. Cheney's meeting with the directors May 26 produced no announced change of policy.

Earlier in May, Watkins acceded to a request by four members of the House Armed Services Committee, among them Chairman Les Aspin, D-Wis., and senior Republican Bill Dickinson, Ala., for an outside review of the risk of an accidental nuclear detonation involving Trident II warheads. The House members asked for a review by three scientists who have extensive nuclear weapons experience but are not currently employed by the government.

Aside from the safety issue, arms control advocates have long been uneasy about Trident II. Because of the missile's accuracy and the W-88 warhead's 450-kiloton punch, they argue, Soviet leaders might see it as a threat to their land-based nuclear missiles.

Zamora, Lewis and David Albright of the Federation of American Scientists have jointly called for a five-year moratorium on production at Rocky Flats. Among other interim steps, they call for equipping Trident IIs with much less powerful warheads from older sub-launched missiles.

In addition to relieving the pressure for resuming production of nuclear detonators at Rocky Flats, Lewis hopes that doubts about the safety of the W-88 will provoke a broader debate about whether such a lethal weapon is necessary. "People are being forced to examine whether it's worth risking the health and safety of the people who live near these facilities," he says.

Beyond the question of how soon Rocky Flats resumes production, arms control activists also hope to restrict the plant's future warhead production rate. A new processing plant, intended to replace buildings that are contaminated with plutonium, could produce 1,000 new warheads annually, according to Zamora. "That kind of capability is unreasonable," he says, particularly if the plant is less than 20 miles upwind from Denver.

Existing warheads could be modified in a much smaller facility, the critics insist. A smaller facility also might reassure members of the Colorado congressional delegation, who are eager to see the Energy Department stick to its long-range plan to shut down Rocky Flats in the next 20 years.

The prospect of new (or redesigned) warheads to replace the unsafe types renews the long battle over whether full-scale nuclear explosions are needed to test weapons designs. Insisting that a full-scale test is the only guarantee, the Energy and Defense departments adamantly resist a comprehensive test ban or a ban on nuclear blasts larger than from 5 kilotons to 10 kilotons.

But Lewis, Albright and other arms controllers insist that the physics of a new warhead design can be adequately tested without setting off a nuclear blast. "We don't crash test cars with real people in them," Lewis contends. "Warhead safety problems must not be used as an excuse for expanding the explosive testing program."

Albright is less sanguine, warning that the safety problem "sets back the effort to get a comprehensive test ban." However, he predicts that the episode may not harm the case for trying to ban tests above a very low threshold.

ENERGY OPTIONS

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Ways of generating energy without adding to the Earth's greenhouse burden include both renewable energy sources and nuclear power. U.S. companies are making pioneering advances in both. Of such essentially exhaustless sources as solar energy, wind power, energy from the sea, and geothermal power, solar and wind technologies appear to offer the best way to provide major, cost-competitive energy supplies for the near term.

In California, for example, Luz Engineering Corp. has built giant solar farms using the solar thermal method of turning sunlight into electricity. Mirrored panels concentrate sunshine onto a synthetic fluid that heats to 735 degrees F and is used to generate steam, which drives an electric turbogenerator. The system is backed by natural-gas heating. These farms provide 275 megawatts of electric power to Southern Cali-

fornia Edison. That may rise to 600 megawatts—half the output of a large nuclear plant—as more solar farms are built.

Photovoltaic systems convert sunlight to electricity directly, using solar cells made of silicon and other semiconductor materials. Because they eliminate the intermediate heating stage of solar thermal plants, they are more efficient. But the materials themselves and the overall cost are expensive.

One of the world's largest photovoltaic solar energy plants is Arco Solar's Carissa Plain facility near San Luis Obispo, Calif. It uses silicon cells to produce 6.5 megawatts, enough to power about 2,000 homes. Other companies, such as Chronar Corp. of Princeton, N.J., are exploring the energy potential of less expensive forms of silicon; sometime in 1990, it expects to complete a plant capable of manufacturing 10 megawatts

Of renewable energy sources, solar and wind technologies may offer the best way to provide major, cost-competitive energy supplies for the near term.

worth of solar cells each year.

The U.S. Department of Energy has proposed budget increases for solar thermal and photovoltaic research and development in 1991.

Farms of giant wind turbines, like those built by U.S. Windpower in California's Altamont Pass, could also play a substantial role in the future. U.S. Windpower supplies electricity to Pacific Gas & Electric. The output of California's wind turbines in 1989—2 billion kilowatt-hours—was enough to power a city the size of San Francisco. General Electric's Space Division figures that wind power could furnish about 40% of the total U.S. electricity demand.

Debates over nuclear power rage on. Meanwhile, nuclear engineers at several companies are pressing forward with designs for reactors that are simpler, safer, and more economical than those now in use.

One of these designs will actually be embodied in two Tokyo Electric Co. plants to be built and put in operation by 1998. The design is General Electric's "advanced boiling water reactor." The design being developed by GE and, separately, by Westinghouse Energy Systems is of a type called "passively safe." That means the reactor could cool itself in the event of an accident for up to 72 hours.

Still more radical designs are being investigated. The Argonne National Laboratory and GE are collaborating on a reactor cooled in a bath of molten sodium. General Atomics in San Diego and a utility consortium called Gas Cooled Reactor Associates, with support from the Electric Power Research Institute, Palo Alto, Calif., are working on a reactor powered by an ultrasafe type of fuel and cooled by helium gas.

Natural Resources Defense Council cut its office energy bill by more than half: occupancy sensors use infrared or ultrasonic signals to detect motion, turning lights off when no one is in the room. Because of such savings, Amory Lovins of the Rocky Mountain Institute says, "this is not a free lunch. This is a lunch you are *paid* to eat."

Even refrigerators can help stave off the greenhouse. In today's models, a single unit lowers temperatures in the freezer and moves chilled air to the fridge—which doesn't need to be as cold. At Oak Ridge, researchers think that using different mixes of coolants and separate cooling loops could offer energy savings of an additional 20 percent. And by replacing the CFC insulation with vacuum insulation as in a Thermos, refrigerators wouldn't need CFCs.

Electric utilities have led the charge toward energy efficiency partly from environmental concern, but largely because of the bottom line: it costs 30 to 50 percent less to cut demand for power than to build new generating capacity. Wisconsin Power Co. offers rebates for installing efficient refrigerators; Southern California Edison will pay customers to install more efficient windows. New England Electric offers rebates to lighting dealers so they will lower the price of fluorescents; it has also insulated more than 100,000 customers' hot-water tanks for free. CEO John Rowe says, "Conservation is the heart of our environmental strategy." But, only 10 states let utilities earn a return on investments in efficiency, hampering widespread adoption.

In the cold: For next year the administration is requesting \$213 million for the Department of Energy's conservation research, which now receives \$411 million. The White House questions whether the United States will suffer from global warming, and therefore opposes making possibly expensive changes to control the greenhouse. But in a significant break with this wait-and-see policy, Prime Minister Margaret Thatcher last month announced that Britain would cut CO₂ growth 20 percent by 2005, stabilizing it at 1990 levels, if other nations follow suit. How? Heavy reliance on energy efficiency is a likely option. "You can cut carbon emissions 20, 30 percent without any economic cost," says Michael Grubb of the Royal Institute for Economic Affairs. Bringing all homes up to the latest standards for insulation, for example, would cut emissions nearly 9 percent, estimates Stewart Boyle of Britain's Association for the Conservation of Energy. This week the West German cabinet is expected to consider a proposal to cut carbon emissions 30 percent by 2010. Increasingly, as the world grapples with the uncertain threat of the greenhouse, the United States is being left out in the cold.

SHARON BEGLEY with DANIEL PEDERSEN
in London

Energy: Just Say No

Using energy more efficiently, whether you're driving or keeping a six-pack frosty, cuts emissions of CO₂. It also saves money.

ITEM	EXTRA COST AT PURCHASE	TIME TO PAY BACK	CARBON SAVED
Refrigerator	\$30	1.5 yrs.	180 lbs.
Car	\$500	3 yrs.	800 lbs.
One fluorescent lightbulb	\$7	1 yr.	223 lbs.

SOURCES: HOME ENERGY; RICHARD HEEDE, ROCKY MT. INSTITUTE

Search for Answers to Climate Warming Heats Up

By **Simson L. Garfinkel**

Staff writer of The Christian Science Monitor

BOSTON

P. 10

WHEN the Du Pont Company announced it was shutting down its plants that make ozone-destroying chlorofluorocarbons (CFCs), countries around the world started calling, asking to buy them.

"Since we announced this total phaseout of CFCs, we have had number of inquiries from developing countries that account for 60 to 70 percent of the world's population to buy our plants or to buy CFC technology," says Leo E. Manzer, a research manager at Du Pont, the world's largest producer of CFCs.

Du Pont refused to sell the plants, giving as its reason that CFCs made in developing countries are as bad for the Earth's ozone shield as CFCs made in the United States.

The Du Pont action followed an international agreement three years ago, when 23 industrialized countries gathered in Montreal and promised to cut their production of CFCs by the year 1999. "Five [CFC] plants have started up since the treaty was signed in 1987," Dr. Manzer says.

In his laboratory at the University of California at Irvine, F. Sherwood Rowland, an atmospheric chemist, analyzes samples of air from all over the world. He has found industrial chemicals like CFC-113, used almost exclusively in the electronics industry, in places as remote as Barrow, Alaska. "There is no place in the world that people live that is free of this pollution," Dr. Rowland says.

Unlike smog or radiation, CFCs do not pose a direct threat to human health. The chemicals, which are used as propellents in aerosol-spray cans, to blow foam, and in refrigerators, eventually escape into the atmosphere

where they contribute to global warming and break down the ozone layer that shields the surface of the Earth from the sun's deadly ultraviolet radiation. "When they stop becoming a greenhouse problem, they start becoming an ozone problem," says Donald Blake, a postdoctoral research assistant in Rowland's laboratory.

Sixteen years ago, Rowland and Mario Molina published an article in the journal *Nature*, hypothesizing that CFCs might damage ozone in the upper atmosphere. Although Rowland and Dr. Molina lacked proof of actual ozone destruction, their argument was convincing enough that the United States, Canada, Sweden, and Norway banned the use of CFCs in most aerosol-spray cans.

In 1985, Dr. John Farman, a scientist for the British Survey, published a paper in *Nature* that said the ozone over the Halley Bay Station had been decreasing since 1957. Two years later, a modified U-2 spy plane flying over the Antarctic confirmed the ozone hole. Experiments proved that chlorine released by CFCs was the culprit.

Companies like Du Pont are now hurriedly searching for ways of making CFC alternatives. But with \$135 billion of equipment that uses CFCs in the United States alone, Manzer says, replacements must match the physical properties of the CFCs closely. If a replacement gas expands more when heated than does CFC-12, commonly used in automobile air conditioners, it might blow pressure-relief valves in cars on a hot day, he says.

A second problem with the alternatives is their price: Because the substitute chemicals require three or four steps to manufacture, instead of the single step for most CFCs, they will

probably cost three to five times as much. That cost will be especially difficult for developing countries — the countries now seeking to buy or build Du Pont's cheaper CFC technology.

Scientists say the problems and issues raised by the ozone layer are just a taste of what awaits the world on an even larger climatological problem: global warming.

The global greenhouse

The Earth's atmosphere acts like the glass in a greenhouse. Visible light from the sun passes through the atmosphere and heats the Earth's surface. But trace gases in the atmosphere, mostly carbon dioxide and water vapor, trap infrared radiation emitted from the surface and keep it from being reflected back into space.

"If we had no atmosphere, the temperature of the Earth would be around 0 degrees F.," says Blake. "Because of carbon dioxide, water vapor, and ozone, we have an average temperature of about 60 degrees F."

Those trace gases have been steadily increasing since the Industrial Revolution began in the 18th century. Carbon dioxide (CO₂) is on the rise thanks to the burning of coal, oil, and natural gas. Methane, another greenhouse gas, is on the rise because of increased agriculture. For developing countries, limits on greenhouse gas

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production – essentially bans on development – might be even more unacceptable than limits on CFCs.

A hundred years ago, the concentration of CO₂ in the Earth's atmosphere was roughly 280 parts per million (ppm). Today, carbon dioxide is at 340 ppm and rising.

In 1896, the Swedish chemist Svante Arrhenius predicted that doubling the amount of carbon dioxide would eventually lead to a 9 degree increase in the Earth's temperature. Most of today's computer-based climatological models forecast a 4 to 9 degree increase in global temperature, "depending on how you represent the clouds," Peter Stone says, an atmospheric scientist at the Massachusetts Institute of Technology (MIT) in Cambridge, Mass.

Although some scientists say it may be years before increased greenhouse gases affect the Earth's temperature, the planet does seem to be getting warmer already. According to James Hansen, director of the NASA-Goddard Institute for Space Studies in New York, 1988 "tied with 1981 as the warmest year on our record." The global average temperature for those two years was 0.63 degrees F. above the world's average between 1950 and 1980. Last year "was warm, but it was not as warm as the previous year. . . . I think it was the sixth or seventh."

Last year would have been warmer, Dr. Hansen says, except for a "periodic up-swelling of cold water in the eastern Pacific," called the El Niño, that has been keeping temperature in that ocean cool. "As we come out of that cool phase, we are going to get hotter temperatures in the next year or two which may rival or exceed the hottest years in the 1980s."

But predicting the actual amount of warming – and how soon it will take place – is difficult, says Kerry Emmanuel, chairman of MIT's Department of Earth and Planetary Sciences and a critic of many global climate models.

Models of Earth's climate

Scientists lack a comprehensive theory, or "analytic understanding," of how the Earth's climate actually works. "One would hope that we would at least have an analytic understanding of some of the subprocesses,

an understanding that is rooted in the physics of the phenomena," Dr. Emmanuel says. Even detailed understandings of the convection of air or the circulation of the oceans remain beyond the grasp of climatologists.

That understanding is vital, Emmanuel says, because "water vapor is a much more important greenhouse gas than CO₂." Like carbon dioxide, water vapor traps in the heat from the ground, but "there is a lot more of it."

Clouds move water around the globe. Since they can't be modeled directly, their effects must be inferred from other variables – which is where Kerry and other scientists say that the models get shaky.

"There may be powerful negative feedback so strong that the amount of extra warmth is so small [as not to matter]," he says. "If you increase the amount of clouds by just a few percent, you could offset the warming. Clouds reflect sun back to space: They're white."

Nevertheless, many scientists say the possibility for global warming should be reckoned with now. "The numbers, to me, are worrisome, even given all of the uncertainties in the models," MIT's Dr. Stone says.

"One of the things that we really need to do is to improve our understanding of some of these processes that are important," he says. "That requires getting lots of data."

For example, Stone says, detailed measurements have to be made to determine the temperature of the ocean at different depths. One proposed experiment involves conducting underwater detonations and measuring the time it takes for the sound to travel to different parts of the world: Because cold water is denser than warm water, sound travels slower through it.

"This would be very valuable to tell us if we are getting a true global warming, and to tell us how rapidly it is coming about. The faster [the heat] penetrates into the deep oceans, the longer it will take" to warm up the surface, Stone says. "It is an important difference if we get a rise in 10 years or in a hundred, and that is the kind of uncertainty there is."

But few scientists doubt that a warming is coming. "The fact that the atmosphere is changing, that much is certain," Rowland says. "Carbon dioxide is going up. Methane is going up. Those [trends] aren't questioned any more."

"You hear a lot of people say, 'I'm not sure that the greenhouse effect is real.' It is very real, in that there are driving forces: We can't change the concentration of these gases in the atmosphere without having a consequence on the climate," he says. "The fact that we can't predict what that climate is going to be doesn't mean that it won't happen. We can't predict earthquakes, but we know that they happen."

One of the most important developments in recent years has been the political agreement to cut the use of CFCs, Stone says: "If nothing were done about CFCs, they would become the worst part of the warming problem in 20 years time."

"The laws that were passed in the US and other countries [in the 1970s] did have a beneficial effect. The [warming] effect in recent years has not been as bad as it would have been if those laws had not been passed." That's because each CFC molecule traps more than a thousand times as much heat as each molecule of carbon dioxide.

One pressing problem, Stone says, is a shortage of scientists in the field of meteorology, a field that has perhaps fewer than 2,000 people engaged in research. "A lot of this money that they are talking [about] spending in [NASA's proposed] Earth Observation System will gather data, but we don't have the manpower to make use of it. So we are going to need money for increasing the supply of scientists working on these problems."

Putting Cleanup First: The National Environmental Trust Fund Proposal

by M.R. Greenberg

Chairman, American International Group, Inc.

P. 67

Alarmed by the poisoning of our environment at Love Canal and other toxic waste sites, Congress created the Superfund program in 1980. Superfund was intended to clean up the most serious abandoned and uncontrolled hazardous waste disposal sites in the United States and to respond to hazardous waste emergencies.

More than a decade later, billions of dollars have been spent under Superfund, but relatively few sites have actually been cleaned up. At the same time, the number of identified Superfund sites has grown significantly to over 1,200 and the average site cleanup cost has risen to more than \$25 million.

A major problem is Superfund's funding approach, which forces the Environmental Protection Agency (EPA) to raise the cleanup funds site by site from parties who sent waste to the site. This system, based on the principle of strict retroactive liability, means that companies are being held responsible today for waste disposal practices that occurred 20 or 30 years ago and which may not have been illegal or irresponsible at the time.

In addition, under Superfund liability, anyone and everyone who sent hazardous wastes to a site is potentially liable for the total cost of cleanup. This extends not only to operators of disposal sites, but also to generators and transporters of the waste, and even to current owners of sites where waste disposal has ceased. This system pits EPA, companies, insurers, local governments and individuals against each other, creating an unparalleled litigation

gridlock. Massive amounts of money have been spent in the courtrooms attempting to assess and shift liability. Meanwhile, cleanup has been delayed and transaction costs have soared.

We must develop a better approach to solving this critical national problem. Superfund's goal of cleaning up the environment is being thwarted by its protracted, litigious system of assessing liability. In an attempt to resolve this costly gridlock, American International Group (AIG) has proposed creating the National Environmental Trust Fund. This Fund's resources would be devoted exclusively to cleaning up those old hazardous waste sites. It could be financed by adding a separate fee to commercial and industrial insurance premiums now paid in the United States, with a method of payment to be determined for those businesses that self-insure.

By our estimates, even a modest assessment of 2 percent of premiums and

an equivalent amount for self-insurance would provide about \$40 billion over the next decade—more than enough to clean up the 1,200 highest priority sites. We have suggested that funds be collected by insurers and remitted to the Trust Fund for use by the EPA in cleanup activities. Adopting this approach would eliminate the need to establish liability site by site among various parties. It would take the action out of the courtroom and move it to the hazardous waste sites. It would let us get on with the job of cleaning up the environment, as Superfund originally intended.

It is important to point out that the AIG proposal would not do away with the one real success of Superfund, namely its effectiveness in providing an incentive for industry to reduce waste and handle the waste it does generate with extreme care. All it would do is replace the retroactive liability system of Superfund with respect to old waste sites. Without a solution like the National Environmental Trust Fund, our businesses and communities will stagger under the burden of establishing liability for cleanup. It's time to break the Superfund gridlock and put cleanup first.

AIG is the leading U.S.-based international insurance organization and the nation's largest underwriter of commercial and industrial coverages. Its member companies write property, casualty, marine, life and financial services insurance in over 130 countries and jurisdictions, and are increasingly engaged in a range of other financial services.

INNOVATIVE APPROACHES

THE JOHNNY APPLESEED UTILITY *P. 66*

Planting trees as a means of increasing the absorption of carbon dioxide from the atmosphere can't be expected to have the same impact in curbing global warming as salvaging huge tracts of forest. Still, every tree helps. Tree-planting programs have begun in many cities around the country. Last year, The American Forestry Association initiated a "Global Releaf" program that calls for the planting of 100 million trees in urban areas. And President Bush has called for planting a billion trees across the United States.

Now an energy company has come up with a fresh idea: a tree-for-electricity swap. Applied Energy Services of Arlington, Va., announced last year that it would contribute \$2 million toward the planting of enough trees in Guatemala to absorb the equivalent of the 15.5 million tons of carbon dioxide that will be emitted over 40 years by its new 180-megawatt coal-fired electric plant in Uncasville, Conn.

By this imaginative arithmetic,

the plant equals 52 million trees. The U.S. Agency for International Development, the Peace Corps, CARE, and the Guatemalan government are treefully supporting the project.

"NO GOLF CART"

The electric car has had a checkered past, promoted mostly by small companies for very limited uses. But in January, General Motors introduced a prototype electric car called the Impact, claimed it was the most advanced yet designed, and said that it could be on the market within five years.

"This is no golf cart," said GM chairman Roger B. Smith. The sleek, two-door passenger car has a range of 120 miles on a charge of its lead-acid batteries. That would make it a reasonable second car or commuter car for many families. An electric car, of course, emits no gases of any kind.

SAFE SPRAY

The potent greenhouse gases called CFCs have been evicted from many of the aerosol spray containers they used to inhabit. But the propellants that mostly replaced them—hydrocarbons such as propane and butane—are also atmospheric pollutants.

Now Exxel Container Inc. has designed a spray can that contains no propellant at all, but doesn't need to be pumped. A rubber bladder expands like a balloon when the can is filled, then contracts to expel the contents in a spray.

The new container is already being used in hair sprays and aerosol sun-block products.

CLEAN PIPES

Cleaning up deposits that form in pipes usually requires chemicals, creating the potential for environmental problems. But Environ Technologies Corp. of Newport Beach, Calif., has developed a nonchemical approach based on conditioning water magnetically so that it doesn't form deposits. The result stops buildup and corrosion, saves energy, and doesn't contribute to

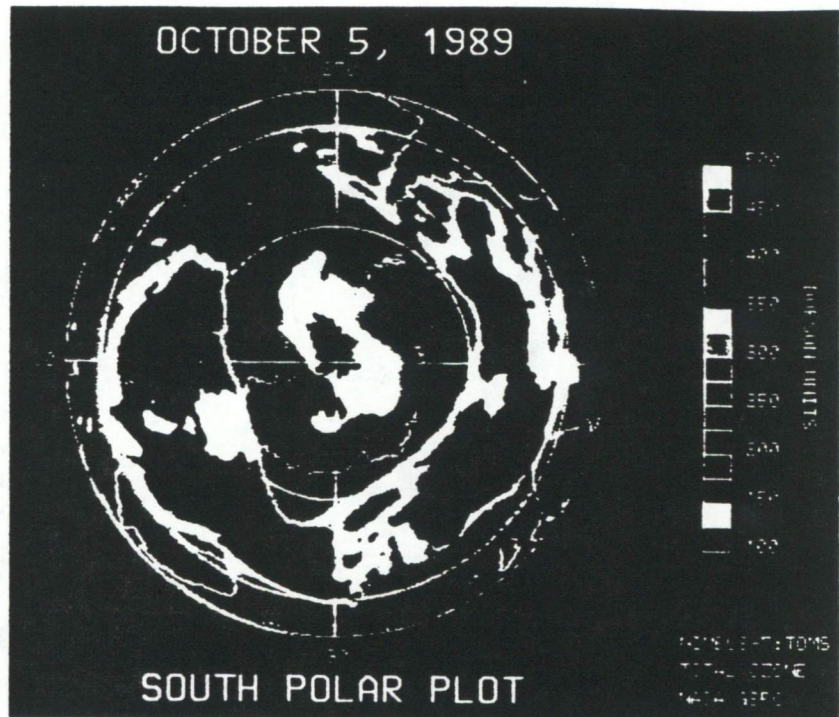
water pollution.

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Rowland and Molina found that the very inertness of CFCs made them destructive to the ozone layer. Released into the atmosphere, CFCs remain intact, floating slowly upward. As they reach the edge of the atmosphere, a small percentage of CFC molecules are broken apart by solar radiation, releasing chlorine atoms. These combine voraciously with ozone, destroying it at an incredibly rapid rate. As the ozone layer thins, more ultraviolet radiation reaches the Earth's surface. The human consequences include more skin cancer and more cataracts—both directly related to ultraviolet exposure—as well as crop damage. A degraded ozone layer may even constitute a threat to the entire ocean ecosystem: Ultraviolet radiation appears to be especially harmful to phytoplankton, the one-celled organisms at the base of the marine food chain.

Recent studies have shown that the size of the Antarctic ozone hole apparently is increasing, covering 10 million square miles in 1989 and sometimes reaching inhabited regions of New Zealand and southern Australia. Discovery of the Antarctic ozone hole was one of the factors that in 1987 led 55 nations to sign an unprecedented international agreement, the Montreal Protocol. These nations pledged, among other things, to halve most CFC emissions by 1998. Shortly afterward, Du Pont, the major producer of CFCs in the United States, reiterated a corporate pledge made in the 1970s to phase out CFC production before the end of the century. Other manufacturers and users of CFCs have also been spurred into action.

Take the electronics industry: It accounts for 12% of CFC use in the United States. In January 1988, AT&T



Satellite plot of the Antarctic ozone hole, showing ozone depletion over 10 million square miles—encompassing areas over New Zealand and southern Australia.

became the first company to announce plans for a CFC-free manufacturing environment. IBM has pledged to end CFC emissions from all its manufacturing facilities by the end of 1993; it reduced CFC emissions from its plant in San Jose, Calif., by 50% in 1988. NCR, another major computer company,

has established in-house CFC recycling plants at facilities in San Diego, Minneapolis, and Columbia, S.C., replacing CFCs with water-based processes in several instances.

Meanwhile, CFC manufacturers, including Du Pont and Allied-Signal, have begun to develop and manufacture replacement chemicals that will not damage the ozone. This major effort will cost Du Pont alone \$1 billion, the company estimates. One approach is to use replacements that do not contain chlorine; another is to develop substitutes that break down in the lower atmosphere.

"AT&T takes its environmental responsibility seriously.

...Toxic waste and toxic emissions are an indictment of the quality process. We want to prevent them at the source."

Robert E. Allen, CEO, AT&T

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But CFCs are not the only threat to the ozone layer. Another problem is halons, which contain bromine atoms that destroy ozone with even greater efficiency than does chlorine. Halons are widely used in fire extinguishers, especially in facilities where water cannot be used to fight fires. Studies show, however, that most halon emissions occur not during fires but when systems are tested; alternative chemicals and testing methods could cut discharges by two-thirds.

NO EASY ANSWERS

The salvation of the ozone layer and cleansing of our air have one thing in common: Both require unprecedented cooperation across state lines in America and across international boundaries as

well. Air pollution is arguably a more difficult problem than ozone depletion because it is a complex set of problems that require different approaches, says Richard Ayres, chairman of the National Clean Air Coalition. "We believe that the declining air quality in our cities can fairly be characterized as a public health crisis."

There is the problem of urban air pollution, which in many cities has become a clear health hazard. Some 150 million Americans live in urban areas where, on certain days, the air has been declared unfit to breathe by the Environmental Protection Agency. More than half the American population lives in counties where ozone levels exceed the EPA's health safety standard at least once each year. Internationally, the World Health Organization estimates that 70% of the global urban population breathes air that contains unhealthy levels of suspended particles at least some of the time, and that 27 of 54 cities with available data on sulfur dioxide were near or over the recommended health standard for this pollutant.

Polluted air endangers other living species, too, in the form of acid compounds that fall from the sky. Sulfur dioxides, nitrogen oxides, and other acidic compounds are emitted by automobiles, power plants, and other fossil-fuel-burning facilities. These pollutants drift with the prevailing winds, descending in snow, rain, and mist on forests and lakes. The change in acidity may sicken trees and kills fish and other inhabitants of freshwater lakes.

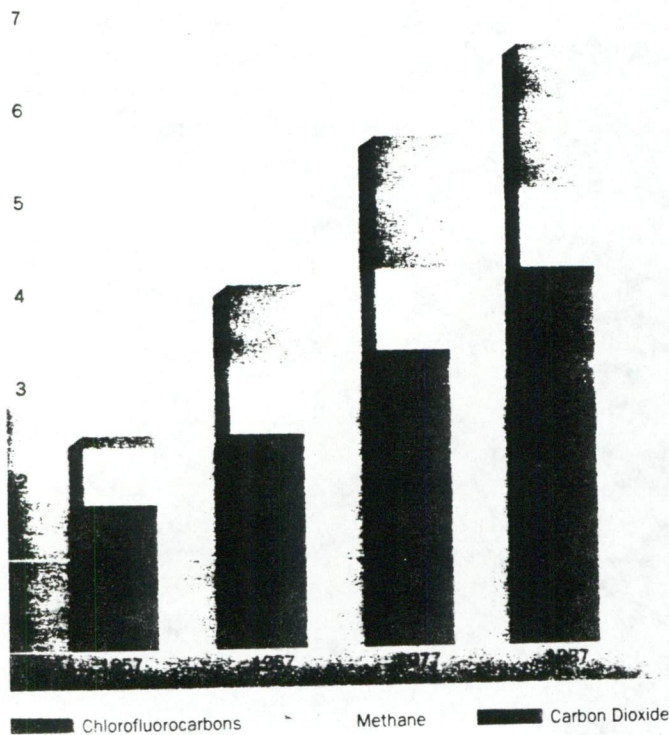
A 1984 survey in the United States found more than 500 strongly acidic lakes; a Canadian survey revealed that 50,000 lakes in that country were dead. In Europe, the share of forests showing damage attributable in part to acid deposition increased from 8% in 1982 to 52% in 1988. A total of 125 million acres, more than a third of Europe's forests, have been blighted by acidic pollutants.

Damage to other valued resources is also great. Many cultural monuments in ancient cities are being eaten away by polluted air. Natural vistas are being obscured: Witness the persistent, sulfuric haze that often shrouds the view of the Grand Canyon.

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Annual Greenhouse Heating Increase

Billion tons of carbon equivalents



Source: World Resources 1990-91

Driven by rising emission rates for gases, the potential for greenhouse heating of the atmosphere is increasing rapidly.

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The ravages of pollution are most evident in popular historic places visited by millions of tourists. The great buildings of Athens are said to have suffered more deterioration in the past quarter-century than in the previous 2,400 years. The Taj Mahal is endangered by polluted air, as are the monuments erected to the Civil War soldiers who fought at Gettysburg, Pa. Even the remote Mayan temples in the Yucatan peninsula are being destroyed by chemical reactions between acidic pollutants and stone.

The sources of the pollutants are many. Automobiles emit carbon monoxide, nitrogen oxides, and hydrocarbons, which generate ozone by a complex set of photochemical reactions induced by solar energy. Pollutants emitted by coal- and oil-burning power plants and factories include particulates, sulfur dioxides, and nitrogen oxides. Hundreds of potentially toxic chemicals used in industrial and commercial processes are released from thousands of factories and workplaces. In Mexico City, one of the most polluted cities in the world, headaches, drowsiness, burning eyes, skin rashes, and other illnesses linked to air pollution are common.

The United States took the lead in air pollution control, starting with the Clean Air Act in 1970. Among other provisions, the act required use of catalytic converters on all new automobiles. The newest generation of converters reduces hydrocarbon and carbon monoxide emissions by more than 90%, and nitrogen oxides by more than 75%. An added benefit of converters is that they require unleaded gasoline; recent evidence that even small amounts of lead in the blood can diminish intellectual performance prompted the phaseout of leaded fuel in most industrial countries. However, the demand for even stricter emission controls has grown because these gains have been largely offset by an increase in the number of autos and miles driven. But Gordon Rinschler, a Chrysler executive engineer, points

out that there are limits to what can be done. "Can we reduce emissions to lower levels? Maybe. But it's not possible to go to zero."

It's much the same story with pollution from fixed sources, such as generating plants and factories. Technological advances in pollution control have been impressive. Much of the visible smoke that U.S. factories once belched into the air has disappeared. But other emissions—including sulfur dioxides and nitrogen oxides—have proven tougher to control, due in part to social and political factors. Elimination of high-sulfur coal would put thousands of Appalachian miners out of work, for example, and scrubbers used to clean up sulfur emissions from power plants are expensive.

"CLEAN COAL"

One emphasis on pollution control from fixed sources is on "clean coal" technology. Globally, coal is much more abundant than oil. Coal looms increasingly important because the United States has an indigenous supply sufficient for centuries (as do China and the Soviet Union), while a growing percentage of our petroleum products must be imported. Coal-burning power plants already provide half our electricity, and use of electricity is growing faster than consumption of other forms of energy. If present trends continue, coal will surpass petroleum as the primary fuel in many countries within 20 years; coal production could triple by the middle of the 21st century.

But all coal contains some sulfur. When coal is burned, sulfur dioxide is produced. Many areas now forbid use of high-sulfur fuel. As a result, a number of methods are being used to reduce these

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emissions. Some sulfur can be removed from coal by washing prior to burning. But most industries have relied on scrubbers, which remove sulfur dioxide from the gas as it travels up the smokestack. Scrubbers can be up to 95% effective, but they use large amounts of water and produce a kind of sludge that requires special disposal. And scrubbers are not used in every plant. Indeed, only 40% of U.S. coal-burning power plants are equipped with these devices. The cost of retrofitting scrubbers to older plants is estimated at \$12 billion or more.

Nitrogen oxides are a nastier problem, because they are inherent in combustion. There are technologies that modify the combustion process to reduce nitrogen oxide emissions, but the technique is at best 50% effective.

Nonetheless, utilities and other large users of coal can point to some impressive advances. Nitrogen oxide emissions, which rose steadily in the United States until 1977, have been decreasing slowly for more than a decade. And while U.S. utilities increased coal consumption by 76% between 1973 and 1986, sulfur dioxide emissions from these plants decreased 18% over the same period. A continuing decrease in sulfur dioxide emissions is expected over the next three decades, as new power stations with advanced pollution-control systems replace aging facilities.

CONFLICTING DESIRES

But the successes of the past are not the demands of the future. Our society has an unslaked thirst for energy; it also has an increasingly urgent desire for cleaner air. Given those conflicting desires, technology must move ever faster to meet society's needs.

Specific technologies for cleaner energy production are being tested with all due speed. One new technology that promises to reduce emissions of both sulfur dioxide and nitrogen dioxide is fluidized-bed combustion. Another promising technology uses gas from coal to run an electricity-generating turbine, with a second turbine powered by excess heat that would otherwise go to waste.

Ultimately, the issues are social and political as much as technological. How clean do we as a nation or planet want our air to be, and how much are we willing to pay to achieve that goal? Virtually everyone is in favor of cleaner air. Yet nearly 20 years after passage of the first Clean Air Act, almost half the U.S. population is exposed to unhealthy air, acid rain continues to degrade our lakes and forests, and more than 2.5 billion pounds of toxic chemicals are pumped into the atmosphere by U.S. companies every year.

There are increasing signs, however, that our resolve is making a comeback. A new Clean Air Act, proposed by the Bush Administration, is wending its way through Congress and seems certain of passage in some form. It will require reductions in emissions of pollutants that cause acid rain and

contribute to urban smog. In California, even more stringent emission limits are being proposed for virtually all sources of air pollution. Individual companies are already sharply cutting toxic emissions and recapturing or phasing out use of CFCs. The oil industry is introducing less-polluting formulations of gasoline, and the utility industry is on the verge of bringing new, more efficient, and less-polluting energy technology on-line.

In the end, a change in the air will come only with a change in attitudes. The air is the ultimate global commons—mixed and moved around the globe by the winds; shared by all living things; used and reused for many different purposes. It not only sustains life but, in the ozone layer, shelters it from the harsh ultraviolet rays of the sun and buffers the Earth from extremes of hot and cold. The air must increasingly be seen as a common resource, not a common sewer. ■

AIR

THE GLOBAL COMMONS

"Because life as we know it would not have developed on Earth without an ozone layer, the continuing manufacture of substances that destroy it is highly alarming."

SHERWOOD ROWLAND, UNIVERSITY OF CALIFORNIA, IRVINE

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The Antarctic ozone hole is perhaps the most prominent example of how human activities can cause sudden, major deterioration in the environment. Moreover, although scientists had warned that the industrial chemicals known as chlorofluorocarbons (CFCs) might damage Earth's protective ozone layer, they did not foresee the Antarctic hole—it was completely unexpected. And the degradation of the ozone layer will increase, since the existing hole was caused by gases released before 1980. CFCs now rising through the lower atmosphere will take seven to 10 years to reach the stratosphere, where they will remain for as long as 100 years.

The ozone hole is not the only sign of environmental degradation in the thin layer of gases that makes life on Earth possible. The signs and symptoms are evident everywhere.

In the Adirondack Mountains of New York, a lake is eerily still and beautiful, made sterile by acid rain. In Florence, the nose of a Renaissance bust is pockmarked and eaten away by corrosive gases in the urban air. In the Black Forest of Germany, the needles of millions of silver fir trees are yellowed and stunted. In the Grand Canyon, a subtle, sulfur-laden haze diminishes the glory of endless vistas. In Los Angeles, many people stay indoors on a day when lungs sting and eyes tear. And

miles above the South Pole, in a region where the air thins to a near-vacuum, chemical reactions that originate with man-made compounds remove a vital protective component of the atmosphere.

All these phenomena are the results of apparently minor changes in the air caused by human activity. The chemicals added to the atmosphere are measured in parts per million—and in some cases, parts per billion. Yet they are concentrated enough to cause crises, not only on a local level, as in the case of Los Angeles smog, but also over vast areas, such as the forests and lakes that cover major regions of Europe and North America. And in the case of the upper atmosphere, whose ozone layer is being eaten away, the problem threatens the whole planet.

The realization that human activity has put the ozone layer in peril has spurred the industrial nations and major corporations to take urgent measures.

THE CFC FACTOR

The first ozone warning was sounded in 1973 by Sherwood Rowland and Mario Molina, two chemists at the University of California at Irvine. They were studying the fate of chlorofluorocarbons, or CFCs, a family of chemicals whose properties had made them essential in a number of industries, from refrigeration to aerosol spray cans to plastics and semiconductor production. Introduced by Du Pont in 1935 under the trade name Freon, CFCs quickly replaced such toxic gases as ammonia in refrigerators and air conditioners; later, they were widely adopted as blowing agents for production of insulated foams and as cleaning solvents for electronic equipment. By the mid-1980s, U.S. companies were making \$750 million worth of CFCs to produce \$135 billion worth of end products.

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ALTERNATIVE FUELS

P.50

Today's new auto emits 96% less carbon monoxide, 96% less hydrocarbons, and 76% less nitrogen oxides than a comparable 1967 model. But Americans drive half again as many miles now as they did then, and more of those miles are in stop-and-go traffic, which maximizes pollution. Strict new emission laws for autos have spurred a drive for alternative, cleaner-burning fuels. The three U.S. domestic car manufacturers and 14 petroleum companies have started a joint research and testing program on alternative fuels, and individual corporations have begun efforts of their own. The leading contenders:

■ Reformulated gasoline. Arco was first on the market with its Emission Control-1, now being sold in southern California. Other companies,

such as the Marathon unit of USX, Exxon, and Shell are following suit. The process removes polluting gasoline components such as butane, olefins, and aromatics and adds a compound called methyl tertiary butyl ether (MTBE), which improves combustion efficiency, reducing carbon monoxide by 9%, hydrocarbons by 4%, and nitrogen oxides by 5%. Its big advantage is that existing autos wouldn't have to be modified to use it.

■ Alcohol—either methanol from coal and natural gas or ethanol from corn or other crops. The state of California is buying 5,000 cars that can burn either methanol or gasoline from General Motors and Ford for testing. Methanol-powered cars have greatly reduced emissions of pollutants that lead to formation of ozone, but they release measurable

amounts of formaldehyde, a suspected cancer-causing agent.

■ Natural gas. It's already being used in 20,000 Canadian vehicles and in some sizable U.S. fleets: Mountain Fuel Supply Co. of Salt Lake City has 105 vehicles running on natural gas and the Northern Indiana Public Service Co. uses 75% natural gas in its 740-vehicle fleet. United Parcel Service is testing natural gas in 10 trucks in New York for possible nationwide use. Use of natural gas reduces nitrogen oxides by 25%, hydrocarbons by 13% compared with gasoline, and costs substantially less. But it requires bulky tanks to hold sufficient fuel for adequate range and the cost of conversion is \$2,500 per vehicle.

■ Propane. It's the most widely used alternative fuel, with 350,000 propane-burning vehicles in the United States and 3.5 million worldwide. Propane engines not only last two to three times longer than gasoline engines but also have substantially cleaner exhaust emissions. Phillips 66 Natural Gas Co. is converting 31 fleet vehicles to propane in a two-year evaluation program and is marketing it as a fleet motor fuel in several cities.

The New York Times

Scientists Warn of Dangers in a Warming Earth

By CRAIG R. WHITNEY P.6
Special to The New York Times

LONDON, May 25 — A panel of scientists warned today that unless emissions of carbon dioxide and other harmful gases were immediately cut by more than 60 percent, global temperatures would rise sharply over the next century, with unforeseeable consequences for humanity.

While much of the substance of the report has already been disclosed, the report had immediate political consequences. Prime Minister Margaret Thatcher of Britain, breaking with the Bush Administration's skepticism over the need for immediate action, said today that if other countries did their part, Britain would reduce the projected growth of its carbon dioxide emissions enough to stabilize them at 1990 levels by the year 2005.

West Germany's Environment Minister, Klaus Töpfer, has proposed that Europe should go further and cut present emissions by 25 percent by that time, but the United States has said until now that the scientific case for global warming — the so-called greenhouse effect — has not been made and that no action needs to be taken.

Mrs. Thatcher's action is a blow to the Bush Administration, which was counting on her as its major ally in slowing any international action to reduce the industrial pollution that causes global warming.

The report by a working group of the United Nations Intergovernmental Panel on Climate Change was approved by all but a handful of the 90 delegates from 39 countries, said Dr. John T. Houghton, chairman. The report said that if nothing at all was done, the global mean temperature could rise 5.4 degrees Fahrenheit by the end of the 21st century.

It said that in that case, ocean water would expand and ice stored at the poles could melt, raising the level of the sea by 25.6 inches. That would be enough to submerge the Maldives and inundate the coastal plains of Bangladesh and the Netherlands, oceanographers say.

Mr. Houghton, Britain's chief meteorologist, said that only a handful of the scientists in the panel disagreed with the findings, which he said were dramatic confirmation of how rapidly the carbon dioxide, methane, chlorofluorocarbons and other gases released into the air by industrial processes, the burning of tropical forests and other factors had been changing the earth's atmosphere since the end of the 18th century. A draft of the report was previously disclosed.

Britain and U.S. Percentages

Britain, with 1 percent of the world's population, is responsible for about 3 percent of its carbon dioxide emissions, Mrs. Thatcher said. The United States, with 5 percent of the population, is responsible for about 25 percent of the emissions, American scientists say.

Prof. Bert Bolin, the chairman of the intergovernmental panel, described Mrs. Thatcher's action as "very useful" but said, "It is not enough in the long term." If all countries did as Britain suggested, Dr. Houghton said, it would still not be enough to stop the enhanced greenhouse effect. "If you want to stop it, you have to cut by 60 percent immediately," he said at a news conference in Englefield Green, where the working group discussed its findings this week.

"She has taken a kind of halfway position between the aggressive moves being considered by the West Germans and the 'What, me worry?' position of the United States," said Michael Oppenheimer, an atmospheric physicist of the Environmental Defense Fund of New York City, who was in a group of scientists Mrs. Thatcher invited a year ago to advise her on global warming.

"While it's not nearly as strong as the West German and European view," he said in a telephone interview, "it does represent a substantial break with the United States."

Called Too Little Too Late

British environmental groups denounced Mrs. Thatcher's proposal as too little, too late. "It does not even go as far as the very modest first step that the European Community proposed back in March of stabilizing emissions at the present level by the year 2000," said Andrew Dilworth, a spokesman for Friends of the Earth.

Mrs. Thatcher, in her speech at the opening of a center for climate predic-

percent in 15 years, just to get them back to their 1990 levels by the year 2005, would mean "significant adjustments to our economies — more efficient power stations, cars which use less fuel, better insulated houses and better management of energy in general."

Cut of 60% Recommended

The working group's report is one of three that were commissioned in November 1988 by the United Nations Environment Program and the World Meteorological Organization for a global climate conference in Geneva in November. Another working group headed by the Soviet Union is considering the impact of climate changes on agriculture, forests, fisheries, water resources, and sea barriers, and the third, headed by the United States, is considering strategies for responding to climate change. Professor Bolin said today that he would not discuss the draft reports of either of them.

The United Nations group's report today said that just to stabilize atmospheric concentrations of carbon dioxide, nitrous oxide and chlorofluorocarbons at today's levels, there would have to be immediate cuts of more than 60 percent in their output. Depending on how much was actually done to cut emissions, it said, global mean temperature would still keep rising between 0.1 degrees centigrade (0.18 degrees Fahrenheit) and 0.2 degrees centigrade (0.36 degrees Fahrenheit) per decade.

Global mean surface air temperature has already increased by 0.3 degrees centigrade (0.54 Fahrenheit) to 0.6 degrees centigrade (1.08 degrees Fahrenheit) over the last 100 years, it said, with the five average warmest years all occurring in the 1980's.

Scientists who study global climate trends concede, however, that the computer models on which they base their predictions are flawed. While the researchers can measure gases in the atmosphere with precision they have not perfected methods of predicting their effects on particular regions on earth.

So far, there has been only one major step to control greenhouse gases — the major industrialized countries' pledge last year to ban production of chlorofluorocarbons, used as refrigerants and propellants, by the end of this century because they rise to the upper atmosphere and destroy the ozone molecules that block most of the sun's harmful ultraviolet radiation. The developing countries will be asked to agree to a similar ban at a conference here next month.

A scientific plea: cut pollution by 60 percent, immediately.

tion and research in Bracknell, said, "It is no good setting political targets for action which are just not realistic in practice." Mrs. Thatcher, who had been briefed on the working group's findings earlier this week, said today that reducing projected increases in British carbon dioxide emissions by 30

working paper 10

(CFCs)

Iran Plans Spending on Oil

^{A.29}
NICOSIA, Cyprus, May 27 (AP) — Iran will direct \$5 billion in hard currency credits to its oil industry this year, its Oil Minister, Gholamreza Aqazadeh, said.

Tehran radio, monitored in Nicosia, quoted Mr. Aqazadeh as saying Friday that the economic backing was made possible "with cooperation between the Ministry of Economy and Finance and Iran's Central Bank."

Iran's oil industry was battered in the country's eight-year war with Iraq, with oil and gas-related industries, which earn more than 90 percent of Iran's foreign exchange, deprived of funds for maintenance and development.

But Tehran began rebuilding immediately after the United Nations-sponsored cease-fire halted the conflict in August 1988. The credits announced Friday represent about 6 percent of the country's \$80 billion

budget for the current fiscal year, which began March 21.

While inaugurating a methanol plant in southern Iran on Friday, Mr. Aqazadeh said Iran's current sustainable production capacity would be increased to 3.7 million barrels a day in four months and to 4 million barrels a day next year. Production capacity is currently about 3.3 million barrels.

Mexico Weighs Oil Plant

^{P.29}
MEXICO CITY, May 27 (Reuters) — Mexico and the Japanese company Mitsui & Company will cooperate on a study of the need for a large new petrochemicals complex, the state oil company Petróleos Mexicanos said this week. The Mexican company said that if the study of the \$354 million complex to be built in northern Mexico was encouraging, Mitsui might help with financing.

Net Additions to the Greenhouse Heating Effect in 1987 (In Metric Tons)

(Source: World Resources 1990)

Country	Carbon Dioxide	Methane*	CFC Use*
United States	540,000	130,000	350,000
(Combined Germany)	118,000	10,100	95,000
Japan	110,000	12,000	100,000
West Germany	79,000	8,000	75,000
United Kingdom	69,000	14,000	71,000
France	41,000	13,000	69,000
Italy	45,000	5,800	71,000
Canada	48,000	33,000	36,000
East Germany	39,000	21,000	20,000

*Methane and CFC use are listed by equivalent Carbon Dioxide Heating effect.

Ranking of Countries for Greenhouse Gas Net Emissions

Country	Greenhouse Index Rank	Percent of Total Among Top 50
United States	1	17.6
USSR	2	12.0
Brazil	3	10.5
China	4	6.6
India	5	3.9
(Combined Germany)	5A	3.9
Japan	6	3.9
West Germany	7	2.8
United Kingdom	8	2.7
France	10	2.1
Italy	11	2.1
Canada	12	2.0
East Germany	20	1.1

Contributions to Global Warming by Greenhouse Gases and Human Activity

(Source: World Resources 1990)

Sector	Carbon Dioxide	Methane	Ozone	Nitrous Oxide	CFCs	% Warming by Sector
Energy	35%	4%	6%	4%		<u>49%</u>
Deforestation	10%	4%				<u>14%</u>
Agriculture	3%	8%		2%		<u>13%</u>
Industry	2%		2%		20%	<u>24%</u>
% Warming by Gas	<u>50%</u>	<u>16%</u>	<u>8%</u>	<u>6%</u>	<u>20%</u>	

Per Capita Greenhouse Gas Net Emissions, 1987

(Source: World Resources)

Country	Rank	Metric Tons Per Capita*
Lao People's Dem Republic	1	10.0
Canada	5	4.5
United States	9	4.2
East Germany	12	3.7
United Kingdom	20	2.7
West Germany	21	2.7
France	30	2.2
Italy	35	2.1
Japan	42	1.8

*Carbon Dioxide Heating Equivalents, metric tons of carbon)

BRIEF HISTORY OF GLOBAL WARMING ISSUE

- o In 1978, a World Climate Conference recommended that the World Meteorological Organization (WMO) establish a program that considers the role of CO₂ and its possible impact on human activities.
- o In 1987, discussions within the General Assembly led to requests of governing bodies of WMO and UNEP to establish an intergovernmental mechanism to address the science of climate change, and the potential environmental, economic, and social impacts of climate change. This led to the formation of the Intergovernmental Panel on Climate Change (IPCC).
- o The first meeting of the IPCC took place in Geneva in November 1988, with 35 countries, including the U.S., Japan, and the USSR attending.
- o The IPCC agreed to three working groups with the following tasks: (1) assess available scientific information on climate change; (2) assess environmental and socioeconomic impacts of climate change; and (3) formulate possible response strategies.
- o This month the first working group released a summary of the science of global warming. This summary states that the most likely expectation is that mean temperatures will rise by 0.3 degrees Centigrade per decade, or 5.4 degrees Fahrenheit by the end of the next century. A report from the third working group on response strategies is expected shortly.
- o In addition to the IPCC meetings, several other international meetings on global warming have been held. These include:
 - the Toronto conference (June 1988) on "The Changing Atmosphere" which concluded by issuing a statement calling for a 20 percent reduction in CO₂ emissions by the year 2005;
 - the Hamburg Conference (November 1988) which called for a 30% reduction in CO₂ emissions by the year 2000;

- the Noordvikjk Conference (November 1989) in which the U.S. "allegedly" supported a declaration supporting a freeze on global warming emissions;
 - the White House Conference (April 1990)
 - the Bergen Conference (May 1990) in which the U.S. did not agree to any specific limits.
- o In the U.S., some states are beginning to take steps to reduce emissions. For instance, in California, the "green initiative" includes a requirement for a 20 percent reduction in CO₂ emissions.

Important Facts on Global Warming

- o Greenhouse gases, other than CO₂, are now responsible for about half of the increase in the greenhouse effect world wide.
- o A goal of stabilizing the composition of greenhouse gases in the atmosphere at present day levels will require an immediate 60 percent reduction in all emissions. (Greenhouse gases remain in the atmosphere for decades. At current emission levels, greenhouse gases are being released into the atmosphere at a faster rate than they are being removed. As a result, even if we were to freeze emissions at current levels, the concentrations of greenhouse gases in the atmosphere would continue to grow over the next century. See attached figure and chart.)
- o This will be difficult, especially since world energy consumption is expected to increase by 50 to 75 percent between 1985 and 2020, with developing countries accounting for 75 percent of that growth.

Stabilizing emissions of greenhouse gases at current levels will not stabilize concentrations. Once emitted, greenhouse gases remain in the atmosphere for decades to centuries. At current emission levels, greenhouse gases are being released into the atmosphere faster than they are being removed. As a result, if emissions remained constant at 1985 levels, the greenhouse effect would continue to intensify for more than a century. Carbon dioxide concentrations would reach 440-500 parts per million (ppm) by 2100, compared with about 350 ppm today, and about 290 ppm 100 years ago (Figure 4). CFC concentrations would increase by more than a factor of three from current levels, while nitrous oxide concentrations would increase by about 20%, and methane concentrations might remain roughly constant.

Drastic cuts in emissions would be required to stabilize atmospheric composition as shown in Table 1 (see also, Box 1), and even if all anthropogenic emissions of CO₂, CFCs, and N₂O were eliminated the concentrations of these gases would remain elevated for decades. It would take more than 50 years, and possibly more than a century, for the oceans to absorb enough carbon to reduce the atmospheric concentration of CO₂ half way toward its preindustrial value. It would also take more than 50 years before excess concentrations for CFCs and N₂O declined by half after all anthropogenic emissions were eliminated.

FIGURE 4

**IMPACT OF CO₂ EMISSIONS REDUCTIONS
ON ATMOSPHERIC CONCENTRATIONS**

(Parts Per Million)

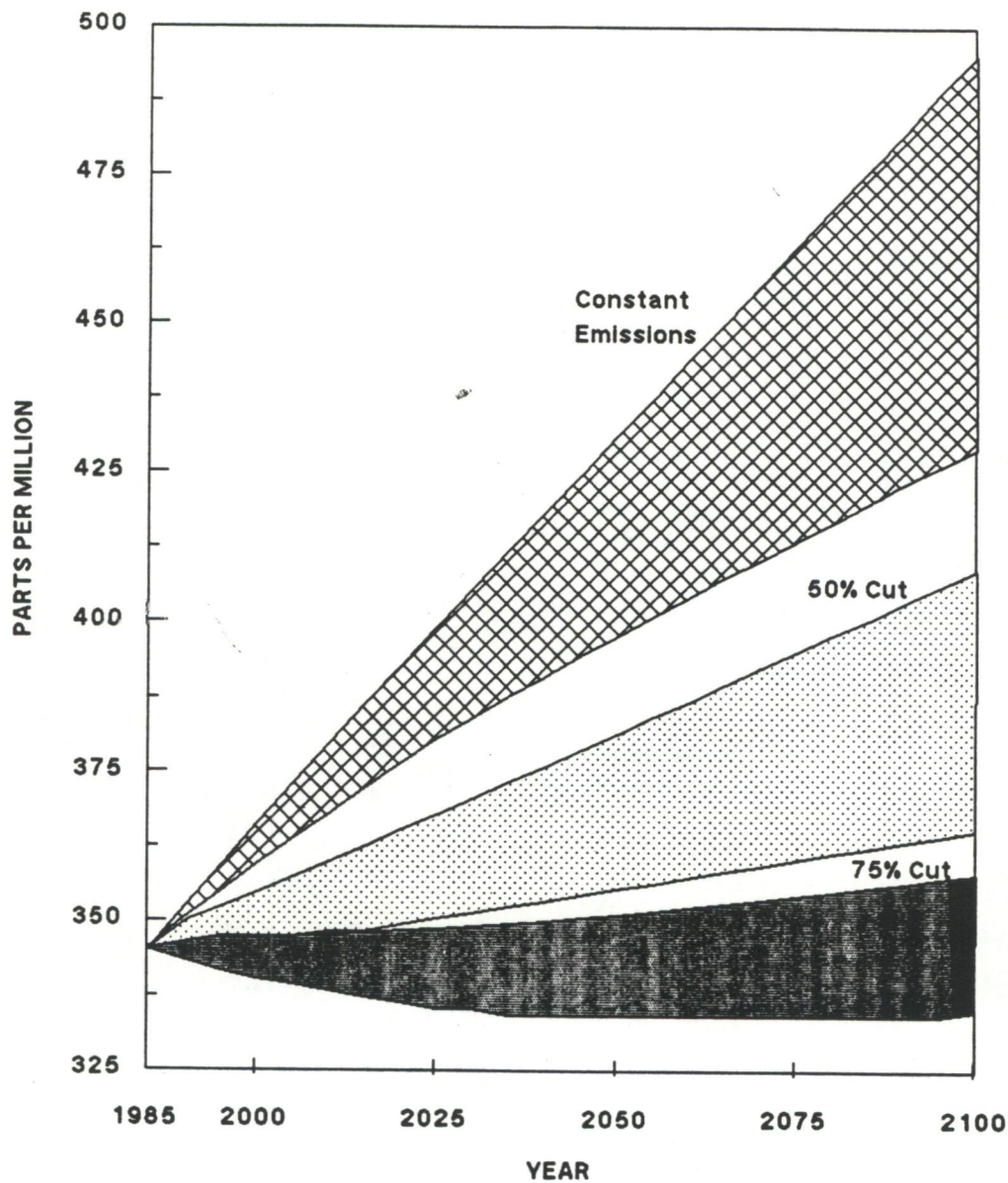


Figure 4. The response of atmospheric CO₂ concentrations to arbitrary emissions scenarios, based on two one-dimensional models of ocean CO₂ uptake. The emissions scenarios are relative to estimated 1985 levels of 5.9 billion tons of carbon per year.

TABLE 1

Approximate Reductions in Anthropogenic Emissions
Required to Stabilize Atmospheric Concentrations at Current Levels

GAS	REDUCTION REQUIRED
Carbon Dioxide (CO ₂)	50-80%
Methane (CH ₄)	10-20%
Nitrous Oxide (N ₂ O)	80-85%
Chlorofluorocarbons (CFCs)	75-100%
CO, NO _x	Freeze

BOX 1

The Greenhouse Gases

Carbon dioxide. Carbon dioxide (CO₂) is the most abundant and single most important greenhouse gas in the atmosphere. Its concentration has increased by about 25% since the industrial revolution. Detailed measurements since 1958 show an increase from 315 to 350 parts per million by volume (Figure 1). Carbon dioxide concentrations are currently increasing at a rate of about 0.4% per year, which is responsible for about half of current increases in commitment to global warming from greenhouse gas buildup (Figure 3). Both deforestation and fossil-fuel combustion have contributed to this rise. Current emissions are estimated at 5.5 billion tons of carbon (Pg C) from fossil-fuel combustion and 0.4-2.6 Pg C from deforestation. Most of this carbon dioxide remains in the atmosphere or is absorbed by the oceans. Even though only about half of current emissions remain in the atmosphere, available models of CO₂ uptake by the ocean suggest that substantially more than a 50% cut in emissions is required to stabilize concentrations at current levels.

Methane. The concentration of methane (CH₄) has more than doubled during the last three centuries. Methane, which is currently increasing at a rate of 1% per year, is responsible for about 20% of current increases in commitment to global warming. There is considerable uncertainty about the sources of methane, and the observed increase is probably due to increases in a number of sources as well as to changes in tropospheric chemistry. Increases in agricultural sources, particularly rice cultivation and animal husbandry, have probably been the most significant factor, but emissions from landfills and coal seams could play an important role in the future. Of the major greenhouse gases only methane concentrations can be stabilized with modest cuts in anthropogenic emissions: a 10-20% cut would suffice to stabilize concentrations at current levels due to methane's relatively short atmospheric lifetime, assuming that this lifetime remains constant and that natural emissions do not change. Whether this is the case will depend on changes in tropospheric chemistry as influenced by emissions of hydrocarbons and carbon monoxide, among others, and on whether global climate change itself affects methane emissions.

Nitrous oxide. The concentration of nitrous oxide (N_2O) has increased by 5-10% since preindustrial times. The cause of this increase is highly uncertain, but it appears that the use of nitrogenous fertilizer, land clearing, biomass burning, and fossil-fuel combustion have all contributed. Each additional molecule of nitrous oxide has over 200 times as much impact on climate as additional molecules of carbon dioxide, and nitrous oxide can also contribute to stratospheric ozone depletion. Nitrous oxide is currently increasing at a rate of 0.25% per year, which represents an imbalance of about 30% between total emissions and total losses. Nitrous oxide increases are responsible for roughly 6% of current increases in commitment to global warming. Assuming that the observed increase in N_2O concentrations is due to anthropogenic sources and that natural emissions have not changed, then an 80-85% cut in anthropogenic emissions would be required to stabilize N_2O at current levels.

Halocarbons. Chlorofluorocarbons (CFCs), currently the most important halocarbons, were introduced into the atmosphere for the first time during this century. The most common species are CFC-12 (CCl_2F_2) and CFC-11 (CCl_3F), which had atmospheric concentrations in 1986 of 392 and 226 parts per trillion by volume, respectively. While these concentrations are tiny compared with that of CO_2 , CFCs have as much as 20,000 times more impact on climate per additional molecule and are increasing very rapidly--more than 4% per year since 1978. A focus of attention because of their potential to deplete stratospheric ozone, the increasing concentration of CFCs also represents about 15% of current increases in commitment to global warming. For CFC-11 and CFC-12, cuts of 75% and 85%, respectively, of current global emissions would be required to stabilize concentrations. However because of growth in other compounds, in order to stabilize the total greenhouse warming potential from all halocarbons, a phaseout of the fully halogenated compounds (those that do not contain hydrogen), a freeze on the use of methyl chloroform, and a limit on the emissions of partially halogenated substitutes would be required.

Other gases influencing composition. Emissions of carbon monoxide (CO) and nitrogen oxides (NO_x), among other species, in addition to the greenhouse gases just described, are also changing the chemistry of the atmosphere. This change in atmospheric chemistry alters the distribution of ozone and the oxidizing power of the atmosphere, changing the atmospheric lifetimes of the greenhouse gases. If the concentrations of the long-lived gases were stabilized, it might only be necessary to freeze emissions of the short-lived gases at current levels to stabilize atmospheric composition.

In preparing this report, EPA did not develop scenarios that achieve zero change in concentrations, instead we have focused on promising options that can significantly slow the rate of greenhouse gas buildup and climatic change.

GREEN DIPLOMACY

A cool look at hot air

The environment is the new stuff of diplomacy. In London this month diplomats will try to broaden the agreement to protect the ozone layer. Infinitely harder will be next year's negotiations on the greenhouse effect

AT ONE time, environment ministers and their officials stayed at home and worried about dirty rivers and smoky air. No longer. These days, they jet from city to city, haggling far into the night over clauses and sub-clauses, just like defence experts or trade ministers. For the past month, frantic efforts have been made to shore up the Montreal protocol, the 1987 agreement to curb the use of chlorofluorocarbons (CFCs) which damage the ozone layer. Should they fail, the outlook for any agreement to tackle the threat of global warming would be bleak.

In the past, countries made agreements to prevent a valuable species being hunted or fished to extinction. Recently, international environmental agreements have become more frequent; and green matters are no longer dealt with merely as side issues. Between 1930 and 1959 the United States put into force only a handful of such treaties, mainly on whaling. In the 1960s and 1970s the numbers rose to five per decade, as marine pollution and endangered species became prominent issues. In the 1980s the total was 11, of which four dealt with air and three with marine pollution.

To understand this increase, start with the main reason for environmental damage. Green resources, be they whales or clean air, often belong to nobody and everybody. That inevitably makes them more vulnerable to overuse. Because the seas belong to nobody, any country that unilaterally cuts its take of fish simply leaves more available for other, less virtuous nations who—in economists' jargon—profit as "free-riders".

In an individual country, the state typically steps in to prevent free-riding. The pea-soup fogs that at one time plagued London were caused by the smoke from coal fires. No individual householder had any incentive to burn smokeless fuel. Only in 1956, after a particularly dreadful fog, was a law brought in forbidding coal fires in certain areas—thus effectively banning free-riding.

Increasingly, the green issues that preoccupy people do not—as London fog did—fit into tidy national boundaries. Sometimes they affect a group of countries, as with the

pollution of the Rhine or with acid rain. Sometimes environmental damage threatens to harm most of humanity. That damage may be caused by a few countries—everybody loses something if Japan and Norway hunt whales to extinction, or if the rain forests burn. Or the damage may come from many sources, as with CFCs or global warming.

What, though, is to be done? There is no world government to pass the equivalent of Britain's 1956 Clean Air Act. Only through international agreement can countries decide not to inflict environmental harm on each other.

From Stockholm to Montreal

The concept of such agreements has its roots in the 1972 United Nations conference on the human environment. This Stockholm conference set up the United Nations Environmental Programme (UNEP), the body which has played the main part in green diplomacy. It also declared that "States have... responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other states or of areas beyond the limits of national jurisdiction." The idea that those who pollute should bear the cost of preventing environmental damage, or at least cleaning up after it, was adopted—also in 1972—by OECD countries, and tagged the "polluter pays" principle. In practice, international negotiations have quite often left not the polluter but the victim footing the bill, in order to get something done.

It was UNEP that developed the idea which has become central to environmental negotiations. One of its earliest exercises was to devise an agreement for the protection of the Mediterranean. When talks got stuck, UNEP came up with the notion of a framework convention, in which countries set out a few broad heads of agreement and ideas—on, say, sewage discharges or cleaning oil slicks—to be developed later in specific protocols. Such conventions typically also set out the machinery for future decision-making: the secretariat and how it

We polluters Net per head emissions* of greenhouse gases, 1987 tonnes of carbon



* Main three such gases (a) converted into their equivalent - in heating terms - in carbon dioxide, and then (b) measured as tonnes of carbon. Source: Heriot estimator from World Resources Institute, Washington DC

should be financed, how disputes should be settled, how voting rights should be allocated, and so on.

Thus with CFCs many governments at first felt there was not enough evidence linking them to ozone holes. So the first stage, the Vienna convention, signed in March 1985, was mainly an agreement to think more about the issue and to discuss future action. Talks on a protocol began in December 1986 and resulted, in March 1987, in the Montreal protocol, with its specific agreement to halve CFC production.

UNEP officials hope it will be possible to start negotiations on a climate-change convention at the end of this year, after a meeting in Geneva to consider the reports of an intergovernmental panel on climate change (IPCC). UNEP would like a convention ready by mid-1992, when Brazil hosts a meeting of world leaders to mark the twentieth anni-

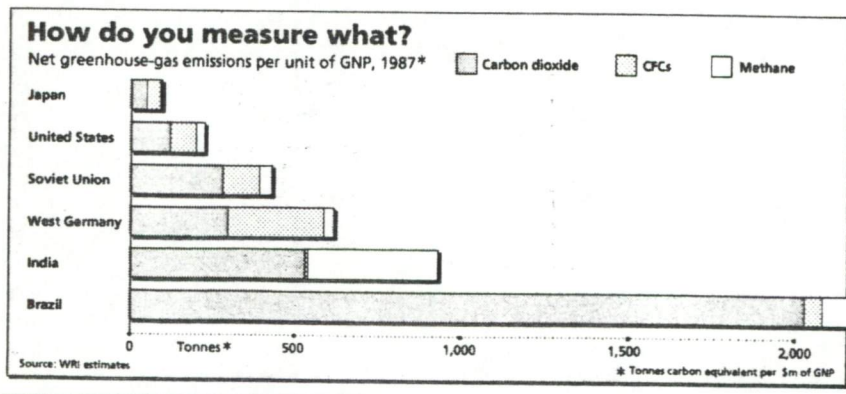
Pandora's gas-mask

GREENHOUSE negotiations will be bedevilled both by uncertain data and by the multiple sources of the trouble. In terms of heating effect, CFCs—potent sources of greenhouse—make up around 45% of West Germany's total emissions, 35% of America's, only 2½% of Brazil's. Methane (from fossil fuels, rice-growing and livestock) accounts for maybe 45% of India's emissions, 15% of America's, 5% of Japan's.

Or do they? These are just one set of heroic estimates for one year, 1987. Even

if everyone can agree on figures for a base year—which?—how should they be measured? Per head (most poor countries could ask why they should make any cuts at all)? Per unit of GNP (easier for the rich)? How should targets for cuts be set? Overall, or gas by gas? In percentage terms? The same for all? Should countries that would find cuts costly (eg, Japan) be able to meet their targets by paying for cuts in other countries (eg, Brazil)?

Only one thing is certain: the arguments could generate hot air for years.



versary of the Stockholm conference.

The groundwork for a climate-change convention has been prepared more thoroughly than for any previous environmental treaty. But it will still be hard to achieve, let alone by 1992. Some countries, such as West Germany, say they want to negotiate simultaneously on a broad convention and a specific protocol. The greener Scandinavian countries feel that a vague convention would look like procrastination. The Americans are too suspicious of even a general convention to start considering protocols. Some third-world countries will not start talking at all until they get assurances that any convention will offer them cash to help meet the costs of complying with it.

From Montreal to Brazil

The Montreal protocol on CFCs is the nearest thing to a dry run for a climate-change convention. It was a remarkable achievement. Governments agreed to steps to protect the environment against future dangers, the main evidence for which was not scientific fact but scientific speculation. They also committed themselves to targets before the technology to achieve them was available. But all this was made possible by special circumstances which may not be there with climate change.

One factor was growing scientific understanding of ozone depletion in the stratosphere. For more than a decade scientists

had suspected this; only in 1985, after the ozone hole over the Antarctic was actually observed and shown to have grown rapidly, did negotiations gather pace. A similar trend, from growing scientific consensus to clear evidence of damage, lay behind the change in West Germany's position on acid rain. Only in 1982, as German forests began to die, did West Germany come to support cuts in emissions of sulphur dioxide. With global warming, a scientific consensus of sorts emerged in the first IPCC report, published last month. But the uncertainties are still immense. It may need firm evidence that the world has already begun to warm to persuade countries to take climate change seriously. "Pray for another hot summer in America," says one negotiator.

The Montreal protocol was also helped by positive pressure from industry. In 1986 Du Pont, the world's largest producer of CFCs, announced that alternatives could be available within five years. In October 1988, even before America and the EC decided to go beyond Montreal and ban CFCs entirely, Du Pont announced that it would support such a ban by the year 2000. Six months earlier it had already said it intended to stop producing the most harmful CFCs altogether. ICI, the leading European producer, made a similar announcement.

Why was industry so helpful? Mr Scott Barrett, of the London Business School, argues that corporate good citizenship was

only one reason. The makers knew CFC would eventually be regulated anyway. So were they to sit around bleating, or get on with developing substitutes? Obviously the latter. But these would be costly to develop and higher-priced than CFCs. So the makers had an interest in an early, clear framework of regulation, applying to as many potential competitors as possible. No one wanted to pour money into alternatives and then find, say, Indian chemicals firms exporting cheap CFC-based products.

Climate change is unlikely to see this convergence between industry and government. CFCs are produced by a small number of companies worldwide, and have a narrow range of uses—air conditioning, refrigeration, cleaning electronic parts, foam-blowing. The producers of fossil fuels, the main source of man-made greenhouse gases, are legion; so are the users; and the fuels are far harder to replace.

The biggest difference, though, will be that of the scale and distribution of costs and benefits. As Mr Barrett points out, international agreements on the environment are rather like producer cartels. Countries or companies join cartels because the gains from acting together are greater than those from going it alone. But if co-operation from time to time demands large sacrifices, some will cheat and the cartel will eventually collapse. OPEC pushed up the oil price on the back of strong demand; once demand fell and big production cuts became necessary to prop up prices, some producers preferred to free-ride.

In the case of CFCs, the gains to countries from co-operating were clearly greater than those from acting alone. And the benefits of avoiding ozone depletion are both reasonably well defined and well distributed: no one country or group of countries stands to gain much more than others. Nor are the costs of cutting CFCs vast: witness the many countries that had acted on their own even before the Montreal protocol, and the large number—56—that have already signed it.

With global warming, few of these points hold true. If the doomsters are right, the gains from international action would indeed be huge, far larger than any one country could achieve on its own behalf. But the costs too would be huge. The benefits, in contrast, are uncertain and far off. And they are likely to be unevenly distributed. Ozone depletion threatens all nations with an increase in cancers, like a kind of worldwide Chernobyl. Global warming may or may not have various climatic effects in various places, but no one yet agrees what or where; and for some nations they could be beneficial. While Bangladesh vanishes under the sea, other countries may find they can grow grain where grain never grew before.

So a climate convention will not be easy to reach. The Americans, the Russians, China and Saudi Arabia, to name no more,

GREEN DIPLOMACY

are dragging their feet. Some countries will prefer to be free-riders rather than sign. Some that expect to gain from global warming may not even consider signing.

Targets and payments

The prospects of agreement may yet be better than this analysis suggests. For comfort, look at the case of acid rain. Countries that emit lots of sulphur dioxide and nitrous oxides, the causes of acid rain, may suffer little either from their own emissions or from those of other countries. Yet two such countries, Britain and the United States, have both, in the past few years, agreed to cut these emissions. Old-fashioned morality has played a part. So has shame. So, more interestingly, has a sense that there may be offsetting gains elsewhere, in trade, defence or other environmental negotiations.

That offers one clue to getting potential free-riders to sign up. Don't ask them to be too virtuous, and compensate them for the costs that they incur. In practice, only poor countries can hope for compensation. But all signatories, of course, must be set standards of virtue. These will be two big issues of negotiations on climate change. Just who should be how virtuous? And how are third-world signatories to be compensated?

The Montreal protocol allows developing countries easier CFC limits than rich ones, and a ten-year grace period to meet them, but makes no distinction among the rich. Things will be harder with greenhouse gases. Already Britain has announced a later date for stabilising its emissions (2005) than fellow-EC countries (2000). Energy-efficient countries (like Japan) will be reluctant to make the same percentage cuts as inefficient ones (like the United States). Nor can third-world countries all be treated alike. One or two, such as Brazil, with its burning forests, send up greenhouse gases on a first-world scale; others produce little. It will be hard to agree even on figures of who emits how much—the calculations are complex—let alone on how much each should cut.

Agreement on compensation for the third world may prove harder still. The Montreal protocol demonstrates the risks here. Last autumn the UN passed a resolution calling for "new and additional" money to help third-world countries become greener. Faced with a specific demand to put up new money for a fund to help them replace CFCs, the Americans two months ago refused. Other first-world signatories were aghast (or tried to look it: several, including West Germany and Britain, may in fact quietly siphon their contributions out of existing aid budgets). Two of the third world's three biggest potential emitters of CFCs, India and China, have not signed the protocol, and will not do so without a promise of cash. The third, Brazil, has signed, but says it will back out unless the cash is enough.

Mr Mostafa Tolba, the canny Egyptian

head of UNEP, argues that the amount of cash needed is modest. One estimate made for UNEP puts the extra cost to the third world of using CFC substitutes at \$1.8 billion (in present-value terms) from 1990 to 2008; and maybe much less, if the cost of substitutes falls fast as the market grows. In addition there would be the capital costs of conversion in user industries. Two estimates here suggest around \$200m over 1991-93, with \$20m more for things like retraining. Premature closure of CFC-producing plants might cost \$150m, mostly after 2000.

One estimate suggests an annual budget for the fund of \$240m-300m in its first three years. That is not much. But the Americans see this as a precedent. Though payments would be tied to measures to replace CFCs, they would be a departure from the polluter-pays principle: crudely, a bribe to discourage free-riding. Bribery may prove the only way to achieve that, but it is risky. At which countries, and at what sums, would it stop?

The idea is not, in fact, unprecedented. In Eastern Europe, payments by the victims will soon be common. Already Sweden helps Poland with technology to prevent acid rain, and other West European countries are considering similar arrangements. They reckon that a dollar spent in Eastern Europe buys far more improvement in air quality than one spent at home. Other conventions too will require side payments. If a convention on the preservation of biological diversity is to persuade countries with rain forests not to destroy them, Brazil will want cash. The possibilities of abuse are evident. Canny third-world countries will see in the environment a new source of first-world cash. Yes, they will promise, we will be good greens—but only at a price.

With the fossil fuels involved in the greenhouse effect, the boundary between meeting the costs of compliance and straight

bribery will be even less clear than with CFCs. Should China, for instance, be compensated for not burning its coal? If so, by whom? First-world signatories to the Montreal protocol are arguing over whether contributions to the proposed fund should be levied on the usual UN formula, related to national wealth, or on a basis of CFC emissions. With CFCs the rival formulae produce similar answers. Not so with carbon dioxide.

In any event, America would be the largest payer. The White House already thinks that the economic costs of a serious attempt to cut greenhouse gases could far outstrip the benefits. Add the budgetary costs of helping the third world to cut its emissions, and the sums look still more alarming.

Even trickier may be the question of technology transfer. Third-world countries want assurances, even before they start haggling, that they will have access to first-world technology to cut their emissions. First-world governments protest that technology transfer is not as simple as some poor countries pretend—and anyway companies' intellectual property is not theirs to dispose of.

A modest start

Because the costs of coping with climate change are so great, the best hope of success will be in those areas where benefits are greatest and most evenly distributed. That might mean a series of specific agreements on research, say, or on energy conservation. Where the costs of action are lowest—as with energy conservation—the temptation to free-ride also will be low. A limited group of countries, such as the EC or the OECD, might therefore take joint action without waiting for the rest of the world. Such modest steps would be less impressive than a global "law of the atmosphere". But they are more practicable. And they would be a start.



We should make cuts?

- cont.

No cooling was apparent, however, which prompted Angell's study. He found that the warming effect of El Nino swamped the cooling from the volcanoes in the original record. When the El Nino warming is deleted the volcanic effects become much more obvious, he explained.

The El Nino is named with the Spanish word for the Christ Child because it was first noticed by South American fishermen and generally occurs around Christmas time.

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^Japanese Professor Demonstrates Hydrogen-Powered Car<

^By DAVID GROSS=

YOKOSUKA, Japan (AP) - A Japanese professor who has built a car powered by highly volatile liquid hydrogen demonstrated the vehicle Thursday and said it causes almost no air pollution.

Industry officials said, however, it may take 10 years to produce a commercial version of the car, developed by Shoichi Furuhashi, president of the Musashi Institute of Technology.

The car's liquid hydrogen fuel is made from water and costs \$22.80 a gallon in Japan, officials said.

In a test drive Thursday, the car, known as the Musashi B, reached a speed of 82 mph. Test drivers at Nissan's Uppama factory, near Tokyo, said they believed the Musashi B could reach a speed of 94 mph.

The car does not backfire before combustion, a defect that has slowed previous research on hydrogen-fueled cars, Furuhashi said. It has computer-run pumps and valves that keep the liquid hydrogen at minus 453 degrees.

Furuhashi said the car creates almost no air pollution.

The engine is in a Nissan Fairlady Z body. Nissan has provided financial support and technical assistance to Furuhashi's research team.

But the new vehicle still has many problems, its developers said.

Liquid hydrogen is extremely volatile and engineers are concerned about the dangers of explosion in a crash. Furuhashi said the difficulty of obtaining liquid hydrogen has prevented scientists from thoroughly studying its safety.

A researcher working with Furuhashi said on condition of anonymity the car also must carry a large volume of fuel. Hydrogen cars sometimes have been jokingly referred to as "cars which carry fuel and not passengers," he said.

Yasuhiko Nakagawa, a researcher at Nissan's Central Engineering Laboratories, said the fuel mileage is also not as high as for conventional vehicles.

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The Houston Summit: Wrangling Threatens Unity

Europeans Accuse the U.S. of Balking on Plans to Combat Global Warming

By **ROBERTO SURO**
Special to The New York Times

A10

HOUSTON, July 9 — Senior European officials at the economic summit conference accused the United States today of frustrating their efforts to reach a new accord to combat global warming.

The European officials, including members of the British, French and Italian delegations who asked not to be identified, angrily complained that John H. Sununu, the White House chief of staff, had taken the leading role in organizing American opposition to the global warming initiative.

Asked at a news briefing this morning why the United States was resisting a West German proposal to set a target for reducing gases that cause global warming, Mr. Sununu replied, "The issue is being addressed with a level of haste." He added, "There seems to be some propensity to deal with the issue without putting all the data on the table."

Kohl Asks 'Radical Measures'

In a letter sent to summit leaders last month, Chancellor Helmut Kohl of West Germany called for "internationally binding regulations with 'radical measures to limit' gas emissions that contribute to the greenhouse effect.

Chancellor Kohl said: "We must view the threat of climate change as a global challenge to all mankind. The world expects the seven summit countries to come up with far-reaching, specific proposals."

Mr. Sununu insisted today that the Bush Administration had endorsed limits on some emissions through the Clean Air Act, but he opposed new emission limits, contending that they would require major changes in the American way of life and the nation's industrial structure.

He noted, for instance, that because the United States was much larger than Japan or any of the European nations it had a greater reliance on cars and trucks to transport people and products.

Commenting on Mr. Sununu's posi-

A letter from Kohl sees a global challenge.

Sununu sees 'a level of haste.'

tion, James T. B. Tripp, general counsel of the Environmental Defense Fund, a Washington-based advocacy group, said, "These statements may serve to explain why United States per capita consumption of fossil fuels is so high compared to Western Europe and Japan, but they are not legitimate excuses for United States refusal to limit carbon dioxide emissions and take steps to use energy much more efficiently."

Although President Bush has mustered allies to support his views on the two other major issues being addressed at the summit talks — aid to the Soviet Union and international trade — he now stands alone on the third area of the agenda, the environment.

Pledges Made by Others

As the summit meeting's official sessions began today, European officials worried that the United States would block their effort to win a commitment to stabilize and then reduce emissions of carbon dioxide and other gases that contribute to the greenhouse effect. Many scientists believe that these gases trap heat from the sun that would otherwise escape back into space. The trapped gases then produce

a gradual warming of the earth's atmosphere.

Except for the United States, all the industrial nations represented at the summit meeting have now pledged to stabilize greenhouse gas emissions, at least by early in the next century.

Even Britain and Japan, which formerly sided with Washington in insisting that more scientific and economic information was needed before taking action, are developing plans to reduce carbon dioxide emissions. West Germany has taken the lead, with a goal of reducing such emissions by 25 percent in the next 15 years.

President Bush's apparent determination to block a global warming initiative at this summit meeting stands in sharp contrast to his embrace of major environmental commitments at last year's economic summit talks in Paris.

In the final communiqué of that meeting, the national leaders declared that "decisive action is urgently needed to understand and protect the earth's ecological balance."

'Common Efforts' Urged

On the issue of global warming the communiqué stated, "We strongly advocate common efforts to limit emissions of carbon dioxide and other greenhouse gases, which threaten to induce climate change, endangering the environment and ultimately the economy."

Even as the summit delegations began gathering here this weekend, European officials hoped that the Houston talks would build on the rhetoric of the Paris communiqué. But at a meeting Sunday night American officials raised a series of paralyzing objections, a European participant said.

"We had thought we were making progress," the European official said today, "but at last night's meeting it was discouragingly obvious that Sununu was back in the ascendancy, and the United States was yielding nothing."

European officials said that the first sign that President Bush would resist a global warming initiative came when William K. Reilly, the administrator of the Environmental Protection Agency was left behind in Washington. Mr. Reilly was a prominent member of the Bush delegation to the Paris talks.

In Mr. Reilly's absence the role of chief adviser on environmental matters has been assumed by Mr. Sununu, who has publicly disagreed with Mr. Reilly on assessments of environmental dangers. At the news briefing this morning, Mr. Sununu rejected the kind of joint commitment to specific limitations on gas emissions that the West Germans among others are pressing the meeting to adopt.

He said, "There is a concern that this idea of a permanent cap in perpetuity does not understand not only our growth needs, but the growth needs of the developing countries of the world."

He added, "so what we are seeking is a commitment that is broader, a commitment that would allow both the industrialized countries and the developing countries to address the broad issue of greenhouse gases without picking them one by one, setting caps on them individually."

OPEC Output Slipped in June

NICOSIA, Cyprus, July 9 (Reuters) — Oil output of the Organization of Petroleum Exporting Countries fell by 420,000 barrels a day in June, to 23.26 million, mainly because of a sharp drop in Iranian production, the Middle East Economic Survey said today.

The Nicosia-based newsletter said Iran's output in June fell by 500,000 barrels a day, to 2.9 million, from 3.4 million in May, below the OPEC quota assigned to Iran of 3.14 million barrels a day.

The survey said production by Kuwait, which has an OPEC quota of 1.5 million barrels, fell by 50,000 barrels in June, to 1.7 million. The United Arab Emirates, another purported violator of its quota, was reported to have cut its output by 100,000 barrels, to 1.95 million.

Saudi Arabia's daily production in June rose to 5.2 million barrels from 5.1 million in May, still well below its quota of 5.335 million, while Iraqi output remained steady at its May level of 3.15 million barrels a day, the newsletter said.

Oil Production By Venezuela

CARACAS, Venezuela, July 9 (Reuters) — Venezuela's state oil company Friday announced plans to increase production capacity nearly 50 percent in the next few years, despite a world oil glut that is driving prices down.

Petróleos de Venezuela S.A. plans to invest \$8 billion in exploration and development programs to bring production capacity up to 3.65 million barrels a day by 1993, the company's president, Andrés Sosa Pietri, said.

Petroleum industry analysts said Venezuela currently has a production capacity of about 2.5 million barrels a day.

The company planned to increase actual production to 2.7 million barrels a day by 1993 and to 3.1 million by 1995, up from an average of 2.02 million barrels a day in the first quarter of this year, and up from the 1.9-million-barrel-a-day quota set by the Organization of Petroleum Exporting Countries.

ENVIRONMENT

Fighting the Greenhouse

And you don't have to freeze in the dark to do it

Of course you know what it will take to save the world from the greenhouse effect. To cut emissions of carbon dioxide—the gas released when coal, gas or oil burn and the one responsible for more than half of the impending global warming—you'll have to turn down the heater in winter and break out the long johns. In summer, don't even *think* of air conditioning. Chuck your 100-watt bulbs, screw in 40s. Trade in the dishwasher and clothes dryer for a dish drainer and laundry line.

But wait. Human nature being what it is, scientists realize that if we depend on a penchant for sacrifice to forestall the greenhouse effect, we might as well start building sea walls to hold back the waters that will rise along with the thermostat. Surveys show that only about one fifth of those questioned would keep their homes warmer in summer or chillier in winter to help the environment. Luckily, though, conservation 1990s style doesn't mean freezing in the dark. From superwindows that leak no heat to fridges that work like giant Thermos bottles, "there is a host of technological changes we can make that will let us keep the amenities we're used to," says Eric First of Oak Ridge National Laboratory.

Last week the World Resources Institute announced new data that suggest the greenhouse threat is more serious than had been realized. Forty million to fifty million acres of tropical forests are disappearing each year, said WRI—50 percent faster than earlier satellite photos showed. Defor-

estation is second only to the burning of fossil fuels as a source of carbon dioxide (CO₂). Even without the new data, an international panel convened at the urging of the Bush administration, and 38 other countries concluded last month that global warming will raise sea levels enough to inundate the plains of Holland and Bangladesh and obliterate the Maldives, among other disasters. It called for a 60 percent cut in CO₂ emissions. Conservation is the cheapest and fastest way to do that, at least until solar and wind power, which emit no CO₂, are widely available. Efficiency alone, calculates Christopher Flavin of Worldwatch Institute, could cut global CO₂ emissions 3 billion tons a year by 2010, from today's 5.6 billion.

Nations might start with that symbol of energy profligacy, air conditioners. They

use hydrochlorofluorocarbons (HCFCs) as the cooling fluid, and indirectly release CO₂ when electricity to run them is generated. HCFCs and CO₂ are greenhouse gases. But plug-in cooling needn't turn up the global thermostat. A model patented last year by Albers Technologies Corp. of Arizona cools air to 54 degrees Fahrenheit, dehumidifies it and removes contaminants. It uses water, not HCFCs, and draws half the electricity of conventional units. At \$2,000 for a unit big enough to cool a 1,500-square-foot house, it costs about the same as current models. No American makers have expressed an interest—they don't want to fiddle with their product unless the government bans

HCFCs. But last month a Saudi Arabian firm, Alessa Industries, agreed to turn out 25,000 every year beginning in 1992—and export 20,000 back to the United States.

Other breakthroughs are as close as the nearest window. During the winter, windows in the United States leak about as much heat as is provided by the oil flowing through the Alaskan pipeline every year. Researchers led by Stephen Selkowitz at the Lawrence Berkeley Laboratory in California can fix that with a "superwindow." It has three layers of glazing and two coatings of metal oxides that cut heat loss; the space between the panes is filled with krypton and argon gases. Result: the window collects more heat on a winter's day than it leaks at night. Superwindows today cost about 30 percent more than moderately efficient ones; even better versions are about to leave the lab. This week Libbey Owens Ford will introduce special glass coatings that allow sunlight to penetrate better than it can through plain glass, providing low-tech solar heating to a room. And LBL is working on a "smart window" that changes electronically from clear, which allows sunshine in on cold days, to reflective, which diverts rays on scorches. Similar chameleonlike glass for car sunroofs can keep out enough sunshine to drastically cut the need for air conditioning, and should be in models next year.

Best bulbs: Researchers also have bright ideas for lighting, which accounts for almost 25 percent of U.S. electricity use. Replacing standard incandescents with the best bulbs, compact fluorescents, can cut electricity use by as much as two thirds. Last year Reno's Peppermill Hotel Casino

installed about 1,000 fluorescents, and halved its lighting bill. Although fluorescents can cost 20 times as much as incandescents, they last 10 times longer, saving the consumer money, and emit light indistinguishable from incandescents. Since fluorescent bulbs draw less electricity, substituting one for an incandescent prevents the emission of up to 382 pounds of CO₂ that would otherwise be emitted from power plants (table). Other gizmos helped the

Energy: Just Say No

Using energy more efficiently, whether you're driving or keeping a six-pack frosty, cuts emissions of CO₂. It also saves money.

ITEM	EXTRA COST AT PURCHASE	TIME TO PAY BACK	CARBON SAVED
Refrigerator	\$30	1.5 yrs.	180 lbs.
Car	\$500	3 yrs.	800 lbs.
One fluorescent lightbulb	\$7	1 yr.	223 lbs.

SOURCES: HOME ENERGY, RICHARD HEED, ROCKY MT. INSTITUTE

Natural Resources Defense Council cut its office energy bill by more than half: occupancy sensors use infrared or ultrasonic signals to detect motion, turning lights off when no one is in the room. Because of such savings, Amory Lovins of the Rocky Mountain Institute says, "this is not a free lunch. This is a lunch you are paid to eat."

Even refrigerators can help stave off the greenhouse. In today's models, a single unit lowers temperatures in the freezer and moves chilled air to the fridge—which doesn't need to be as cold. At Oak Ridge, researchers think that using different mixes of coolants and separate cooling loops could offer energy savings of an additional 20 percent. And by replacing the CFC insulation with vacuum insulation as in a Thermos, refrigerators wouldn't need CFCs.

Electric utilities have led the charge toward energy efficiency partly from environmental concern, but largely because of the bottom line: it costs 30 to 50 percent less to cut demand for power than to build new generating capacity. Wisconsin Power Co. offers rebates for installing efficient refrigerators; Southern California Edison will pay customers to install more efficient windows. New England Electric offers rebates to lighting dealers so they will lower the price of fluorescents; it has also insulated more than 100,000 customers' hot-water tanks for free. CEO John Rowe says, "Conservation is the heart of our environmental strategy." But, only 10 states let utilities earn a return on investments in efficiency, hampering widespread adoption.

In the cold: For next year the administration is requesting \$213 million for the Department of Energy's conservation research, which now receives \$411 million. The White House questions whether the

World

Cont'd

United States will suffer from global warming, and therefore opposes making possibly expensive changes to control the greenhouse. But in a significant break with this wait-and-see policy, Prime Minister Margaret Thatcher last month announced that Britain would cut CO₂ growth 20 percent by 2005, stabilizing it at 1990 levels, if other nations follow suit. How? Heavy reliance on energy efficiency is a likely option. "You can cut carbon emissions 20, 30 percent without any economic cost," says Michael Grubb of the Royal Institute for Economic Affairs. Bringing all homes up to the latest standards for insulation, for example, would cut emissions nearly 9 percent, estimates Stewart Boyle of Britain's Association for the Conservation of Energy. This week the West German cabinet is expected to consider a proposal to cut carbon emissions 30 percent by 2010. Increasingly, as the world grapples with the uncertain threat of the greenhouse, the United States is being left out in the cold.

SHARON BEGLEY with DANIEL PEDERSEN
in London

end

Cruz County, have similar programs, as do Minnesota, South Dakota and Wisconsin. And last year, San Francisco became the nation's first city to impose similar energy standards on commercial real estate.

In Newton, Massachusetts, city officials are saving energy by replacing light bulbs. Republican Mayor Theodore Mann says that by simply replacing all the light bulbs in city buildings with fluorescent ones that use less energy, Newton will save \$200,000 a year in electricity bills.

The mayor also wants to expand the environmentally wise choices that residents can make and says that local grocery chains have expressed interest in his proposal that they copy a Canadian idea and create "green aisles" that carry items that do less damage to the environment—with biodegradable or minimal packaging, for instance. Not only that, Newton is literally becoming "greener." City officials bought three tree farms and are busy planting trees to help absorb carbon dioxide, the most harmful of the greenhouse gases, and make the city more attractive at the same time.

There are, however, limits to what a city can do. Newark's Sharpe James observes, for example, that while a recycling program keeps a lot of bottles out of the waste stream, requiring a deposit for bottle return would be even better. That is not, however, something the city can do alone. A bottle deposit bill in Newark would simply encourage shoppers to get their sodas and beer in the nearest town without a deposit. "It's just not in the interest of a city or a county to do it," says the mayor. "On some of these issues, we're going to have to win at the state level."

A more powerful illustration of the limits of local power relates to automobiles, the largest producers of carbon dioxide. Newark did convert some of the city's vehicle fleet to use propane, which burns cleaner than gasoline, but with few gas stations selling propane, the cars often burn extra fuel getting to those stations.

One way to reduce auto emissions is to toughen "tailpipe standards" that directly regulate what cars can emit. California is already taking this step, and it will soon be joined by a number of northeastern states. Another way is to provide economic incentives at the consumer level for production of more fuel-efficient automobiles. That means increased taxes, either on the cars themselves or on the fuel they use.

It is an idea a lot of states are pondering. In Connecticut, Democratic Representative Mary Mushinsky is proposing, for the second year in a row, precisely these two ideas. As part of a comprehensive energy bill, she wants to increase the state sales tax on gas guzzlers and the excise tax on auto fuel. Mushinsky is the first to admit that these proposals played a big part in defeating the bill last year, but she concludes, "It would not have been intellectually

A lot of states are pondering reducing auto emissions by increasing taxes on the cars themselves or on the fuel they use.

honest not to address cars."

In California, an initiative still in the signature-gathering stage, but expected to be on the ballot in November, would require the state to develop a plan to reduce carbon dioxide by 20 percent, from 1988 levels, by the year 2000 and by 40 percent by 2010. Although the initiative doesn't specify

whether the reductions would come from cars or industrial sources, a reduction that large would be expected to include both.

While Americans are loathe to pay more taxes for the privilege of driving their cars, two things are happening that may give proposals like these some political help. The first is that politicians are now linking the fuel efficiency proposals with other public concerns, such as traffic congestion and smog. The second is that a new idea, called calculating the "external cost" of energy use, is catching on. Simply put, it means figuring how much society pays to deal with the environmental damage caused by producing energy—not just the direct costs of bringing the energy to the consumer. Thus, a user of a gallon of gas should pay not only for the cost of refining and marketing the gas but also for rectifying the environmental harm.

In Missouri, Democratic Representative Karen McCarthy heads a study commission charged by the legislature to examine these external costs and recommend what Missouri can do to mitigate global warming through changes in its energy, agricultural and industrial policies. The commission, made up of politicians, environmentalists, educators and industry leaders, is trying to come up with ideas that will make economic sense and environmental sense. It is to report by the end of the year.

A state that has already plunged into the environmental policy arena is Vermont. In 1987, it banned the use of polystyrene made with chlorofluorocarbons. Last year, it passed legislation banning, by 1993, the sale and registration of cars that have air conditioners that use CFCs in their coolants. Also last year, Democratic Governor Madeleine M. Kunin issued an executive order requiring state officials to come up with a comprehensive energy plan by January 1991. The goal of the plan is to reduce energy use in the state 20 percent and greenhouse gases 15 percent by the year 2000.

The governor says that these actions were taken in response to citizens' concerns. And Kunin, too, thinks that this kind of public policy makes good politics. "There are higher expectations of government," she says. "Government used to provide for the health and safety and welfare of its people. . . . Now that includes the environment."

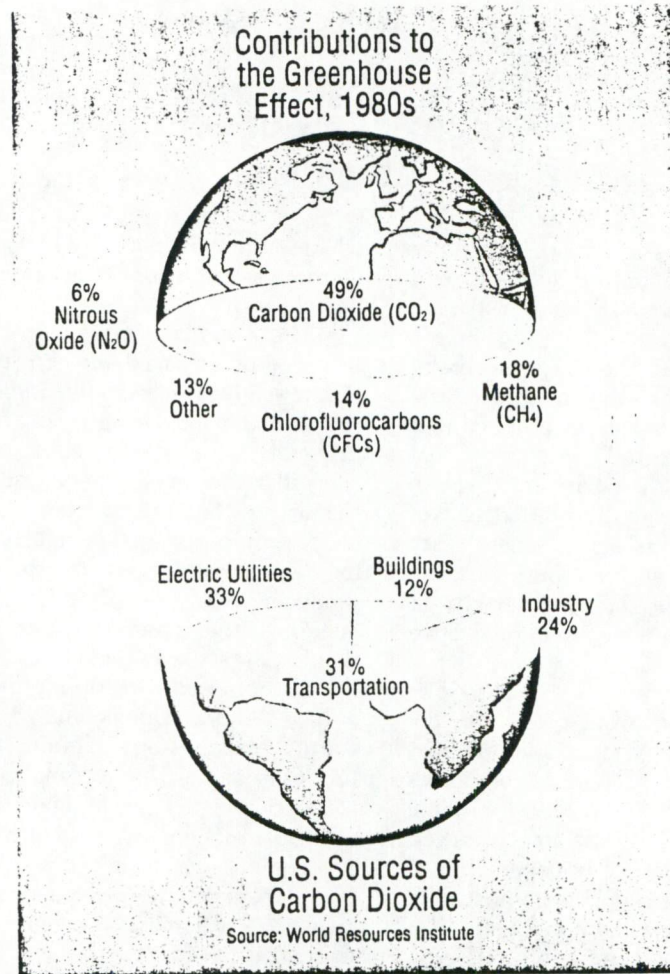
The new environmental awareness was the reason for celebrating the first Earth Day, in 1970. It contributed to the enactment of landmark legislation to provide federal standards for clean air and clean water. This April 22, the 20th anniversary of Earth Day will be much more a celebration of state and local initiatives and the new role of state and local officials as environmental activists. □

THE VILLAINS IN THE GREENHOUSE EFFECT

The "greenhouse gases" got their name from the "greenhouse effect" they create when they accumulate in large amounts: They act like the glass panes of a greenhouse, preventing heat from escaping from the earth's atmosphere.

The gases are for the most part the product of human activity. These gases—which include carbon dioxide, chlorofluorocarbons, halon, methane and nitrous oxide—are created through the combustion of fossil fuels in automobile engines and in manufacturing, from refrigeration and air conditioner use, and from the disposal of solid and liquid waste.

The most significant contributor to the greenhouse effect is carbon dioxide, which is normally a harmless and colorless gas that is not considered a pollutant. When it reaches the earth's upper atmosphere, however, it accounts for about half of the greenhouse effect. Carbon dioxide is one of the byproducts of the combustion of fossil fuels—coal, oil and natural gas. The biggest users of those fuels are, in descending order, cars, factories,



electric utilities and homes.

Next on the list, accounting for about 15 percent of the greenhouse effect, is a group of synthetic gases called chlorofluorocarbons. CFCs are used as coolants in refrigerators and air conditioners, and in the production of some plastic packaging material. In addition to being greenhouse gases, CFCs also contribute to the breakdown of the ozone layer, which filters out deadly ultraviolet radiation, when they reach the stratosphere. For that reason, CFCs were banned for use as the propellant ingredient in aerosol sprays in the United States in the mid-1970s.

Another synthetic gas, called halon, often used in fire extinguishers because of its ability to smother electrical fires, has a similar greenhouse effect.

The other greenhouse gases include methane, which is a naturally occurring gas associated with the microbes present in cattle and in rice fields, and nitrous oxide, which is produced by fossil fuel combustion and also is released by nitrogen fertilizers.

—K.S.

Newark economy.

Now, interest is growing in other ways to reduce the gases that contribute to the greenhouse effect. On Earth Day, Newark will become the second U.S. city, after Irvine, California, to ban the manufacture and use of all compounds that deplete the planet's protective ozone layer. It also will require that local refrigeration, air conditioning and fire extinguisher repair services recycle all of these compounds, rather than releasing them into the air in the course of repairing machinery.

Other cities have chosen different approaches to reduce greenhouse gas emissions. Energy conservation works because it reduces the need for burning fossil fuels. And chilly San Francisco has one of the best energy conserva-

tion programs in the country. Since 1983, the city has required property owners to make their residences more energy efficient. When a piece of real estate is sold there, it must be certified as energy efficient, and the cost of bringing the property up to standard is paid by the seller. The residential requirements include attic insulation, weatherstripping on outside doors, insulating blankets on hot-water heaters and insulation on heating and cooling ducts.

In the first five years, says Terry O'Sullivan of the city's Public Utility Commission, about one-fifth of the city's residences changed hands, resulting in an estimated savings of \$5 million in energy costs. A number of other local governments, including neighboring Berkeley and Santa

U.S. Urged to End Opposition to Ozone Aid

By PHILIP SHABECOFF

Special to The New York Times

WASHINGTON, June 12 — The head of the United Nations Environment Program strongly urged the United States today to reconsider its decision to oppose new financial aid to third-world countries to help them phase out chemicals that are destroying the earth's ozone layer.

The official, Mustafa K. Tolba of Egypt, executive director of the program, said that if the industrialized countries failed to provide the economic and technical help required by the third-world nations, the "global bargain" to protect the earth's envi-

ronment would fall apart.

He said he was optimistic that the United States would change its position before a meeting in London this week called to strengthen an existing international treaty to protect ozone in the atmosphere from being destroyed by chlorofluorocarbons and other industrial chemicals.

But at a Senate Foreign Relations Committee hearing today, Secretary of State James A. Baker 3d reiterated that the Administration preferred to use "existing resources" to help the third-world countries adhere to the ozone treaty.

Opposition to providing additional money to help the third-world countries phase out the offending chemicals originated with Richard G. Darman, director of the Office of Management and Budget, and John H. Sununu, the White House chief of staff, Administration officials said.

While the American contribution would only be about \$20 million, the White House officials reportedly feared that providing such additional funds would open the door to broad demands by those countries for assistance in solving their environmental problems.

The Bush Administration wants such aid to be provided from existing funds

from the World Bank or other international lending institutions. The Administration also opposes the creation of a new fund at the World Bank for environmental programs.

Legislation has been introduced in Congress that would require the Government to contribute funds to help the poorer countries protect the ozone layer.

In a speech at the National Press Club today, Dr. Tolba called for a ban on the chemicals destroying the ozone layer when the nations gather in London this month. Under a protocol signed in Montreal in September 1987, those who agreed to the treaty committed themselves to a 50 percent reduction in the production and use of the chemicals by the end of the century.

Since then, new scientific information has shown that the destruction of the ozone layer is proceeding even more rapidly than previously recognized. A thinning ozone layer permits more ultraviolet radiation from the sun to penetrate to the earth's surface, causing skin cancer and cataracts in humans and harming crops and wildlife.

Dr. Tolba also said today that he expected the international community to adopt a treaty "with teeth" to address the global-warming problem when it gathers at a conference in Brazil two years from now.

Carbon dioxide, chlorofluorocarbons and other industrial and agricultural gases are accumulating in the atmosphere and, by trapping radiation from the sun, will cause the earth to warm substantially in the next century through a process called the greenhouse effect, many scientists believe.

Despite some lingering skepticism about the scientific issues surrounding the greenhouse effect, Dr. Tolba said, "we are moving toward a truly global consensus on the need for action and action now."

Although the Bush Administration has been stressing the need for more information about the scientific and economic implications of a global-warming treaty, "the United States, I am sure, will not block unanimity" but will meet "its responsibilities toward its own people and the world at large," he said.

At the luncheon, which was sponsored by the World Resources Institute, the United Nations official also emphasized the need for a treaty through which the nations could cooperate to preserve the world's biological diversity.

So what does Schelling's game-theoretic perspective suggest about the global warming debate? The prospects are not good, says Schelling, if you aim to prevent it from happening. Any nation that attempts to mitigate changes in climate through unilateral action pays the cost alone, he says, while sharing the benefits with the rest of the world—and the benefits might not be all that great. If the United States decided to cut its fossil fuel use by a third over a 20-year span, for example, at a yearly cost of something like \$150 billion to \$200 billion, the result would be a mere 10 percent decline in the world's carbon dioxide emissions—and that only if other countries did not increase their emissions. Much more significant effect could be accomplished if China, the Soviet Union and the United States agreed to give up the use of coal, but Schelling thinks the chances of a global fuel compact are remote today.

But then he brightens. "What difference does climate change make, especially if it comes slowly? The interesting thing is that, to a first approximation, it isn't going to make any difference, at least to advanced countries, where there's hardly any economic activity that's terribly affected by the weather. Of course agriculture is, but agriculture is only 3 percent of GNP [gross national product]. So if agriculture costs went up even by a third, a 1 percent reduction of real GNP—taking place over the course of a century, a period in which personal income would probably double anyhow—would scarcely be noticed. Then if you look at what it's going to do to human health and human comfort and recreation, even extinction of species, it's very hard to identify. . . .

"Now this may not be true for developing countries, where they are much, much more dependent on food production and where they may have much less margin for adaptability. This leads me to conclude that the countries that can afford to do something about it—maybe Western Europe, the United States, Japan and a few others—probably won't be able to identify a powerful national interest, not when it's time to talk about our president putting a dollar-a-gallon tax on diesel fuel and gasoline. And the countries where probably the most might need to be done, like India and China, the countries that are already very inefficient consumers of fuel, are probably going to become bigger and bigger consumers of it. They probably won't and shouldn't do anything to curb greenhouse emissions, unless somebody else pays for it. I think eventually it will get around to that—but it will take 20 years instead of two years."

David Warsh is a columnist for the Boston Globe.

Cleaning Up on the Environment

Pollution Control Provides Investment Possibilities for the '90s

By Thomas Watterson
Boston Globe

After all the hoopla about Earth Day 1990 has faded, some people will still be cleaning up—if they put their money in the right place.

Pollution-control and environmental management will be "the growth industry of the '90s," said Remy Fisher, a vice president and analyst with J.W. Seligman & Co., a New York brokerage. While several new "environmental" mutual funds have started up in recent years—and faced some charges of opportunism—there are indeed good opportunities for investors interested in the environmental management industry who want to buy some of its stocks on their own.

The choices can include companies that own and manage landfills, recycling companies, businesses that make air- and water-filtration equipment for smokestacks and drainage systems, companies that clean machinery and tools, and even some of the firms that pick up your garbage. Stocks generally mentioned favorably by analysts include such well-established companies as Waste Management Inc., Calgon-Carbon Inc., Wheelabrator Technologies, Safety-Kleen Inc., Metcalf & Eddy, Laidlaw Inc. and Wahlico Systems.

The stocks are favored because spending by corporations and government on environmental control "is definitely going up," Fisher said. "And it's not just solid waste and hazardous materials. It's medical waste streams, acid rain, a lot of things."

With sound fundamentals and a consistently high record of growth, the industry ought to be able to weather any oncoming recession fairly well, analysts believe. "I would say it's one of the recession-resistant businesses," Fisher said.

But investors expecting to make a quick killing in garbage could be disappointed, analysts say. With long lead times for regulatory approval, difficulties in overcoming the not-in-my-back-yard problem and the time it is expected to take for more industries and consumers to make waste management and recycling a major



force in the economy, the payoff from some of these stocks could take awhile.

Also, publicity about the environment has pushed up some stocks to the point where they are a bit overpriced now, although that could be corrected before too long.

"It does require a longer-term approach," said Elliott Schlang, a vice president with Prescott, Ball & Turben Inc., a Cleveland brokerage. "But we're not talking about fly-by-night companies here."

Schlang follows companies in the Great Lakes region for his firm. One of his recommendations, Calgon-Carbon, a Pittsburgh-based manufacturer of filtration equipment, has had 11 years of increasing earnings, he said.

"You absolutely have to think long term," said David Beckwith, portfolio manager of John Hancock Mutual Life Insurance Co.'s Freedom Environmental Fund. "This is something for the '90s and beyond."

But several factors that could help this industry are coming together right now, said Geoffrey Hyde, marketing vice president of Alliance Capital Management in New York. First, he said, there is the government factor. "We're getting more legislation where companies have to respond to the law," Hyde said.

The second factor is corporate. More companies, Hyde said, now see economic benefits in environmental management, whether it is using recyclable boxes and packing material, or changing the containers their products come in.

Recently, for instance, H.J. Heinz Co. announced that, starting next year, it will put its ketchup in plastic bottles made almost entirely of polyethylene terephthalate, or PET, which can be recycled through a growing network of PET recycling

centers. The old plastic bottle was made with multiple layers of different plastics and adhesives, and there were almost no facilities to recycle them.

The third factor, Hyde said, is the consumer. The number of consumers willing to recycle, or even pay a few cents more for environmentally friendly packaging, continues to grow.

With these three elements in place, Hyde said, "Companies can now justify spending on more research. The corporate, government and consumer sectors have never before all merged at the same time."

Some of the push for the environmental movement in the United States is coming from Europe, Hyde said. "There's a huge demand in Europe, especially Eastern Europe, for new environmental techniques," he noted. Some East German utilities, he said, are using 40-year-old plants that

burn brown coal "that's so sulfurous it's outrageous." In time, he said, there will be new business for companies that sell air- and water-filtration and monitoring equipment.

Again, however, this is a long-term proposition. "Eastern Europe does have severe pollution," said Vishnu Swarup, a pollution-control analyst at Prudential-Bache Securities. "But they don't have a lot of funds now."

In Western Europe, some environmental-management programs, such as recycling, incineration, trash-to-energy plants and other efforts, are moving ahead at a faster pace than they are in the United States, as is consumer awareness, Hyde said.

Hyde, a native of Britain, got a taste of this recently. His children attend boarding schools in England and they were visiting him in New York. "One morning, I came into the bathroom and all my spray cans were gone," he recalled. "They'd thrown them out." Now all his deodorants and spray items are either roll-ons, sticks or pump bottles.

"We like Europe," Beckwith said. His Freedom Fund can invest as much as 30 percent of its assets in European stocks, and it is up to that limit, he said. "Europe will have to do a lot of spending on environmental

Cont'd

some now predict, temperatures dropped several degrees and what is now New York City was covered by ice one kilometer thick.

But this isn't about temperatures alone. It's about drastically changing climatic patterns that affect the distribution of rainfall, the intensity of storms and droughts and the directions of prevailing winds and ocean currents, which in turn dramatically affect our weather and climate. Some scientists say the first effects will be erratic weather patterns with extremes of heat and cold.

Q.: Isn't it easier to adapt to these changes than to prevent them?

A.: The changes could occur so swiftly that effective adaptation might become virtually impossible. The longer we wait, the more unpleasant our choices become.

We are in fact conducting a massive, unprecedented — some say unethical — experiment with consequences for all future generations. As

obstacles may seem immovable, but so did the Berlin wall. With bold leadership and a new political "ecolibrum," we too shall overcome. □

and

... You're wrong on facts and reasoning.

you make your choice, bear in mind that you're choosing not only for your own generation but for your grandchildren as well. And remember too that our abuse of the environment could lead to the extinction of more than half of all species within the lifetimes of our children.

Q.: Isn't the cost of preventing this problem too high?

A.: Many of the solutions, such as eliminating subsidies for clear-cutting forests, actually save money. In any event, the costs of inaction are much higher, even if the skeptics refuse to measure them.

Q.: The changes you say are needed are too sweeping to be politically possible.

A.: What if I had asked you six months ago to assess the possibility that people in every country in Eastern Europe would abandon Communism, sing "We Shall Overcome" and embrace democracy within 90 days? Would you have called that "unlikely?" We all would have. But it happened because people changed their way of thinking about Communism.

People are changing their thinking about the importance of protecting the global environment. We too are showing our willingness to act. The

National Governors' Association
Task Force on Global Climate Change

Chairman's Forward

Terry E. Branstad, Governor of Iowa

Although there is considerable uncertainty about the rate, magnitude, and effects of global climate change, and the costs of prevention could be substantial, we must take action. For the sake of future generations, we must take the issue of global climate change with the upmost seriousness.

Task Force Chairman Gov. James R. Thompson of Illinois
--Goal is developing recommendations for the nation for the 1990s, and illuminating the role that states can play in addressing the problem of GCC. Met with scientists and policymakers from several nations and engaged in constructive dialogue w/ business and environmental leaders. Meetings in Charlottesville, New York, Sacramento, Washington, D.C., New Orleans, Burlington

Executive Summary and Statement of Goals

We owe the habitability of our planet to the phenomenon commonly known as the "greenhouse effect.

EPA and others have predicted that a doubling of atmospheric carbon dioxide or its equivalent in some combination of greenhouse gases --- expected by the middle of the next century --- could raise the earth's average temperature by 3 to 10 degrees Fahrenheit (1.5 to 4.5 degrees Celsius). In January, the National Academy of Sciences estimated that 4 degrees Fahrenheit (2 degrees Celsius) is the most likely temperature rise.

Scientific uncertainty and the difficulty in accurately predicting climate change are compounded by the existing natural variability of meteorological and biological systems.

Second, the social and economic costs of the measures that might reduce the threat are not yet well understood, and a comprehensive assessment of the available options has only recently begun. Finally, mitigation and adaptation to climate change is an issue that can be effectively addressed only with the cooperation of all nations.

Findings:

1. Atmospheric concentrations of greenhous gases are increasing due to human activities. Over the past 100 years,

atmospheric concentrations of carbon dioxide have increased by about 25 percent. Methan is up 140% since the middle of the 19th century.

2. Broad scientific consensus has developed that increasing the concentration of carbon dioxide and other greenhouse gases will increase the atmosphere's heat-trapping ability and warm the climate to some degree. There is debate and uncertainty, however, about the magnitude and timing of the warming and the implications of that warming for the earth's climate system, environment, and economics.

3. Controlling emissions is central to reducing potential climate change. This should be done through energy policy, and measures to slow deforestation.

4. States have key role because of authority over utilities, land-use, transportation, taxation etc.

5. An effective solution to GCC must involved sustained action by the federal government and the international community. Developing nations, must be full partners in the international negotiations.

Economists have estimated that the economic costs for the US for combatting GCC range from virtually nothing to 5-6 percent of GNP. Overreaction could have serious effects on the economic well-being of the nation.

The costs must be compared to the risks associated w/ delay.

Although the magnitude and timing are uncertain, today's emissions are likely to "commit" the planet to some degree of warming. EPA's 1989 report on policy options found that early governmental response to GCC would result in less severe problems in the next century. Assuming a policy response starting in 1990, the severity of the problem could be reduced by about 40 percent compared to the same policies initiated in 2010.

Goals for U.S. in 1990s

1. Develop an international agreement to protect the atmosphere.

U.S. reductions in carbon dioxide emissions should not be offset by a net increase in other countries. We should sponsor appropriate agreements to assure a coordinated international approach to the threat of climate change.

2. Utilize cost-effective energy conservation and efficiency measures to stabilize U.S. emissions of carbon dioxide.

Between 1973 and 1986, the U.S. economy grew by more than 1/3

w/no significant increases in carbon dioxide due to energy efficiency. Building, lighting, appliance, and transportation efficiency measures also can yield substantial reductions in carbon emissions by reducing the amount of fuel we use.

3. Stop production of and recycle chlorofluorocarbons, and use cost-effective strategies to stabilize or reduce other greenhouse gases.

Amend the Montreal protocols to eliminate the productions of chlorfluorocarbons and to require that those already in use be recycled so they are not raised into the environment. We should stabilize or reduce U.S. emissions of methane, nitrous oxide, ozone, and other greenhouse gases. Methane recovery from waste should be encouraged. Some methane emissions from animals can also be reduced.

4. Develop and commercialize alternative energy systems, including clean fossile, renewable energy sources, and safe nuclear power.

Push clean fossil technologies, cogeneration, solar energy, wind power, geothermal energy, biomass fuels, hydroelectricity, and a new generation of safe nuclear power.

5. Implement forestry programs to reduce the effects of global climate change.

Planting trees, particularly in urban areas, can reduce the severity of climate change because they take up carbon dioxide as well as provide shade. Responsible management and expansion of our existing forest resources can improve the quality of forest ecosystems, increase our production of wood, and reduce atmospheric carbon dioxide.

6. Plan and act now to adapt to climate change.

Pay attention to water resources, sea level rise, and agricultural and forestry practices.

7. Pursue an aggressive research program to reduce key uncertainties about GCC

The U.S. should support a program of research to better define the potential magnitude and timing of future climatic changes; the possible ecological effects of such changes; and the cost and effectiveness of various response options, including changes in energy sources.

The federal gov't bears a special responsibility for assisting states or industries that may be adversely affected by a move to a less energy- and carbon-intensive economy. The federal gov't must plan for and provide a transition so that our national goals do not become unreasonable limitations on

exceeding the National Ambient Air Quality Standards for ozone.

Human Health Effects

More negative effects in summer, fuer in winter.

Climate Extreme Changes

Summer heat waves could intensify considerably. But increased temps may be manifested primarily in the evening.

Meteorological Events

Hurricanes could become more frequent, violent and widespread.

Environmental Refugees

Evacuation of America's Pacific Trust Territories could be required. Other refugees possible from low-lying countries

Costs of new electric facilities could reach \$3 b to \$6 b by 2010. Climatic change could add between \$33 b and \$73 b to capital costs in this sector by 2055.

Goal One: Develop an International Agreement To Protect the Atmosphere

* The U.S. should help lead negotiations of an international framework convention that ensures international cooperation to protect the atmosphere.

o Individual protocols or treaties containing specific commitments from all nations on greenhouse gases, neergy efficiency, population growth, and other items should be negotiated as soon as possible.

o Agreements to stop deforestation of the earth's tropical belt should be given high priority.

Goal Two: Utilize Cost-Effective Energy Conservation and Efficiency Measures to Stabilize U.S. Emissions of Carbon Dioxide

o Reform the regulation of electric utilities- through least cost planning and rate design reform

- o Improve building energy efficiency standars
- o Improve appliance efficiency standars
- o Improve transportation energy efficiency
- o expand state gov't energy efficiency programs.

Electricity currently accounts for 37% of U.S. energy use. Although total U.S.> energy use has risen by less than 7 percent since 1972, electricity use has increased by 55 percent, and

the growth and development of particular states or industries.

EPA and others have estimated that, at current rates of emissions, atmospheric concentrations of carbon dioxide will have doubled from preindustrial levels by around the middle of the next century.

Problems with modeling: inability to accurately gauge the role of clouds and ocean currents, and the interaction of various greenhouse and non-greenhouse gases (e.g. sulfur dioxide)

Because these (various) relationships and the overall sensitivity of the world's climate system are not well understood, the magnitude of climate change as the result of doubled carbon dioxide remains subject to considerable uncertainty.

The timing of any change in global temperature is also highly uncertain.

Scientists expect that temps will increase more at higher latitudes than closer to the equator.

EPA's report to Congress The Potential Effects of GCC on the US, compiles data from numerous studies and analyzes the results region by region and sector by sector. The numerous effects described in the report suggest that GCC may be among the greatest threats humanity has ever faced.

Water Resources

More frequent and severe droughts and floods. Several studies suggest that mid-continental areas--such as the American Midwest will become drier.

Other effects could include:

- o Greater demand for water and decreasing supply
- o Lower river flows
- o Earlier winter melts - creating more seasonal flooding problems
- o Greater variability in river and lake levels
- o Decreased water quality.

Agricultural Changes

Increased heat, lower moisture, irrigation pressures, and expanded pest ranges must be balanced against any potential improvements in plant growth that result from increased concentrations of carbon dioxide and longer growing seasons. EPA studies suggest that:

- o Yields of corn, soybeans, and wheat would probably be reduced in all but the northernmost U.S.

o There may be a small to moderate aggregate reduction in agricultural output. This reduction should not threaten domestic food supplies, but could negatively affect world food supplies and the U.S. trade balance.

o Farmlands dependent upon natural rainfall could become less reliable, and the demand for irrigated acreage is likely to increase. This could put stress on regional water demand.

o Higher temps will probably increase the range and survivability of agricultural pests.

It is likely that the predicted climate change will push the southern boundary of sugar maples and many other crops further northward, causing further economic disruption in northeastern ag communities.

Sea Level Rise

GCC in the range of most predictions could raise the ocean level from one and one-half to six feet over present levels by the year 2100, though recent estimates suggest the probable actual increase would be one to two feet. As water warms, its volume increases.

In the fact of a three-foot sea level rise, EPA estimates it would cost \$73 b to \$111 b to protect barrier islands and developed mainlands through 2100. Financial loss of coastal industries such as tourism fishing could be much higher.

Increased salinity into coastal waters has already damaged oyster harvest in Chesapeake Bay and pressured water supplies in Florida and New Jersey. According to EPA, a three-foot rise in sea level could eliminate up to 82 percent of continental U.S. wetlands.

Forests

Climate change could force the southern ranges of many forests northward by hundreds of miles.

Temperature increases would make forests more susceptible to fires, pest attacks, and replacement w/low-value trees, grasslands and shrubs.

Air Quality

As a result of higher temperatures, the formation of ground-level ozone, would increase in many areas. Acid rain would also increase in the atmosphere.

EPA estimates that in the Midwest and Southeast, a 7 degree Fahrenheit temp. increase could triple the number of areas

electric utilities currently account for about one-third of U.S. carbon dioxide emissions.

States can begin to reconcile shareholder and ratepayer interests by giving utilities proper incentives to implement programs that improve the efficient use of energy by all ratepayer classes. This can ensure that it is as profitable for utilities to save energy as it is to develop new supplies.

Options include:

- o breaking the link between utility sales and profits so that utility profits do not fall in lockstep with conservation and efficiency improvements
- o allowing rate-basing and incentive rates of return for utility investments in customer conservation measures.
- o encouraging financial incentives in the form of equipment rebates, low-cost loans, or shared savings arrangements to all classes of customers
- o offering energy audits and technical assistance to homeowners, businesses, and industries.

In partnership with the federal gov't, states should establish an aggressive model building efficiency code and urge its adoption and enforcement in all jurisdictions throughout the country where no such standards exist.

States and the federal gov't could act in concert to build on the National Appliance Energy Conservation Act and DOE's recent rules on refrigerators and freezers to implement more stringent national standards for fluorescent and incandescent lamps and fixtures.

Using currently available high-efficiency lighting technology could cut the amount of electricity used for lighting by 50-90%.

U.S. Ivory Market Collapses

After Import Ban

A YEAR after the Federal Government banned the importation of ivory from the African elephant, the commercial ivory market in the United States has collapsed, a study by a conservation group has found.

Demand for ivory has plummeted, dragging down the price of products still legally available in this country, as well as the price of ivory obtained illegally in Africa, according to a draft of the report being released today by the World Wildlife Fund.

Moreover, with demand down, the ban has evidently not spurred more

poaching and smuggling in Africa, as had been feared, the report says.

"The U.S. market for ivory is dead," said Ginette Hemley, director of the Washington-based Traffic USA, a division of the World Wildlife Fund that tracks trade in endangered species. In the last decade alone, the number of elephants has fallen from 1.3 million to 609,000, primarily because of poaching in Central and East Africa.

Before the ban, announced a year ago today by President Bush, the United States accounted for 10 to 15 percent — or about \$20 million — of

the world's annual ivory imports.

Surveying the 15 largest ivory wholesalers here, the conservation organization found that dealers have discounted jewelry and simple carvings by 40 to 70 percent and have found few buyers.

"Clearly, there's a public mood against the trade of ivory," said Marshall Jones of the Fish and Wildlife Service.

There is no evidence "at this time" of any organized efforts to smuggle ivory into this country, Mr. Jones said. Only sanctioned ivory trophies taken in South Africa and Zimbabwe

are allowed into the country.

The United States ban was followed by others throughout the world, including the European Community and Japan. In October, member states of the Convention on International Trade of Endangered Species (Cites) agreed to an international ban, which took effect Jan. 18.

The World Wildlife Fund's report said initial evidence suggests poaching has decreased in most African nations, including Kenya, though there have been reports of incidents in several countries, and poaching remains acute in Zaire and Tanzania.

"Where once there was only despair, there's now some hope," said Iain Douglas-Hamilton, who monitors African elephants for the European Community.

The bans on imports have cut the price of raw ivory in Africa as much as 90 percent, according to the report.

"There is really no incentive to smuggle since there is no longer a demand," said Michael Sutton, a co-author of the report.

Demand has even fallen in some Asian countries, the largest importers of African ivory. In Hong Kong, which received a six-month exemption on the Cites ban to allow traders to unload an estimated 570 tons of stockpiled ivory, wholesale prices have fallen 15 to 20 percent, the report found.

But markets in South Korea, which is not a party to Cites, and China, which is a party but refused to accept the ban, could encourage continued poaching. With countries closing their doors to ivory, South Korea imported 34.5 tons of worked ivory in 1989, 100 times the 1988 total.

Richard Luxmoore of the World Conservation Monitoring Center in Cambridge, England, surveyed the ivory trade at the March meeting in Paris of the International Union for the Conservation of Nature.

"The ivory trade is certainly in a state of shock," Dr. Luxmoore said in a telephone interview, but "the incentive for poaching may still be there." He said low ivory prices could entice speculators to snatch up stockpiles.

Bush named a task force last year, headed by Interior Secretary Manuel Lujan, to work with the National Academy of Sciences in studying the environmental impact of opening the three areas to oil leasing — off northern, southern California and the Florida keys.

The task force, in its report to Bush in January, cited a need for further study on the environmental and socioeconomic ramifications of new lease sales, sources have said.

The broadest set of options initially placed before the president by his staff ranged from allowing immediate drilling in the study areas to permanently barring oil companies from the regions.

Environmentalists have long opposed oil drilling in the three regions — a 6.7-million acre section of ocean off Southern California, 1.2 million acres

off Northern California, and 13 million acres in the Gulf of Mexico near the Florida Everglades.

AP-NF-06-04-90

TUESDAY, JUNE 5, 1990

The Washington Times

Pollution picture brighter, Bush told

By Ronald A. Taylor
THE WASHINGTON TIMES

Success in controlling pollution since 1970 has been a mix of "remarkable improvements" and "slow and painful" progress, but there's plenty of reason for optimism about the environment, the Council on Environmental Quality told President Bush yesterday.

The optimism is fueled by developments since 1970. Since then, economic growth has not necessarily led to more pollution. Environmental protection is now a high-ranking goal of both government and corporations, and polluters face tougher enforcement at all levels of government, council Chairman Michael Deland told the president and his Cabinet yesterday.

The nation's environmental experience since Earth Day 1970 "sug-

gests that Americans in 2010 will respond to environmental problems with energy, creativity and a deep-seated sense of responsibility for future generations," CEQ concluded in its 20th annual progress report.

"The nation's success at fulfilling the promise of 1970, as measured by environmental trends data, has been mixed," the report said.

According to the report, the bright spots are improvements in general air quality — a 96 percent decline in lead emissions and a 35 percent reduction in sulfur dioxide.

for instance — and the expansion of waste-water treatment facilities to 127 million Americans, compared with 80 million in 1970.

Those achievements coincided with the expansion of the gross national product from \$2.42 trillion in 1970 to \$4.17 trillion in 1989. Since 1970, the report noted, the number of cars on the road increased 56 percent, from 89.2 million to 139 million in 1989. The amount of driving in-

creased 48 percent, from 920 billion vehicle miles traveled in 1970 to 1.31 billion miles in 1987.

Meanwhile, progress in controlling pollution in coastal waters, curbing urban smog and preserving wetlands has been "slow and painful," the report concludes.

Among the bad news for coastal waters is a 14 percent increase, to 7.5 million acres, in the shellfish harvest areas closed due to environmental contamination between 1971 and 1985. By 1985, 40 percent of the nation's shellfish beds were closed for some or all of the season, the report said.

Since 1970, the nation's 99 million acres of wetlands — those swamps, marshes and mudflats where the beginnings of the marine food chain spawn — are being filled in at a rate of 450,000 acres a year, it noted.

Under Bush administration fiscal 1991 plans, the panel's budget is to be increased 90 percent to \$2.7 billion.

GLOBAL WARMING: THE ANSWERS ARE NOT ALWAYS GLOBAL

Public officials discover the political payoffs of fighting the 'greenhouse effect.'

By Kathleen Sylvester

Sharpe James is a true believer. The mayor of Newark, a large and gritty city blighted by the familiar urban woes of crime, drugs and homelessness, says one of the most important things he is doing for the people of Newark is trying to reduce the threat of global warming.

"It's a question of survival," he says. The mayor is not talking about saving the planet. He is talking about saving his city. James says that if Newark is to survive, it must become livable.

Like many other state and local officials, James has discovered that the strategies that will mitigate global warming also make good public policy—and good politics.

So Newark, New Jersey—big, bad, ugly Newark—has become one of America's most environmentally conscious cities. Newark will be the focal point of New Jersey's Earth Day activities on April 22 because it is setting the environmental pace in New Jersey. City officials are enthusiastically doing whatever they can, from banning plastics to recycling to pondering mass transit, in order to reduce the emission of the so-called "greenhouse gases" that cause global warming.

Global warming is a gradual heating up of the earth's atmosphere caused by production of these gases, which can accumulate and prevent the escape of solar heat from the earth's atmosphere. While scientists generally agree that global warming is occurring, they are divided about how drastically the earth's temperatures will rise and how soon it will happen.

Initial predictions included warnings that the changes in the next 50 years could rearrange weather patterns, flood coastal areas, transform agriculture and disrupt entire economies. As those early predictions have been challenged by scientists who suggest that the warming may be much less severe, the federal government has adopted a wait-and-see attitude. President Bush said recently that it is too soon

to formulate a national policy based on such uncertain evidence.

Many state and local officials, however, are not waiting for a federal policy. They are persuaded by the environmentalist argument that if they wait until all the evidence is in, it will be too late. Jeremy Rifkin, president of the Washington, D.C.-based Greenhouse Crisis Foundation, puts it this way: "If you knew there was a 10 percent chance that your home would be blown up, you'd take steps to prevent it. With global warming, there is a better than 50 percent chance it will happen."

Dan Becker, who heads the Sierra Club's Global Warming and Energy Program, suggests that another dynamic is at work, too. "People draw their conclusions about the world from their own experiences," says Becker, "and when needles started washing up on the beach, and it was 100 degrees in Phoenix for 145 days in a row, people's intellectual interest in the environment was suddenly confronted by a reality that they could see and smell." State and local officials are taking that to heart.

Dealing with global warming might at first glance seem to be the province of international and national policy makers. But a large number of the relevant decisions, such as land use, transportation and energy conservation policies, are either made or enforced by state and local officials.

In Newark, Sharpe James is not paying a whole lot of attention to the scientific debate. What he knows about is Newark. And what he sees just blocks from City Hall are abandoned buildings, graffiti-covered walls and vacant lots knee-deep in rubble.

It happens that the same tactics that will mitigate the effects of global warming are also mitigating those blights and making his city of 316,000 a better place to live. While homelessness, poverty and AIDS are urgent priorities, James insists that "quality of life" issues are no less

CONTINUED

important to the city's survival.

The nerve center of Newark's environmental effort is a small office in the city's engineering department, where Frank Sudol has the responsibility for monitoring city contracts and reviewing environmental impact statements. But in his spare time, Sudol runs a series of programs that are turning Newark into a model environmental city. "This is my fun stuff," he says.

The process works because Sudol understands where and how global concerns intersect with local ones, and he understands how to reduce a "global" concern to a local political one. He uses this example: "The environment, to inner-city folk, is litter on vacant lots; it's graffiti." A plastic cup is litter. When it is produced using one of the chlorofluorocarbon "greenhouse gases," it creates something that people don't want on vacant lots. "It all ties together," says Sudol, "because if you ban that kind of packaging, you eliminate litter and also reduce harmful air emissions."

Newark's city council agreed, and in February 1989 it approved an ordinance banning the use of polystyrene and polyvinyl chloride in retail food packaging unless at least 60 percent of the packaging is recycled. To make the ban work, Sudol's staff blitzed Newark businesses with letters explaining the ordinance and placed ads in the local papers. Sudol says this public relations campaign was critical in order to make the ban self-enforcing. City officials want consumers to complain to restaurant owners who use plastic products and to insist on paper grocery bags instead of plastic at supermarkets.

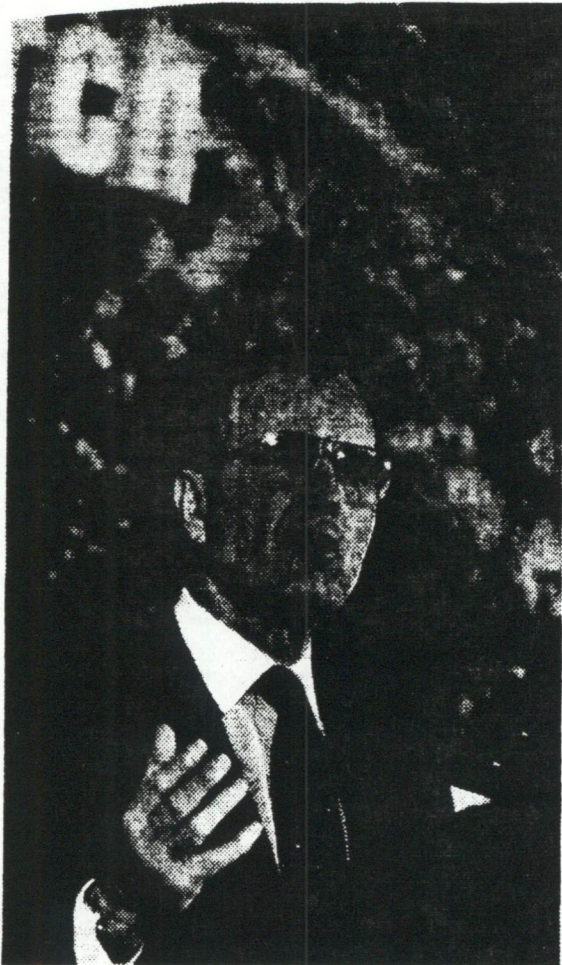
The plan is working. While polystyrene, better known by its most common trade name, Styrofoam, is now made with a chemical that is less harmful to the environment, the city's ban is still in effect. And only Newark's six McDonald's restaurants are sticking with polystyrene, because they say their volume is high and paper packaging is so much more expensive than polystyrene. For the rest of the city's 1,700 retail food establishments, it was easier to switch than recycle. At the federal building, the cafeteria is back to reusable plates and cups; New Jersey Bell has asked employees to bring their own mugs to the coffee room and reports that it saves \$7,000 a year by not having to supply foam cups; the pizzeria down the street from city hall serves up slices on reusable aluminum trays.

Recycling is another simple way to reduce global warming. In general, it takes less energy to make products of recycled materials than to produce them from raw materials. Because less fuel is used, fewer harmful emis-

sions are released into the atmosphere. But recycling needed a political strategy too. "In the low-income areas, it was really kind of tough," admits Sudol, "so we used a lot of gimmicks." The city sent mailers to all Newark residents, written in English, Spanish and Portuguese and illustrated with simple pictures. The "hook" is that participation in the recycling program enters the residents in a contest to win \$50 worth of groceries. In a city where 30 percent of the residents are on public assistance, that is a great incentive.

There is more. "You name it. We do it," says Sudol. The city has an office paper recycling program; a cardboard collection program; a collection program for discarded major appliances, such as refrigerators and stoves; a compost program for leaves; a waste oil disposal program; an automobile battery disposal program; and a program that turned 17,000 discarded Christmas trees into mulch. Newark has even found a way to recycle plastic soda bottles: They are turned into park benches.

What does all this effort cost? Not that much, says Sudol. The city will spend about \$500,000 of its \$301 million operating budget this year on its tree-planting program, but other costs are minimal because most tasks are done by people already on the city payroll. The bonus, he adds, is that the recycling program takes 41 percent of the city's solid waste from the waste stream and a new local recycling industry has added several thousand jobs to the



BY RICH LIPSKI—THE WASHINGTON POST

"What we need are facts," Bush said at opening of conference, attended by delegates from 17 countries.

Bush Says More Data On Warming Needed

U.S. Criticized at Conference

By Michael Weisskopf
Washington Post Staff Writer

President Bush kicked off his much-ballyhooped White House conference on global warming yesterday by restating his call for more research before setting up costly programs to meet what many experts call mankind's greatest threat.

"What we need are facts," Bush said in opening remarks to the two-day meeting.

But several participants at the 17-nation conference turned the event into a challenge to Bush's go-slow approach, accusing the administration of ignoring key scientific data and manipulating the conference to obscure European arguments for aggressive measures to combat rising world temperatures.

"We have the feeling we were invited just to listen," said Brice Lalonde, the French environmental minister.

"There is sense in Europe that the Americans are falling behind on this, and that the time for action has come," said Jorgen Henningsen, an environmental director at the Commission of European Communities. "But the Americans are primarily concerned about having their point of view forwarded to the public here."

See CONFERENCE, A23, Col. 1

GOING GREEN

Bush Calls for More Data on Warming

CONFERENCE, From A1

Some delegates were especially angry that they were not given an opportunity to share their judgments and plans at public sessions. Usually governments are provided a forum for opening statements to set out national objectives. But the agenda, prepared by the White House, is all but monopolized by administration officials.

Sources close to the White House said aides to Chief of Staff John H. Sununu had structured the conference that way to mute opposition to Bush's stance, which Sununu was instrumental in formulating.

D. Allan Bromley, the president's science adviser and cochairman of the conference, said delegates will have ample time in closed working sessions to present their views.

The conference, billed as the first to integrate scientific and economic aspects of global warming, grew out of a 1988 campaign pledge by Bush to use the "White House effect" to curb the "greenhouse effect," which is said to occur when industrial gases blanket the Earth and trap solar heat.

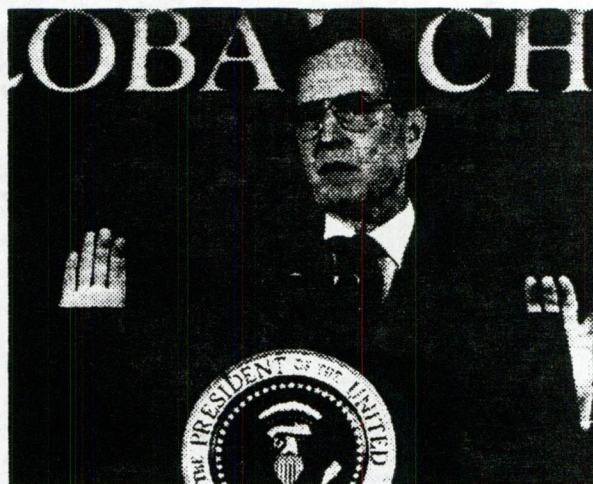
"The agenda will be clear," Bush promised at the time. "We will talk about global warming . . . and we will act."

But Bush has assumed a cautious stance in office, bowing to advisers who view global warming as a scientific fad and see proposals to curb greenhouse gases, created by the burning of coal and oil, as potentially ruinous to the U.S. industrial base.

Although he supports a United Nations-sponsored panel considering an international convention on global warming, Bush has backed away from plans by some European nations to freeze or cut emissions of carbon dioxide—the primary greenhouse gas—by early next century. Instead, he publicly questions the scientific certainty of global warming, even avoiding use of the popular term in favor of the more innocuous "climate change."

Few scientists doubt that steady increases in carbon dioxide emissions will raise world temperatures as they have since industrialization. The question is how much, with most estimates ranging from 3 to 8 degrees by the middle of next century.

A scientific team assigned by the U.N. panel to sort out the uncertainties issued a draft report last month



Bush emphasized scientific differences on global warming.

affirming the range of 3 to 8 degrees with "substantial confidence."

Yesterday the president continued to emphasize scientific differences, citing a recent television interview in which scientists disagreed on the extent of temperature change. "Two scientists, two diametrically opposed points of view," Bush said. "Now where does that leave us?"

Noting his proposal for a 60 percent increase in spending for climate change research, Bush called for further study to "advance the scientific understanding we need if we are to make decisions" on remedial action.

His brief remarks were greeted by polite applause, after which European delegates quickly headed for the lobby with critical comments for reporters. Governments of the Netherlands, West Germany, France and the Nordic nations already have plans for concrete action to stabilize or cut back emissions of carbon dioxide.

"The country with the highest carbon dioxide emissions is the most reluctant to take precautionary action," Pier Vellinga, director of the Dutch National Climate Program, said of the United States.

German environmental minister Klaus Topfer said "gaps in information should not be used as an excuse for worldwide inaction."

ADDITIONAL CLIPS WILL BE AVAILABLE IN FRIDAY'S CLIPS LIST:

Indians Peyote Religious Rites

Clean Air - Global Warming - Acid Rain

Environment - Earth Day

McDonald's/Recycling

Oil & Gas Issues - Other Clips On DOI Issues

THE WHITE HOUSE

WASHINGTON

June 22, 1990

MEMORANDUM FOR ED GOLDSTEIN

FROM: ADAM ISLES

SUBJECT: State Governors' Energy Efficiency Report

Goal 2. The governors want the Federal government to increase the corporate average fuel economy beyond the 27.5 miles per gallon; they also urge the Federal government encourage transportation modes such as electric-powered subways and railroads, since they release less carbon dioxide. They also supported increased emphasis in telecommuting and ride sharing initiatives. The governors called for the U.S. to encourage and provide more financial support for these programs.

Goal 3. The governors, citing evidence of CFC-related damage to the ozone layer, called on the Federal Government to call for an international agreement to phase out CFCs at the earliest possible date and to recapture and recycle those in use. They also suggested recovering more methane for energy use, reducing animal production of methane, and encouraging the production of more efficient and environmentally sensitive fertilizers.

Goal 4. DOE studies suggest that a more efficient use of renewable energy sources, such a hydropower, could displace 18 percent of CO2 emissions in 2010. More specifically, they suggested using such new technologies such as pressurized fluidized bed combustion and integrated gasification combined cycle technologies to improve coal production, promoting cogeneration of electricity and heat, encouraging the use of solar energy (which can now provide baseload electricity to the power grid and will be able to supply transportation fuel through hydrogen production in the future), utilizing wind power which currently displaces 304,000 tons of carbon annually, utilizing geothermal energy, developing biomass (plant and wood-product) fuels, improving the efficiency of hydroelectric plants, and developing a new generation of safe nuclear power.

Goal 5: Implement Forestry Programs to Reduce the Effects of Global Climate Change. This goal can be accomplished by using existing conservation programs like CRP and more efficient trees to offset new CO2 emissions, improving forest management, and planting trees, especially in urban areas.

Goal 6: plan and act now to adapt to a changing climate. The

plan advises the Federal Government to strengthen coastal zone management programs, to develop appropriate land-use plans, to develop appropriate protective infrastructure (i.e., levies, dams), and to take steps to prepare for agriculture under conditions very different from those most farmers have experienced, such as migration of the climate zone northward, changes in plant and animal pests and diseases. The governors call for strengthening agricultural research and planning, for improving the conservation of soil and water, and for encouraging greater diversity and flexibility in farming systems.

Goal 7: pursue an aggressive research program to reduce key uncertainties about global climate change. The governors call for an aggressive pursual of the U.S. Global Change Research Program.

U.S. bungle angers others at warming threat conference

By Anne Reifenberg

Washington Bureau of The Dallas Morning News

WASHINGTON — A White House effort to control an international conference it sponsored on global warming backfired Wednesday when delegates rebelled and U.S. officials apologized for issuing a statement claiming consensus on the need for caution.

The statement — circulated as delegates were meeting in workshops in which they were to be debating the warming threat and the economic costs of fighting it — said the 18 nations represented agreed that “gaps in scientific and economic understanding” limited their ability to set policy.

Padraig Flynn of Ireland, president of the European Community Environmental Council, was among those who angrily rejected the statement and confronted U.S. Environmental Protection Agency Administrator William Reilly at one of the closed-door workshops.

“It looked like my working group was going to explode,” Mr. Reilly told reporters later.

Other groups also revolted, and Dutch delegate Pier Vellinga called it “embarrassing” when U.S. Energy Secretary James Watkins had to apologize to his group. President Bush’s science adviser, D. Allan

Bromley, also issued an apology, characterizing the statement’s issuance as “a mistake.”

Mr. Flynn, who complained that “we’re not here to be preached to by the Americans,” and others said the statement drafted by the White House did not reflect the nature of the discussions taking place at the conference or the positions of the countries participating in them.

Many European nations have called for significant worldwide reductions in carbon dioxide and the other “greenhouse” gases whose unchecked accumulation in the atmosphere could cause disastrous climate disruptions, coastal flooding and drought.

The United States has taken the position that too little is yet known about both the science of the global warming theory and the economic consequences of acting to avert it.

In keeping with that theme, President Bush opened the conference Tuesday with a speech outlining the circumspect U.S. position and calling for more research.

In a second speech Wednesday, he sought to assure delegates that he has “never considered research a substitute for action.”

Mr. Bush declared that the United States is “leading the search for response strategies and working

through the uncertainty of both the science and the economics of climate change.

“But there is one area where we will allow for no uncertainty and that is our commitment to action, to sound analysis and sound policies,” he said. “Above all, the climate change debate is not about ‘research versus action’. . . . To those who suggest we’re only trying to balance economic growth and environmental protection, I say they miss the point. We are calling for an entirely new way of thinking, to achieve both.”

After Mr. Bush’s speech, Ireland’s Mr. Flynn said: “We came here to find common ground and we’ve found common ground — that research and action are inseparable.”

The Associated Press and Reuters contributed to this report.

House Democrats' plan could threaten collider

By Anne Reifenberg **AI**
 Washington Bureau of The Dallas Morning News

WASHINGTON — House Democrats recommended on Wednesday that science programs receive \$60 million less next year than sought by President Bush, igniting fears that the Superconducting Super Collider would bear the brunt of the cut.

The proposed fiscal 1991 budget blueprint, drafted by House Budget Committee chairman Leon Panetta, D-Calif., and other party leaders, calls for \$1.214 billion to be spent on U.S. Department of Energy science endeavors.

The Bush administration has asked for \$1.274 billion.

"I believe that any cut in general science is going to go 2-to-1 against the collider," said Rep. John Bryant, D-Dallas, a member of the budget panel. "There is just no constituency on the committee for Texas projects this year."

But Mr. Bryant added that he had spoken with Mr. Panetta and was "hopeful" that the chairman would decide to beef up the science funding category — perhaps by as much as \$40 million, bringing it to \$1.254 billion — when he makes his official presentation to his committee Thursday.

"Our goal has been to kick general science funding up high enough to guarantee keeping the Super Collider (appropriation for fiscal year 1991) above \$300 million," Mr. Bryant said.

He and other lawmakers from Texas, where the \$8 billion collider would be built, said they believed that the project's budget was ripe for slashing and that a move by the committee to shrink science funding substantially would hurt it more than any other program.

Trouble was brewing for the collider a year ago when the House began to get serious about its annual budget-writing chores. Then-Speaker Jim Wright of Fort Worth jumped into the fray to shield the project from fatal attacks, and Con-

gress in the end gave the program \$225 million for fiscal 1990, only \$25 million less than initially sought.

But Mr. Wright resigned last summer. And the collider's ultimate price tag has jumped by more than \$2 billion, with critics beginning to question the feasibility of some of its most important components.

Texasans said Mr. Wright's absence would be felt in the fight to secure the \$318 million sought for the collider for the fiscal year beginning Oct. 1.

"I don't think there is any question that we are missing the leadership we had a year ago," said Rep. Jim Chapman, D-Sulphur Springs.

The depth of collider support will be put to its first test of 1990 next week, when the full House is to consider a bill that would for the first time authorize the project as an individual federal program. It also would limit federal spending for the project to \$5 billion, leaving the other \$3 billion to be picked by the state of Texas, foreign nations and other non-federal sources.

The House Rules Committee decided Wednesday to allow unlimited amendments to be introduced on the floor, and observers said they expected as many as a dozen — some of them aimed at killing the project and others at delaying its construction for so long that the effect would be the same.

"We've got to win the vote on this bill," Deputy Energy Secretary Henson Moore told scientists and congressional staff members who attended a collider pep rally organized Wednesday by the SSC Coalition, an industry lobbying group.

"If we win this vote, it will have a very telling effect on appropriations. . . . We need \$318 million. Anything less than that will cause problems."

Rep. Martin Frost, D-Dallas, a member of the rules panel, said the authorizing bill had strong bipartisan support and would pass "by a wide margin." If it does pass, collider supporters said, the word would be out that the House is truly committed to building the collider.

But Mr. Bryant said that without a Texan in the powerful speaker's chair, the 29-member Texas congressional delegation would find it more difficult to defend "a rather esoteric scientific project . . . that other states wanted in the first place."

Texas beat six other states in an intense 1988 competition to win the collider project and the huge revenue and thousands of jobs it would carry with it.

Project foes in the House never complain about its Ellis County location when arguing against its construction. But Henry Gandy, a collider lobbyist and former director of the Texas Office of State-Federal Relations, said he suspected "some Texas bashing" was behind the opposition.

Mr. Bryant went further.

"The reality is that there is a very negative view toward Texas projects," he said. "It is prudent for us to view it as a serious danger. . . . We'll have a difficult time without Jim Wright as speaker fending off this anti-Texas sentiment."

The fiscal 1991 budget plan recommended by the Democrats on Wednesday would set Energy Department science spending at \$1.214 billion in the annual budget resolution adopted by Congress. The resolution serves as a general guide for congressional authorizing and appropriating committees. It is not binding.

But a resolution making a \$60 million cut to the president's request for science programs could send committees with collider oversight a message that project supporters would rather they not receive.

"The collider is not getting killed, but this (cut) would place it in a tough spot," said a congressional aide involved in the budget-writing process.

"It's very serious."

Staff writer Chris Jensen contributed to this report.



Earth Observations & Global Change Decision Making: A National Partnership
Fall Conference ■ October 23-24, 1990

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**Earth Observations & Global Change
Decision Making: A National Partnership**

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Sessions

Tuesday, October 23, 1990

Master of Ceremonies: National Geographic Society

Mr. Noel R. Grove, Senior Assistant Editor for Environment

7:00 Registration and Continental Breakfast

There will be no seating from 8:15 a.m. until the completion of the President's address.

8:15 Welcome—Dr. William M. Brown, President, Environmental Research Institute of Michigan

"Global Change: The Challenge"—

Payson R. Stevens presents his multimedia production

Conference Overview—Mr. Noel Grove, Senior Assistant Editor for Environment, National Geographic Magazine

9:00 Keynote Address—President George Bush (Invited)

9:45 U.S. Strategy for Global Change Research—Dr. Dallas L. Peck, Chairman, Committee on Earth and Environmental Sciences; Director, United States Geological Survey

10:15 Break

10:30 Session 1: Mission to Planet Earth—National Partners

Space-based and ground-based measurements are crucial to the success of the U.S. Global Change Research Program (GCRP), which calls for an integrated, comprehensive, and global approach to monitoring the earth system. This first in a series of three consecutive sessions designed to explore the U.S. and international earth observation programs will focus on the U.S. space-based contribution to Mission to Planet Earth.

As the cornerstone of the U.S.-initiated international program, the NASA Earth Observing System (EOS) and Earth Probes, along with the NOAA Operational Satellites, will be the main discussion topics of this session. Speakers will provide detailed mission descriptions, highlight the planning and status of the proposed FY 1991 budget initiatives, and discuss how these programs relate to other planned earth science missions.

Moderator:

Mr. James R. Asker, Space Technology Editor, Aviation Week & Space Technology

Panelists will include:

Dr. Francis Bretherton, Director, Space Science & Engineering Center, University of Wisconsin

Dr. Robert Corell, Vice Chairman, Committee on Earth and Environmental Sciences; Assistant Director, Geosciences Directorate, National Science Foundation

Dr. Lennard A. Fisk, Associate Administrator, Office of Space Science and Applications, NASA

Dr. John Knauss, Undersecretary of Commerce for Oceans and Atmosphere, U.S. Department of Commerce

Mr. John Swihart, President, American Institute of Aeronautics and Astronautics Inc.; President, National Center for Advanced Technology

U.S. Senate Member (To be announced)

Papers submitted for publication in association with this session should address related matters, such as proposed enhancements to the missions.

12:00 Lunch (JW Marriott Hotel, Capitol Ballroom). "Mission to Planet Earth—A Senate Perspective"

Luncheon Speaker:

U.S. Senate Member (To be announced)

2:00 Session 2: Mission to Planet Earth—International Partners

International cooperation and collaboration are essential to increasing our knowledge of global change. This session will be devoted to discussing the international space-based earth measurement programs, how they relate to the U.S. component, and how future research plans fit into an evolving international global change program. International space agency representatives will address the status of and plans for their participation in Mission to Planet Earth, as well as other global change research missions and operational missions.

Moderator:

Dr. John McElroy, Dean, College of Engineering, University of Texas, Arlington

Panelists will include:

Mr. Phillip Goldsmith, Director, Observation of the Earth and its Environment, European Space Agency (Invited)

Dr. Larkin Kerwin, President, Canadian Space Agency

Academician Guriy Ivanovich Marchuk, President, Academy of Sciences, U.S.S.R. (Invited)

Mr. Thomas Pyke, Jr., Assistant Administrator for Satellite and Information Services, NOAA/NESDIS

Papers submitted for publication in association with this session should address such issues as anticipated economic impacts and the data and information needed to predict them; sample studies; current technical obstacles; evaluation of models; special requirements of developing countries; and means to coordinate business, government, and international views of global change.

12:15 Lunch (JW Marriott Hotel, Capitol Ballroom). "Mission to Planet Earth—A House Perspective"

Luncheon Speaker:

The Honorable Robert Traxler (D-MI), U.S. House of Representatives; Chair, House Subcommittee on VA, HUD, and Independent Agencies, Committee on Appropriations

2:00 Session 6: Policy Response to Global Environmental Change: A Socratic Dialogue

Over the past several years many ideas have emerged on what mankind can do to halt or reverse the degradation of Earth's environment. Some ideas have become policies; some policies have become law.

Based upon challenging hypothetical situations posed by the moderator, this session will focus on the critical issues and actual processes involved in making such policy decisions. Topics will include developments within the United States, within other nations, and globally; policies proposed or under consideration; and anticipated developments in the year ahead.

Moderator:

To be announced

Panelists will include:

Ms. Joan Barvaria, Social Investment Forum

Dr. Frederick Bernthal, Chairman, Working Group III on Response Strategies, Intergovernmental Panel on Climate Change; Deputy Director, National Science Foundation

The Honorable Pierre R. DuPont IV, Richards, Layton, & Finger (Invited)

Mr. Gregg Easterbrook, Contributing Editor, Newsweek magazine

Mr. Thomas Finnigan, Vice Chairman, Global Climate Coalition; Assistant Director of Federal Affairs, Union Carbide, Inc.

The Honorable Bill Green (R-NY), U.S. House of Representatives; House Subcommittee on VA, HUD, and Independent Agencies, Committee on Appropriations (Invited)

Mr. Donald R. Lesh, President, Global Tomorrow Coalition

Dr. John McElroy, Dean, College of Engineering, University of Texas, Arlington

Dr. Roger B. Porter, Assistant to the President for Economic and Domestic Policy (Invited)

Papers submitted for publication in association with this session should address such issues as information needs of the policy community; proposed mechanisms to reach national or international consensus on policy issues; the degree of certainty required to implement policy changes; history of sample policy proposals, especially those which illuminate the decision-making process; and means of interaction between the policy and scientific communities.

3:30 Break

3:40 Session 7: Building a National Partnership—Getting Our Act Together

This panel, composed of selected members from previous panels, will address the actions required to develop an integrated plan of action. The moderator will summarize conclusions on various issues identified in preceding sessions. Audience questions not already addressed will be presented and discussed by the panel.

Moderator:

Ms. Judy Woodruff, Chief Washington Correspondent, MacNeil/Lehrer Report (Invited)

Panelists will include:

Dr. Frederick Bernthal, Chairman, Working Group III on Response Strategies, Intergovernmental Panel on Climate Change; Deputy Director, National Science Foundation

Dr. John A. Dutton, Dean, College of Earth and Mineral Sciences, Pennsylvania State University

The Honorable Jake Garn (R-UT), U.S. Senate; Appropriations Subcommittee on VA, HUD, and Independent Agencies (Invited)

Mr. Russell Koffler, Deputy Assistant Administrator for Satellite and Information Services, NOAA/NESDIS

Mr. Donald R. Lesh, President, Global Tomorrow Coalition

Dr. Roger B. Porter, Assistant to the President for Economic and Domestic Policy (Invited)

Mr. Robert C. Stempel, Chairman and Chief Executive Officer, General Motors Corporation (Invited)

Dr. Shelby G. Tilford, Director, Earth Science and Applications Division, Office of Space Science and Applications, NASA

5:00 Adjourn

Sessions

Wednesday, October 24, 1990

Masters of Ceremonies: Smithsonian Institution

Dr. Thomas E. Lovejoy, Assistant Secretary for External Affairs

Dr. Michael H. Robinson, Director of National Zoological Park

7:45 Registration and Continental Breakfast

8:30 Welcome Remarks—Dr. Thomas E. Lovejoy, Assistant Secretary for External Affairs, Smithsonian Institution

8:45 Keynote Address—Dr. D. Allan Bromley, Assistant to the President for Science and Technology

9:15 Session 4: Data Policy and Availability

Success in the U.S. Global Change Research Program requires that data be acquired, analyzed, and synthesized from an evolving international array of scientific, operational, and commercial satellite sensors, in situ measurements, historical data, conventional data, model outputs, etc. This vast quantity of information must be managed, safeguarded, standardized, and made available in a wide variety of compatible media and formats. The challenge of this task will require extensions of and changes in current policy as well as major implementation efforts. This session will focus on defining these problems and discussing initiatives underway to address these concerns.

Moderator:

Dr. John A. Dutton, Dean, College of Earth and Mineral Sciences, Pennsylvania State University

Panelists will include:

Dr. Dixon Butler, Chief, Advanced Mission and Interdisciplinary Branch, Earth Science and Applications Division, NASA

Dr. Graham Harris, Director, CSIRO Office of Space Science & Applications, Australia (Invited)

Mr. Shoichiro Katayama, Director for Earth Science and Technology, Research and Development Bureau, Science and Technology Agency, Japan (Invited)

Dr. S. Ichtiaque Rasool, Chairman, Data and Information Systems, International Geosphere-Biosphere Program; Chief Scientist for Global Change, Office of Space Science and Applications, NASA

Dr. Mark Settle, Chairman, The GEOSAT Committee, Inc.; Manager, Integrated Exploration Research, Exploration Research Group, ARCO Oil & Gas Company

Mr. Allen Watkins, Chief, EROS Data Center, U.S. Geological Survey, Department of Interior

Dr. Gregory Withee, Chairman, Task Group on Earth Systems Measurements and Data Management, Committee on Earth and Environmental Sciences; Director, National Oceanographic Data Center, NOAA

Papers submitted for publication in association with this session should address such issues as defining national and international data policies; understanding the Global Change Research Program data and information system requirements; data availability to industry, developing countries, and others; standardization, emphasizing an evolutionary approach which addresses the need to incorporate advances in technology and to respond to changing requirements and policy; development of new hardware, software, data sources, models, etc.; and approaches for coordinating international and interdisciplinary data requirements.

10:30 Break

10:45 Session 5: Economics of Global Environmental Change

Global environmental change and the actions taken in response to it will have profound economic effects. But unless the impacts associated with global change are understood, quantified, and predicted, it will be difficult to make wise choices in regard to mitigation and adaptation strategies. Earth observations leading to a predictive capability are the foundation of rational decision making. Key to addressing potential social and economic effects are the activities and initiatives of industry, public interest groups, the EPA, and DOE.

Moderator:

To be announced

Panelists will include:

Dr. Sharon L. Camp, Vice President, Population Crisis Committee

Academician Yuri Izrael, Chairman, Working Group II on Impacts, Intergovernmental Panel on Climate Change; U.S.S.R. State Committee for Hydrometeorology (Invited)

Mr. Mark L. Kerrigan, Principal Associate Deputy Undersecretary for the Office of Policy, Planning, and Analysis, Department of Energy

Dr. Michael McCloskey, Chairman, Sierra Club

Mr. Robert A. Mosbacher, Secretary, Department of Commerce (Invited)

Mr. Robert C. Stempel, Chairman and Chief Executive Officer, General Motors Corporation (Invited)

Representative, Environmental Protection Agency

Mr. Tasuku Tanaka, Director, Earth Observation Program Office, National Space Development Agency, Japan

Dr. Shelby G. Tilford, Director, Earth Science and Applications Division, Office of Space Science and Applications, NASA

Papers submitted for publication in association with this session should address issues such as proposed enhancements to these international initiatives, means to promote further international collaboration, and means to ensure international awareness of EOS and its results.

3:15 Break

3:30 Session 3: Earth-Based Observations—U.S. Initiatives

While the space segment of the Global Change Research Program has garnered much attention, in situ observations and research are also essential to the understanding of global change—both to calibrate and validate space observations and to measure parameters not accessible or suitable to satellite remote sensing. The President's FY 1991 budget reflects this requirement with a number of new starts and program budget increases in this area. Session panelists will discuss these new starts and their critical contributions to understanding global change.

Specific topics include: What is the significance of this new research initiative? How does it fit into the overall program from both a technical and programmatic perspective? What are the future plans for these programs?

Moderator:

Ms. Barbara Pyle, Vice President, Environmental Policy, Turner Broadcasting Systems, Inc.

Panelists will include:

Dr. Gary Evans, Special Assistant for Global Change Issues, Office of the Assistant Secretary for Science and Education, U.S. Department of Agriculture

Dr. J. Michael Hall, Director, Office of Climatic and Atmospheric Research, NOAA

Dr. W. Franklin Harris, Executive Officer, Biological, Behavioral, and Social Sciences, National Science Foundation

Dr. Allen Hecht, Deputy Assistant Administrator, Office of International Activities, Environmental Protection Agency

Dr. Aristides A.N. Patrinos, Program Manager, Carbon Dioxide Research Program, U.S. Department of Energy

Dr. Ronald W. Roskens, Administrator, Agency for International Development, Department of State (Invited)

Papers submitted for publication in association with this session should address such issues as means to combine data from earth-based and satellite observations; the proper balance between remote sensing and in situ observations; proposals to augment the terrestrial component; means to involve developing countries in this research; and the status of and plans for other earth-based components.

5:00 Adjourn

7:30 Evening Program—A Celebration of Planet Earth (National Air and Space Museum)

Welcome and Introductions by ERIM and Smithsonian

Special Guest Speaker

IMAX screening at the Samuel P. Langley Theater.

Reception and dinner (co-sponsored by ERIM and the National Air and Space Museum). Music provided by members of the Washington Symphony Orchestra.

Bus transportation provided from the conference hotels.

Location

The conference will be held at the National Press Club, located in the National Press Building at 14th and F Streets, NW, in downtown Washington, DC.

Hotels

Rooms have been reserved at The Hotel Washington, overlooking the White House just one block from the Press Club, at the special rate of \$130 (single) and \$145 (double). A few rooms are also reserved at the convenient JW Marriott Hotel adjoining the Press Club at the rate of \$180 (single) or \$190 (double) and at the Days Inn Downtown, a 15-20 minute walk to the Press Club, for \$65. To qualify for these special rates, contact the Hotel Washington at (800) 424-9540, the JW Marriott Hotel at (800) 228-9290, or the Days Inn at (800) 562-3350 before **October 1, 1990**, and identify yourself with the conference code ERIM.

Special Airfares

Northwest is offering attendees a 45% discount off normal coach fare or 5% off any published fare in effect when tickets are purchased. To obtain this discount, call Northwest meeting services at (800) 328-1111 or have your travel agency contact Northwest; refer to file number 05031.

Social Activities

Guests of registered participants are invited to join in refreshments and informal social activities in the conference hospitality room each morning. The luncheons and the guest hospitality room will be located in the

adjoining JW Marriott Hotel. The reception and buffet dinner (co-sponsored by ERIM and the National Air and Space Museum) is scheduled for 7:30 p.m., October 23, at the National Air and Space Museum.

Registration

To register, please return the attached form by mail or fax. Due to the Press Club's limited seating, attendance will be strictly limited to 500 participants.

The \$390 (U.S.) registration fee guarantees seating at all sessions, continental breakfast and refreshments for the two days, one ticket to each day's luncheon at the JW Marriott Hotel, one ticket to the evening buffet reception at the National Air and Space Museum, and one copy of the full conference proceedings. Additional tickets to the luncheons and reception can be purchased.

Cancellations/Refunds

ERIM will refund the full registration fee upon receiving a written request before October 1, 1990, or when the Press Club seating limit is reached.

Proceedings

The conference proceedings will provide a permanent record of the meeting. One copy of the proceedings is included with each registration. Additional copies of these proceedings and copies of the 1989 conference proceedings can be ordered from Krieger Publishing, P.O. Box 9542, Melbourne, FL 32902-9542, Telephone: (407) 724-9542, Fax: (407) 951-3671.

Earth Observations & Global Change Decision Making: A National Partnership Advance Registration Form National Press Club

Fall Conference October 23-24, 1990

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\$25 Guest Luncheon Ticket, Wednesday (Oct. 24)

\$50 Guest Ticket, Air & Space Buffet/Reception (Oct. 23)

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Earth Observations & Global Change Decision Making: A National Partnership

Fall Conference ■ October 23-24, 1990



Photo by David Valdez

Global climate has changed dramatically throughout humanity's evolution. Yet, while human impact on the natural world has slowly accumulated over centuries, historically climatic changes have been almost entirely of natural origin. In the future, changes may well be attributed directly to human causes.

Recently it has become clear that human alteration of the earth is occurring with unprecedented rapidity. Continuation of these trends may lead to global climatic conditions well outside the range experienced in recent history. Indeed, some experts have stated that climatic effects are already observable.

The magnitude of the potential impacts on climate and the entire earth system has led to calls for changes in policy and for an enhanced research program to serve as the foundation for national and international policy discussions. Satellite earth observations and the development of a concomitant scientific data and information system are critical to establishing that research base, as well as to setting the parameters of the discussion and providing the opportunity for sound policy making.

In 1987 the presidential science advisor established the Committee on Earth Sciences (CES) to develop a coordinated national research strategy to address these concerns. Early in 1989 the CES (composed of senior representatives from each Federal agency involved in monitoring and under-

"Let us remember as we chase our dreams into the stars that our first responsibility is to our Earth, to our children, to ourselves. Yes, let us dream, let us pursue those dreams, but let us also preserve the fragile world we inhabit."

Presidential Greeting to 1989 Global Change Conference

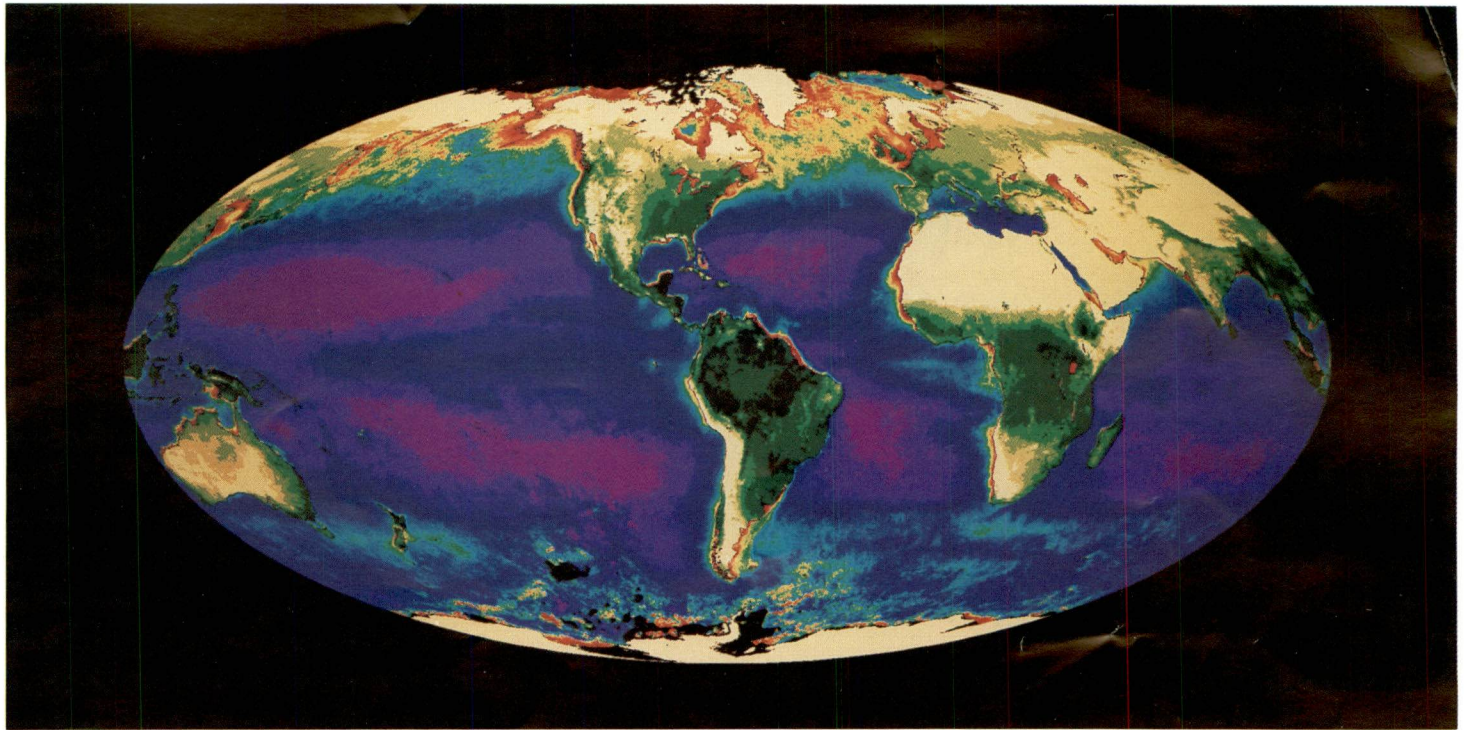
standing the earth) developed goals, an implementation strategy, and a research budget for the U.S. Global Change Research Program. The CES report, *Our Changing Planet: The FY 1991 U.S. Global Change Research Program*, presents an excellent foundation for establishing the crucial Federal research program element of a national global change program.

Because the national global change effort must involve many participants beyond the Federal Government, communication of the Federal strategy to a national and international audience is imperative to the success of the U.S. Global Change Research Program. The Federal earth observation community, the research community, educators, the media, the industrial sector, public interest groups, and policy makers at all levels must work as a team to effect any significant change on a global scale.



Earth Observations & Global Change Decision Making: A National Partnership

Fall Conference ■ October 23-24, 1990



Data from NASA's Nimbus-7 Coastal Zone Color Scanner and the NOAA-7 Advanced Very High Resolution Radiometer were combined to create this image of the global biosphere. Color codes represent phytoplankton pigment concentrations in the ocean and vegetation patterns on land. (Image courtesy of NASA Goddard Space Flight Center.)

Purpose

In a pivotal decade for the U.S. Global Change Research Program, this unique conference is intended to help build a national partnership for earth observations and global change decision making by:

- Facilitating dialogue between the various communities involved in global change research and policy;
- Communicating the Federal research strategy (including Mission to Planet Earth);
- Identifying and discussing issues not addressed by Federal initiatives; and
- Discussing how the national agenda fits into the evolving international program.

Conference Participants

The conference will be of special interest to the:

- Federal earth observation community,
- Research community,
- Educators and students,
- Industry,
- Policy makers (local, state, Federal, and international),
- Public interest groups, and
- Media.

Panel Sessions

Presentations and panel sessions that include high-ranking elected officials, senior-level administrators, and private sector representatives are being organized to address the following topics and issues:

- Mission to Planet Earth—National Partners
- Mission to Planet Earth—International Partners
- Earth-Based Observations—U.S. Initiatives
- Data Policy and Availability
- Economics of Global Environmental Change
- Policy Response to Global Environmental Change
- Building a National Partnership—Getting Our Act Together

The conference proceedings will include records of the panel sessions and contributed papers that address one or more of the session topics. Those interested in contributing papers should contact ERIM for additional information and the author's kit.

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Ann Arbor, MI 48107-8618, USA
Telephone: (313) 994-1200, ext. 3382
Telex: 4940991 ERIMARB
Fax: (313) 994-5123

All contributed papers received by **October 24, 1990**, will be reviewed and those selected will be published in the conference proceedings.

Our Changing Planet: The FY 1990 Research Plan

Executive Summary



This photograph of the Earth was taken from the Apollo 10 Spacecraft. Much of the Earth is heavily cloud covered. A portion of the United States from the Great Lakes to Southern California, including the Rocky Mountain area, is visible. The North American coastline from Southern Mexico to Alaska can be seen.

Our Changing Planet: The FY 1990 Research Plan

Executive Summary

**THE U.S. GLOBAL CHANGE
RESEARCH PROGRAM**

**A Report by the Committee
on Earth Sciences**

July 1989

**Office of Science and Technology Policy
Federal Coordinating Council on Science,
Engineering, and Technology**

Committee on Earth Sciences

Chairman

Dallas Peck, Department of the Interior, United States
Geological Survey

Vice-Chairman

Richard G. Johnson, Office of Science and Technology Policy
(Consultant)

Members:

Beverly J. Berger, Office of Science and Technology Policy
Frederick M. Bernthal, Department of State
Erich Bloch, National Science Foundation
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Richard H. Truly, National Aeronautics and Space Administration
Harlan L. Watson, Department of the Interior

Executive Secretary

John Houghton, Department of the Interior, United States
Geological Survey

(See Appendix for the CES Charter)

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
Washington, D.C. 20506

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Early in 1989, I transmitted to the U.S. Congress a report which accompanied the President's FY 1990 Budget outlining the goals, implementation strategy, and research budget of the U.S. Global Change Research Program. This strategy document, entitled "Our Changing Planet: A U.S. Strategy for Global Change Research," was the product of an intense inter-agency effort by experts in various earth sciences and other disciplines. This interagency effort was coordinated by the Committee on Earth Sciences (CES) of the Federal Coordinating Council for Science, Engineering, and Technology. The strategy document promised a detailed and comprehensive research plan based on the research strategy to be published in 1989.

I am pleased to forward with this letter the U.S. Global Change Research Program research plan for FY 1990. This research plan focuses on establishing a sound scientific basis for developing national and international policy on global change issues. Global changes such as desertification, drought, volcanism, and global warming can have a tremendous economic and societal impact. The relative roles of human activity and natural processes in these changes are of great importance but are, at present, unknown. In addition, our knowledge is insufficient to reliably predict the likely degree, rate, or timing of these changes. Improving our ability to understand and to ultimately predict global changes, whether natural or human-induced, is essential. The CES research plan represents a well-coordinated federal research program to address these issues and provides a strong foundation for international cooperation.

The scientific objectives of the research plan are to monitor, understand, and ultimately predict global change. The report outlines a priority framework for focusing and integrating the interagency research efforts to ensure that they meet these objectives. This priority framework was derived from numerous research priorities outlined by both the U.S. and international communities. It indicates research areas that require progress to improve our understanding of both natural and human-induced global changes. This research plan provides a solid foundation for future planning and will be updated periodically to reflect our growing understanding of global environmental changes.

I take this opportunity to thank and commend Chairman Dallas Peck and his interagency committee members and staff who have done an outstanding job in preparing this report.


William R. Graham
Director

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THE U.S. GLOBAL CHANGE AT-A

- ❑ Many global changes can have tremendous impact on the welfare of humans. These events may stem from natural processes that began millions of years ago or from human influence. Responding to these changes without a strong scientific basis could be futile and very costly.
- ❑ This report presents a comprehensive research plan for the U.S. Global Change Research Program.
- ❑ The goal of the Program is to provide a sound scientific basis for national and international decision making on global change issues.
- ❑ The Program's goals, objectives, research priorities, and strategy are consistent with current national and international global change planning and research efforts.
- ❑ The scientific objectives of the Program are to monitor, understand, and ultimately predict global change.
- ❑ The Program is broad in scope, encompassing the full range of Earth system changes, including physical, chemical, geological, social, and biological changes. The Program addresses both natural phenomena, as well as the effects of human activity.

RESEARCH PROGRAM GLANCE

- ❑ The particular research activities which comprise the U.S. Global Change Research Program are grouped into seven interdisciplinary scientific elements:
 1. Climate and Hydrologic Systems
 2. Biogeochemical Dynamics
 3. Ecological Systems and Dynamics
 4. Earth System History
 5. Human Interactions
 6. Solid Earth Processes
 7. Solar Influences

- ❑ In fiscal year 1989, funding for focused global change research activities total \$133.9 million. The President's FY 1990 budget proposes a funding level of \$191.5 million, a 43 percent increase for focused programs. This substantial increase will enable the Program to expand and accelerate its research activities in most areas of global change research.

- ❑ This strategy was developed by a U.S. Federal interagency group, the Committee on Earth Sciences of the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET). The FCCSET is chaired by the Director of the Office of Science and Technology Policy in the Executive Office of the President.

Introduction

The Earth is a changing place. Over the past million years deserts, forests, and grasslands have migrated across the land, seashores have advanced and retreated, and wet and dry periods have come and gone. The dramatic rise in industrial activities during the 19th and 20th centuries has produced a new set of concerns, namely, that human activities may be affecting the Earth system. Consequently, wise use of the Earth for human habitation has become an important political and scientific issue. World population growth, intense industrial and agricultural activities, and the need to maintain man's health and welfare require that each individual and country exercise appropriate environmental care and sensitivity.

The global changes that may affect both human well-being and the quality of life on this planet include ozone depletion, global climate warming, sea level change, drought, deforestation, desertification, and reduction in biodiversity. While dramatic and complex in and of themselves, these discrete global environmental concerns cannot be fully understood unless they are addressed collectively.

Many of these changes are the result of interrelated natural processes, including changes in the climate system, in solar processes, in the Earth's orbit, in volcanic processes, and in the distribution of biological species and landmasses that may have been ongoing for centuries. Although human activities may have the potential to alter the Earth system, it is clear that variations occur naturally over a wide range. For many of these changes, current knowledge is insufficient to reliably predict the likely degree, rate, or timing of these changes. To understand and ultimately predict the impact of both natural processes and human activities on these changes, it is necessary to improve our understanding of the underlying physical, geological, chemical, biological, and social processes that control the Earth's environment.

In the past several decades, science has provided increased insight into how the Earth and its global environment function. This capability provides the opportunity for a new and more responsible partnership with nature and a mechanism to improve the scientific basis for making policy decisions on global change issues. An effective and well-coordinated national and international research program will be required to dramatically improve our knowledge of these complex Earth processes — to provide the basis to discriminate between natural and man-influenced changes, and ultimately to predict global change.

The Purpose of This Report

To address this need, the President transmitted to the Congress in early 1989 a report entitled *Our Changing Planet: A U.S. Strategy for Global Change Research*. This report outlined the goals and objectives of the U.S. Global Change Research Program (Program) and recommended that a comprehensive research plan be developed to further integrate Federal global change research activities.

Our Changing Planet:
A U. S. Strategy
for Global Change Research



A Report by the Committee on Earth Sciences

To Accompany the
U. S. President's Fiscal Year 1990 Budget

In response to this recommendation, a comprehensive research plan, entitled *Our Changing Planet: The FY 1990 Research Plan*, has been developed for the U.S. Global Change Research Program. This document is the Executive Summary of the Research Plan. All of these documents have been developed by a U.S. Federal interagency group, the Committee on Earth Sciences (CES) of the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET). The FCCSET is chaired by the Director of the Office of Science and Technology Policy in the Executive Office of the President.

In addition to information included in the original strategy document, the Executive Summary also includes identification of the key scientific questions, the priorities among research needs, and identification of specific agency roles. Both the strategy document and the Executive Summary cover the Program's FY 1989-1990 activities. The purpose of this Executive Summary and the Research Plan is to present the FY 1990 program in the priority framework that has been developed over the past year. This format will be the basis for the Program in FY 1991 and future years.

The Scope of The U.S. Global Change Research Program

The overall U.S. strategy to address global change issues requires efforts in three areas: research to understand the Earth's environment; research and development of new technologies to adapt to, or mitigate, environmental changes; and formulation of national and international policy response options required for a changing environment. The goal of the U.S. Global Change Research Program is to provide the scientific basis for informed decision making. It is not the role of the Program to formulate policies regarding global change, nor does its mandate cover the research required to develop new

technologies that might be used to mitigate or adapt to a changing environment.

The CES recognizes that, while alternative technologies are not a component of the Program, high priority should be given to this important research. Agencies such as the Environmental Protection Agency (EPA), Department of Energy (DOE), and U.S. Department of Agriculture (USDA) must play a leadership role in the important area of research in adaptation and mitigation technologies. Such research would be complementary to the U.S. Global Change Research Program and to ongoing studies of response strategy formulation.

The U.S. Global Change Research Program

Program Goal

Rational response strategies and sound policy can only be built upon reliable information, predictions, and assessments of the complex phenomena of the global earth system. It is in this context that the U.S. Global Change Research Program goal has been developed.

U.S. Global Change Research Program Goal

Recognizing that effective and rational response strategies to environmental issues can be built only on sound scientific information, the overarching goal of the U.S. Global Change Research Program is:

To gain a predictive understanding of the interactive physical, geological, chemical, biological, and social processes that regulate the total Earth system and, hence, establish the scientific basis for national and international policy formulation and decisions relating to natural and human-induced changes in the global environment and their regional impacts.

In formulating the Research Plan, the CES has drawn upon the national and international research plans and recommendations developed by the scientific community over the past few years that call for a systematic and integrated study of the global Earth system and its susceptibility to change. In particular, the CES relies heavily on the advice and recommendations of the U.S. National Academy of Sciences' (NAS) Committee on Global Change. The goals, objectives, and strategies of the Program are also consistent with the International Council of Scientific Unions' (ICSU) International Geosphere-Biosphere Programme, and the ICSU and World Meteorological Organization's (WMO) World Climate Research Programme.

Key Scientific Questions

Meeting the above goal will require addressing the following three major questions of the U.S. Global Change Research Program:

- *What global changes have occurred in the past and are occurring now?*
 - *Proxy Record*
 - *Direct Measurement*

- *What physical, geological, chemical, biological, and social processes are involved in influencing global change and its environmental impacts?*
 - *Global Change Forcing Agents*
 - *Global System Interactions*

- *How well can global change and its impacts be predicted?*
 - *Model Simulation of the Past*
 - *Model Simulation of the Present*
 - *Model Prediction of the Future*

A central goal in addressing all three of these scientific questions is improving our ability to distinguish between natural and human-influenced changes in the global environment.

Implementation Strategy

The strategy for implementing the U.S. Global Change Research Program requires the identification of scientific objectives, the integration of traditional scientific disciplines, and the establishment of new coordination mechanisms.

Scientific Objectives. The Program has three parallel scientific objectives that address the key questions mentioned above.

These three objectives are the monitoring, understanding, and predicting of global change. Work toward these objectives must proceed simultaneously and in concert, since progress in each of these objectives influences the others. These three objectives are part of the Program priority framework and will be discussed in detail in the following priority framework section.

Disciplinary Integration. The Program recognizes the need to achieve a greater level of integration among both single-discipline and multi-discipline scientific activities. These levels of disciplinary integration include:

- *The Single-Discipline Level.* This fundamental level of activity comprises programs of observations, process studies, theory, and information systems in the basic and traditional Earth and social science disciplines, such as geology, oceanography, meteorology, biology, atmospheric chemistry, hydrology, agronomy, glaciology, economics, geography, and sociology.
- *The Interdisciplinary Level.* The knowledge of global subsystems is developed and tested at this level. Examples include interdisciplinary topics such as atmospheric-biospheric exchange; coupled oceanic-atmospheric dynamics; and chemical, dynamical, and radiative couplings in polar stratospheric ozone processes.
- *The Integrated Level.* Here the conceptual and predictive models of the whole Earth system are developed. Achieving this fully integrated level of perspective and activities is the overarching objective of the U.S. Global Change Research Program.

The Program requires support for activities across all three levels of disciplinary integration. It is this multi-level structure that draws upon the strengths of the existing and separate fundamental disciplines, while building the interdisciplinary

approaches that an integrated Earth picture also demands. The Program's seven science elements reflect the integrated and interdisciplinary nature of such a complex research effort. These science elements are:

- *Climate and Hydrologic Systems*. Includes the study of the physical processes that govern physical climate and the hydrological cycle, including interactions between the atmosphere, hydrosphere (i.e., oceans, surface and ground water, clouds, etc.), cryosphere, land surface, and biosphere.
- *Biogeochemical Dynamics*. Includes the study of the sources, sinks, fluxes, trends, and interactions involving the biogeochemical constituents within the Earth system, including human activities, with a focus on carbon, nitrogen, sulfur, oxygen, phosphorus, and the halogens.
- *Ecological Systems and Dynamics*. Includes the study of the responses of ecological systems, both marine and terrestrial, to changes in global and regional environmental conditions and of the influence of biological communities on the atmospheric, terrestrial, oceanic, and climatic systems.
- *Earth System History*. Includes the study and interpretation of the natural records of past environmental change that are contained in terrestrial and marine sediments, soils, glaciers and permafrost, tree rings, rocks, geomorphic features, and other direct or proxy documentation of past global conditions.
- *Human Interactions*. Includes the study of (i) the social factors that influence the global environment, including population growth, industrialization, agricultural practices, and other land usages; and (ii) the human activities that are impacted by regional aspects of global change.

- *Solid Earth Processes.* Includes the study of geological processes (e.g., volcanic eruptions and erosion) that affect the global environment, especially those processes that take place at the interfaces between the Earth's surface and the atmosphere, hydrosphere, cryosphere, and biosphere.
- *Solar Influences.* Includes the study of how changes in the near-space and the upper atmosphere that are induced by variability in solar output influence the Earth's environment.

The success of the U.S. Global Change Research Program requires progress in all seven scientific elements, as well as the development of data management/information systems to facilitate reduction and analysis of integrated data sets.

Coordination Mechanisms. The planning for and implementation of a broad and comprehensive global change research program will require collaboration and program coordination among many institutions and agencies; these can be broadly grouped into three "communities" that are involved with the science of global change:

- *National and international scientific community.* Including both structured (NAS, ICSU) and informal mechanisms (scientist to scientist) for planning science activities.
- *Government agencies.* Including individual agencies of governments (U.S. and foreign) that support and conduct global change scientific research and the coordinating bodies for these agencies within governments (e.g., CES).
- *Intergovernmental science bodies.* Including the multi-national bodies, such as the WMO, the United Nations Educational, Scientific, and Cultural Organization (UNESCO), and the United Nations Environment Program (UNEP).

No one Federal agency encompasses the breadth required by the U.S. Global Change Research Program. An effective confederation is required to support and conduct the needed activities, as outlined in the CES Charter (Appendix). Moreover, the complexity and scope of the research required underscores the advantages of an effective interface with coordinating bodies, including the National Academy of Sciences. Furthermore, since such national, and analogous international, interactions are far from being spontaneous or automatic processes, it is of paramount importance to establish and maintain these coordinating mechanisms.

Priority Framework for the U.S. Global Change Research Program

The CES has developed a multi-level priority-setting framework that can be used to focus and integrate program development and budget proposals. In order to address the Program goal of establishing the scientific basis for sound policy formulation, CES has identified several high priority research activities for each of the seven science elements. These represent the current understanding of the most serious intellectual hurdles limiting (i) the knowledge of the controlling processes of global change, and (ii) the capacity to develop comprehensive predictive capabilities.

For any given funding level, the mix of activities both within and between science elements will be determined through an iterative process involving many different participants, including the CES, the National Academy of Sciences, and others. It is likely and expected that these priorities will change as scientific understanding and capabilities evolve. Figure 1 lists the Program's strategic, integrating, and science priorities that are included in the priority framework.

Figure U.S. Global Change Research

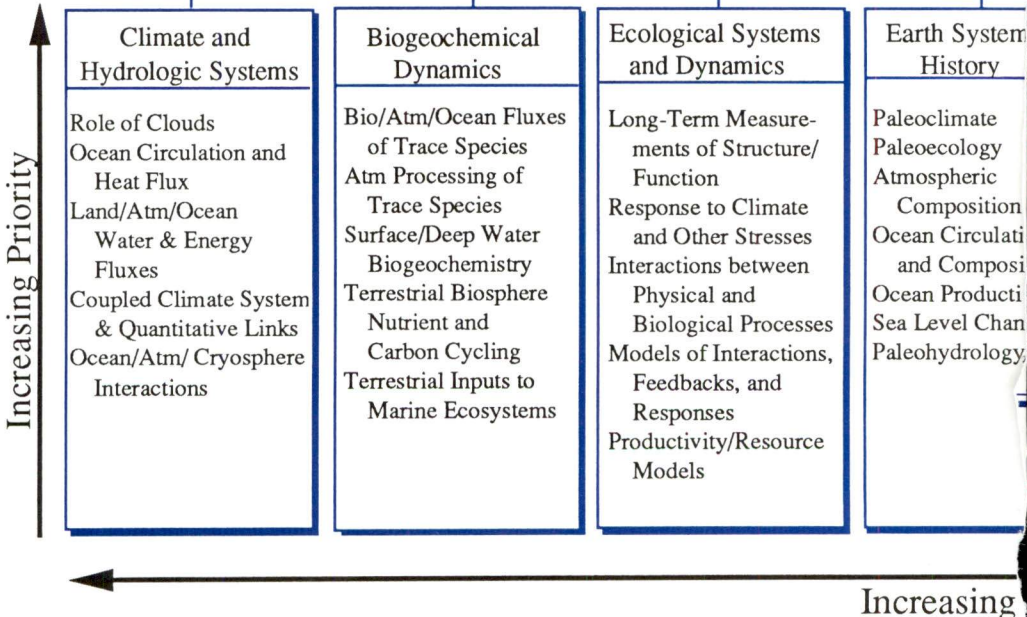
STRATEGIC

- Support Broad U.S. and
- Identify Natural and Hu
- Focus on Interactions
- Share Financial Burden

INTEGRATING

- Documentation of
 - Observational
 - Data Manage
- Focused Studies on
- and Improved
- Integrated Concep

SCIENCE



1

Program Priority Framework

PRIORITIES

International Scientific Effort
 man -Induced Changes
 and Interdisciplinary Science
 Use the Best Resources,

PRIORITIES

Earth System Change
 Programs
 ment Systems
 Controlling Processes
 Understanding
 tual and Predictive Models

PRIORITIES

	Human Interactions	Solid Earth Processes	Solar Influences
on tion vity ge	Data Base Development Models Linking: Population Growth and Distribution Energy Demands Changes in Land Use Industrial Production	Coastal Erosion Volcanic Processes Permafrost and Marine Gas Hydrates Ocean/Seafloor Heat and Energy Fluxes Surficial Processes Crustal Motions and Sea Level	EUV/UV Monitoring Atm/Solar Energy Coupling Irradiance (Measure/ Model) Climate/Solar Record Proxy Measurements and Long-Term Data Base

Priority

Strategic Priorities

The major purposes for establishing strategic priorities are to provide an overall framework to help determine the key elements of the U.S. Global Change Research Program, to keep the focus on the most central goals and objectives of the Program, and to compare budget decisions against broad strategic guidelines. The following research program characteristics are deemed to be of high strategic importance:

- *Supports Broad U.S. and International Scientific Effort.* Supports a broad U.S. and international effort to improve the scientific basis needed to address the environmental, societal, and economic challenges related to global change.
- *Identifies Natural and Human-Induced Changes.* Distinguishes natural changes from industrial, social, and other forms of human-induced changes.
- *Focuses on Interactions and Interdisciplinary Science.* Advances the scientific understanding of global change processes through a fundamental research program that focuses on the interactions among physical, geological, chemical, biological, and social processes and emphasizes interdisciplinary science.
- *Shares Financial Burden, Uses Best Resources, and Encourages Full Participation.* Shares the financial burden nationally and internationally, utilizes the best physical and intellectual resources, and encourages the full participation of all nations.

Integrating Priorities

As stated above, the U.S. Global Change Research Program has three parallel and interrelated scientific objectives, one or more of which must be served by any research project or activity

of the Program. These scientific objectives also serve as the following integrating priorities:

- *Establish an integrated, comprehensive long-term program of documenting the Earth system on a global scale through:*
 - *Observational programs*
 - *Data management systems.*
- *Conduct a program of focused studies to improve our understanding of the physical, geological, chemical, biological, and social processes that influence Earth system processes and trends on global and regional scales.*
- *Develop integrated conceptual and predictive Earth system models.*

Science Priorities

The science priorities are drawn from numerous sources, including (i) the extensive CES analysis of the current weaknesses in the understanding of global change and what research is needed to address these weaknesses; (ii) the 1988 NAS report entitled *Towards an Understanding of Global Change*; (iii) the 1984 WMO and ICSU report entitled *Scientific Plan for the World Climate Research Programme*; (iv) the 1988 Earth System Sciences Committee (National Aeronautics and Space Administration [NASA] Advisory Committee) report entitled *Earth System Science: A Closer View*; and (v) the 1988 ICSU report entitled *The International Geosphere-Biosphere Programme: A Study of Global Change — A Plan for Action*.

The science priorities are shown schematically in the lower part of Figure 1. The science elements are listed from left to right in descending order of priority. Within each of the seven science elements, the research activities are listed in descending order of priority. These priorities are designed to ensure

that the Program makes rapid progress toward resolving the most significant uncertainties with a given level of support. The CES recognizes that some level of effort is necessary in all the scientific activities to achieve the ultimate goal of reliably modeling the Earth system.

Although the priorities are ordered along each axis of the matrix, the importance of neighboring science elements is similar and virtually interchangeable. In many instances, the research activities shown in the matrix are complementary; hence funding one scientific activity may influence the priority of others, leading to lower priority activities being funded.

These science priorities include:

Climate and Hydrologic Systems. Studies need to be conducted to improve the understanding of (i) the role of clouds in the radiation budget of the atmosphere; (ii) oceanic circulation patterns and the redistribution of energy within the oceans; (iii) the fluxes of water and energy between the atmosphere, biosphere, and land and ocean surfaces; (iv) the quantitative links in the climate system, including feedbacks among atmosphere, ocean, cryosphere, land surface and biosphere; and (v) the influence of polar ice sheets and sea ice on climate and the hydrologic cycle.

Biogeochemical Dynamics. Studies must be conducted to improve the understanding of (i) the fluxes of radiatively and chemically active species between the atmosphere, biosphere, and land and ocean surfaces; (ii) the atmospheric cycling and transformations of radiatively and chemically important trace species; (iii) the biogeochemical processes responsible for the exchange of carbon and nutrients between the surface, deep ocean waters, and sediments; (iv) the cycling and transformation within the terrestrial biosphere of nutrients and carbon; and (v) the terrestrial flux of nutrients and carbon to coastal waters and oceanic ecosystems.

Ecological Systems and Dynamics. Research is required on (i) the structure and function of biological systems on various time scales; (ii) the response of species, ecological communities, and natural and managed ecosystems to carbon dioxide, climate, and physical/chemical stresses; (iii) the interactions between physical and biological processes on varying time and space scales; (iv) modeling ecology and physical climate interactions; and (v) modeling biological productivity of natural and managed ecosystems.

Earth System History. Research needs to be conducted to reconstruct the Earth's past climates and environments on both regional and global scales from evidence preserved in the geologic record, including past (i) natural variability of climate on all time scales, (ii) responses of ecosystems to climate change, (iii) changes in the composition of the Earth's atmosphere, (iv) changes in oceanic circulation and composition, (v) changes in oceanic productivity, (vi) changes in sea level, and (vii) changes in surface water and ground water in response to climate change.

Human Interactions. Research on human interactions in global change must be conducted to (i) establish long-term, comparable, cross-national data bases that encompass human activities such as land-use practices, energy transformations, legal and regulatory requirements, and economic behavior; and (ii) develop models linking population growth and distribution, energy demands, changes in land use, and industrial production.

Solid Earth Processes. Research is required to improve knowledge of (i) coastal erosion and wetland loss caused by sea level changes; (ii) the role of subaerial and submarine volcanism in contributing radiatively important gases, aerosols, heat, and fluids to the atmosphere and the ocean; (iii) how changes in the areal extent of permafrost will alter the quantity of radiatively important gases released to the atmosphere; (iv) the role of mid-ocean ridge systems in releasing heat, volatiles, fluids, and

particulates into the ocean and how these may influence ocean circulation, chemistry, and the carbon dioxide budget; (v) the erosional, transport, and depositional processes on the Earth's surface; and (vi) the Earth's crust and its deformation, both past and present, to establish local versus global absolute sea level change.

Solar Influences. Studies are required to (i) obtain long-term records of solar ultraviolet output; (ii) improve the understanding of the coupling of energy between atmospheric regions, from the thermosphere to the troposphere; (iii) obtain a long-term record of total and spectral solar irradiance; (iv) model climate response to solar inputs and variability; and (v) develop new measurement techniques to determine solar output.

The need for effective data management will be common to all of these science element activities. The studies need to provide these common resources: (i) the management of global-scale, long-term data from observation systems; (ii) the organization of data sets to improve the understanding of global change processes; and (iii) the analyses and preparation of data sets for the development and validation of predictive global change models.

Evaluation Criteria

Within the priority framework, the CES will implement the Program on the basis of the following criteria:

- *Relevance/Contribution.* The research addresses the overall goal and the three key scientific objectives of the Program.
- *Scientific Merit.* The proposed work is scientifically sound and of high priority.

- *Readiness.* The level of planning is high, the capabilities are of high quality and in place, and the research is likely to produce early advances.
- *Linkages.* National and international programmatic connections, including interagency partnerships, are in place.
- *Costs.* The identified resources are adequate, they represent an appropriate share of total available resources, there are prospects for joint funding, and long-term resource implications have been evaluated.

FY 1989-1990 U.S. Global Change Research Program Budget

FY 1989-1990 Budget Summary. Over the past year, the CES conducted several interagency global change research budget planning and analysis activities to ensure that the President's FY 1990 Budget includes requests that are well integrated and responsive to the Program's goals and priorities.

Table 1 presents the FY 1989-1990 Program budget. In FY 1989, funding for focused global change research activities totals \$133.9 million. The President's FY 1990 Budget proposes a funding level of \$191.5 million for this Program. This budget will allow the focused Program to expand and accelerate its research activities across most areas of global change. As a result of subsequent CES discussions, the levels of effort between science elements have changed slightly since the original strategy document.

FY 1990 Initiatives. Based on the priority framework, the Program has identified several new initiatives for FY 1990. The majority (approximately 76 percent) of the resources allocated to FY 1990 initiatives have been directed toward scientific activities within the three higher priority interdisciplinary science elements: Climate and Hydrologic Systems, Biogeochemical Dynamics, and Ecological Systems and Dynamics. These new initiatives include new programs and augmentations to ongoing efforts. In most cases, the research initiatives contain significant elements of all three scientific objectives, i.e., monitoring, understanding, and predicting global change, and are components of coordinated national and/or international programs.

The fact that the FY 1990 initiatives cut across many of the seven science elements and three scientific objectives demonstrates the interdisciplinary and multi-objective nature of the Program. However, this also makes it very difficult to display

the individual agency programmatic contributions. Some examples of these agency initiatives will be presented here along with the budget by science element, by agency, and by Federal Budget Function. The reader is referred to the Research Plan for a thorough listing of the FY 1990 initiatives. The following brief section analyzes the characteristics of some examples of the FY 1990 initiatives:

The Department of Commerce/National Oceanic and Atmospheric Administration (NOAA) Radiatively Important Trace Species initiative focuses on Biogeochemical Dynamics, is a single agency program that contains elements of all three science objectives, complements other ongoing U.S. agency programs (primarily in NASA and NSF), and is part of the high priority research outlined in the ICSU International Global Atmospheric Chemistry Programme.

The NSF and DOE Global Ocean Flux Study initiatives focus on Biogeochemical Dynamics, contain elements in all three science objectives, and are key components of a well-coordinated national (NSF, DOE, NASA, NOAA) and international program.

The proposed NASA Earth Observing System is a broad-based program that contains elements in all three science objectives and will contribute to an improved understanding of five of the seven scientific elements. The Program includes advanced technology definition studies for this future initiative. A significant international contribution has been negotiated through a series of bilateral agreements with the European Space Agency and other nations having major space programs.

U.S. GLOBAL CHANGE RESEARCH
(Dollar)

AGENCY	TOTAL BUDGET		CLIMATE AND HYDROLOGIC SYSTEMS		BIOGEOCHEMICAL DYNAMICS		ECOLOGICAL SYSTEM DYNAMICS
	FY89	FY90	FY89	FY90	FY89	FY90	FY89
AGENCY TOTALS	133.9	191.5	37.0	60.2	26.1	38.6	32.5
DOC/NOAA	9.0	20.0	8.5	16.5	0.5	3.5	0.0
DOE	20.2	27.2	7.0	12.0	6.0	5.5	4.2
DOI *	5.3	11.3	1.8	4.6	0.2	0.3	0.0
EPA	27.4	35.3	0.7	2.2	0.8	3.5	7.4
NASA	14.5	21.5	4.3	6.4	3.0	4.4	4.3
NSF	39.2	53.5	13.2	17.0	13.5	18.3	1.9
USDA	18.3	22.7	1.5	1.5	2.1	3.1	14.7

* NOTE: FY 1990 Focused Program Total differs from the amount reported in *Our* changes made after the printing date.

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BUDGET FOR FISCAL YEARS 1989 AND 1990
(in Millions)

BIOLOGICAL SYSTEMS & MICROBES	EARTH SYSTEM HISTORY		HUMAN INTERACTIONS		SOLID EARTH PROCESSES		SOLAR INFLUENCES	
	FY89	FY90	FY89	FY90	FY89	FY90	FY89	FY90
46.9	3.3	8.0	22.0	20.1	8.9	10.4	4.1	7.3
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.3	0.0	0.0	2.0	1.2	0.0	0.0	1.0	1.2
0.0	1.3	3.3	1.5	2.5	0.5	0.6	0.0	0.0
13.2	0.0	0.0	18.5	16.4	0.0	0.0	0.0	0.0
6.4	0.0	0.0	0.0	0.0	2.2	3.3	0.7	1.0
1.9	2.0	4.7	0.0	0.0	6.2	6.5	2.4	5.1
18.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Changing Planet: A U.S. Strategy for Global Change Research due to budget

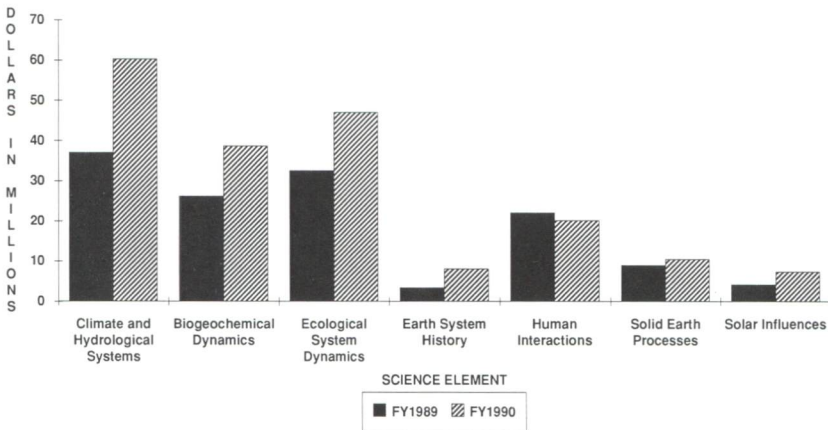
The Tropical Oceans and Global Atmosphere (TOGA) program addresses all three scientific objectives of the U.S. Global Change Research Program. It addresses an important problem in climate prediction, incorporating large-scale observations, intensive process research, and work on predictive models. In the U.S., TOGA involves formally coordinated work by four agencies (NOAA, NSF, NASA, and the Department of Defense [DOD]) advised by a panel from the NAS. Internationally, as part of the World Climate Research Programme (WCRP), 16 nations are cooperating through an intergovernmental board formally established for TOGA implementation. Several important bilateral relationships, which involve the U.S., have also been established to support TOGA.

The DOE Carbon Dioxide Program will initiate focused research on the problem of early detection of global climate change. This initiative seeks to identify the atmospheric and other measurements that appear promising in providing the early warming signals and to develop the analytical methodologies for quantifying the links between the "greenhouse" gas increases and climate change. The initiative spans the first two science elements and will examine the cause and effect relationships involved in global warming.

The National Ozone Expedition is an interagency program (NASA, NOAA, NSF) designed to obtain an improved understanding of the seasonal stratospheric ozone depletion over Antarctica and the biological significance of the resultant changes in ultraviolet radiation reaching the surface of this region of the Earth. Increased monitoring of solar ultraviolet fluxes in Antarctica will be initiated by NSF to help meet the program's objectives.

Budget by Science Element. From the scientific perspective, the best way to understand the Program budget is to examine it by science element. Figure 2 presents the FY 1989 and FY 1990 budgets by science element for focused research efforts.

Figure 2
U.S. Global Change Research Program
Budget by Science Element



- Climate and Hydrologic Systems.* The FY 1990 budget proposes \$60.2 million for this element, a 63 percent increase over the FY 1989 level. This increase will primarily focus on monitoring, understanding, and predicting aspects of (i) ocean circulation through tracer experiments (NOAA and NSF); (ii) interactions between the tropical oceans and the global atmosphere (NSF); (iii) sea level (NOAA); (iv) the exchange of energy and water between the atmosphere and terrestrial ecosystems and the cryosphere (NSF, Department of the Interior/United States Geological Survey [USGS], and NOAA); (v) the quantitative links between radiative and climate change (DOE), and advanced space remote-sensing technology (NASA).

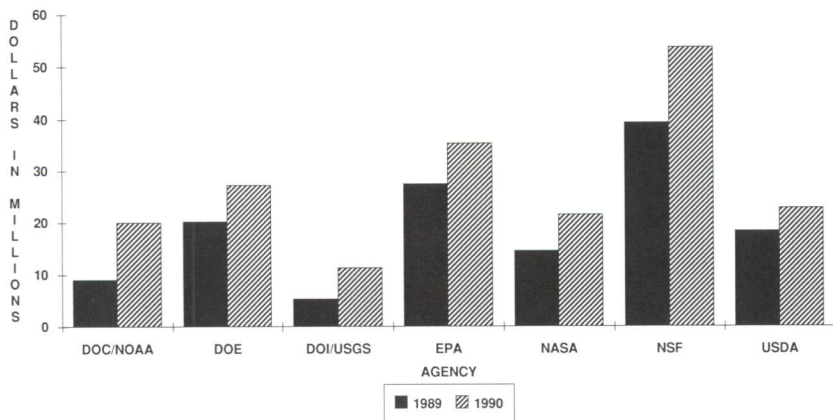
- *Biogeochemical Dynamics.* The FY 1990 budget proposes \$38.6 million for this element, a 48 percent increase over the FY 1989 level. This increase will primarily focus on monitoring, understanding, and predicting aspects of (i) the fluxes of radiatively important trace gases between the atmosphere and the oceans and terrestrial ecosystems (NSF, NOAA, EPA, USDA); (ii) fluxes of nutrients and carbon within the oceans (NSF, DOE); (iii) transformations, distributions and trends of trace species within the upper and lower atmosphere (NOAA, NSF), and development of advanced space remote-sensing technology (NASA).
- *Ecological Systems and Dynamics.* The FY 1990 budget proposes \$46.9 million for this element, a 44 percent increase over the FY 1989 level. This increase will primarily focus on understanding the response of managed and unmanaged ecosystems to changes in climate, carbon dioxide, ultraviolet radiation and other stress factors (USDA, EPA, DOE); and development of advanced space remote-sensing technology (NASA).
- *Earth System History.* The FY 1990 budget proposed \$8.0 million for this element, more than doubling the FY 1989 level. This increase will focus on an improved reconstruction of certain aspects of the Earth's climates and environments (USGS, NSF).
- *Human Interactions.* The FY 1990 budget proposed \$20.1 million for this element. While the budget table indicates no new FY 1990 resources for Human Interactions, NSF and USGS will augment efforts in this area through a reprogramming of existing funds in FY 1990.
- *Solid Earth Processes.* The FY 1990 budget proposes \$10.4 million for this element, a 17 percent increase over the FY 1989 level. This increase will primarily focus on

observations and understanding of crustal motions and dynamics (NSF), and developing advanced space remote-sensing technology (NASA).

- *Solar Influences.* The FY 1990 budget proposes \$7.3 million for this element, a 78 percent increase over the FY 1989 level. This increase will primarily focus on monitoring solar ultraviolet fluxes in Antarctica (NSF), understanding and predicting the solar driven energetics and dynamics of atmospheric regions (NSF, DOE), and developing advanced space remote-sensing technology for monitoring and understanding the influences of solar processes on the Earth's environment (NASA).

Budget by Agency. Figure 3 shows the FY 1989 and FY 1990 proposed focused program budgets by agency. The individual agency efforts reflect their particular mission and build upon their respective scientific and technical strengths.

Figure 3
U.S. Global Change Research Program
by Agency



- *Department of Commerce/National Oceanic and Atmospheric Administration (DOC/NOAA)*. The FY 1990 budget proposes \$20.0 million for DOC/NOAA, roughly doubling the FY 1989 level. NOAA maintains a balanced program of observations, analytical studies, climate prediction and information management in the national global change program. NOAA will be responsible for: operational *in situ* and satellite observations and monitoring programs; mission-directed research on physical and biogeochemical processes in the climate system (including their effect on marine ecosystems and resources); development, testing, and application of models and diagnostic techniques for the detection and prediction of natural and human-induced climatic changes; and the acquisition, maintenance, and distribution of long-term data bases and related climate information.
- *Department of Energy (DOE)*. The FY 1990 budget proposes \$27.2 million for DOE, a 35 percent increase over the FY 1989 level. DOE shall conduct research on carbon dioxide and other emissions from energy supply and end use systems. The research shall include the climate's response to those emissions and shall develop the base of scientific information necessary to assess the climate's response, assuming various energy and industrial policies. Associated efforts may include, but not be limited to, research to quantify the relationships between carbon dioxide and other trace gases and temperature rise, assessment and application of predictive models, evaluation of global and regional climate and environmental responses to various energy policy options, and research on industrial sources of trace gases. Research may include all causes of climate change and how possible responses to change could affect energy options.

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- *Department of the Interior/United States Geological Survey (DOI/USGS)*. The FY 1990 budget proposes \$11.3 million for DOI/USGS, roughly doubling the FY 1989 level. DOI/USGS program efforts address the collection, maintenance, analysis, and interpretation of short- and long-term land, water, biological, and other natural resource data and information. Such efforts include, but are not limited to, monitoring of hydrologic and geologic processes and resources, land use, land cover, and biological habitats, resources, and diversity. Some DOI research areas include: past global change recorded in the physical, chemical, and biological record; the hydrologic cycle; land-surface and solid Earth processes that relate to environmental change; geography and cartography; polar and arid region processes; ecosystem modeling and dynamics; and resource ethnology. The Department utilizes knowledge developed in these and other agencies' programs to evaluate and when necessary respond to potential effects of global change on water, land, biological, and other natural resources.
 - *Environmental Protection Agency (EPA)*. The FY 1990 budget proposes \$35.3 million for EPA, a 29 percent increase over the FY 1989 level. EPA conducts research to assess, evaluate, and predict the ecological, environmental, and human-health consequences of global change, including the feedbacks of these systems on climate change. Additional areas of activity include research to determine emission factors, and inventories for radiatively important trace gases, and research to predict the interactions between global atmospheric change and regional air and water quality.

- *National Aeronautics and Space Administration (NASA)*. The FY 1990 budget proposes \$21.5 million for NASA, a 48 percent increase over the FY 1989 level. NASA is responsible for Earth science research from space, including those studies of broad scientific scope that study the planet as an integrated whole. Associated efforts include related process studies; sub-orbital and ground-based studies; remote-sensing and advanced instrument development; improvement of techniques for the transmission, processing, archiving, retrieval, and use of data; related scientific models; and other research activities in atmospheric, oceanographic, and land sciences.
- *National Science Foundation (NSF)*. The FY 1990 budget proposes \$53.5 million for NSF, a 36 percent increase over the FY 1989 level. NSF is responsible for maintaining the health of basic research in all areas of Earth, atmospheric (including solar-terrestrial), and ocean sciences, including the relevant biological and social sciences and research in the polar regions. The basic research program is focused on ground-based studies on regional and global scales; large-scale field programs; interpretation and use of remotely-sensed data and geographic information systems; theoretical and laboratory research; research facilities support; and the development of numerical models, information and communication systems, and data bases.
- *Department of Agriculture (USDA)*. The FY 1990 budget proposes \$22.7 million for USDA, a 24 percent increase over the FY 1989 level. USDA conducts research to assess the effects of global change on the agricultural food and fiber production systems and on forests and forest ecosystems of the United States and worldwide, including, but not limited to, basic research on the biological response mechanisms to increasing “greenhouse” gases; improvement of plant and animal germ plasm to respond to global change;

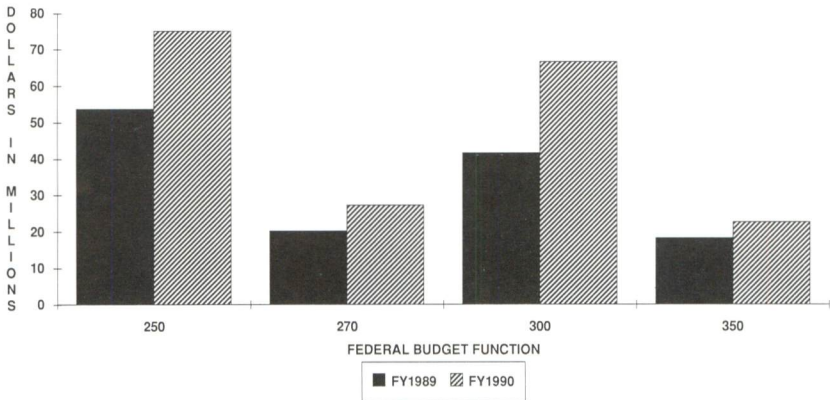
and development and implementation of plans for terrestrial mitigation systems to ameliorate the observed increases of greenhouse gases, including crops and forests. An additional responsibility shall include research on applications of agricultural climatology to improve management decisions and conservation of resources, while maintaining quality and quantity of crop yields.

The DOD and Department of Transportation currently do not conduct research that is focused on the goals and objectives of the Program, although both agencies conduct research that contributes to this research effort. These programs are discussed further in the Research Plan.

Budget by Federal Budget Function. Scientific, environmental, energy, and agricultural resources are very important to the nation. All either impact or are impacted by global change.

Figure 4 and Table 2 illustrate the Program's focused funding levels by the Federal budget functions that encompass these national resources. As would be expected, the budget proposes significant increases for budget functions 250 (General Science, Space and Technology) and 300 (Natural Resources and Environment). In FY 1990, \$75 million is proposed for function 250, a 40 percent increase over FY 1989. For function 300, \$66.6 million is proposed for FY 1990, a 60 percent increase over FY 1989.

Figure 4
U.S. Global Change Research Program
by Federal Budget Function



Despite the broad distribution across these budget functions and, hence, across many Executive Branch and Congressional decision making paths, it is crucial to view the Program as a single integrated research effort. The success of many of the science objectives depends on the cooperation and contributions of all the individual agency programs. Thus, decisions concerning these investments should attempt to recognize the full scope and structure of the U.S. Global Change Research Program.

Table 2

**U.S. GLOBAL CHANGE RESEARCH PROGRAM
BUDGET**
by Federal Budget Function for Fiscal Years 1989 and 1990
(Dollars in Millions)

Budget Function	Budget Function Number	1989	1990
Total		133.9	191.5
General Science, Space and Technology	250	53.7	75.0
NASA		14.5	21.5
NSF		39.2	53.5
Energy (DOE)	270	20.2	27.2
Natural Resources & Environment	300	41.7	66.6
DOI/USGS		5.3	11.3
EPA		27.4	35.3
DOC/NOAA		9.0	20.0
Agriculture (USDA)	350	18.3	22.7

Epilogue: The Fundamental Rationale

In the coming decades, global change may well represent the most significant societal, environmental, and economic challenges facing this nation and the world. The national goal of developing a predictive understanding of global change is, in its truest sense, science in the service of mankind.

Appendix
CHARTER
COMMITTEE ON EARTH SCIENCES
of the
Federal Coordinating Council for Science, Engineering,
and Technology

The Committee on Earth Sciences (CES) is hereby established by action of the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET). FCCSET derives its current authority from Executive Order 12039 of February 24, 1978.

Purpose and Functions

A goal of Earth sciences is to understand, on a global scale, how the highly interactive system comprised of the solid Earth, the oceans, the atmosphere and magnetosphere, and the biosphere has evolved, how it functions today, and how it will evolve in the future. In addition to the basic research, important components of Earth science R&D include continued development of the technology for needed observations of the Earth system and increased emphasis on collection, analysis and archival of data on a global scale from satellite and ground-based measurements needed for long-term research efforts and also needed to address national policy issues which depend on a characterization of humankind's impact, or potential impact, on the global environment. The purpose of the Committee on Earth Sciences is to increase the overall effectiveness and productivity of Federal R&D efforts directed toward an understanding of the Earth as a global system. In fulfilling this purpose, the Committee addresses significant national policy matters which cut across agency boundaries.

Specifically the CES:

- a. reviews Federal R&D programs in Earth sciences including both national and international programs;

- b. improves planning, coordination, and communication among Federal agencies engaged in Earth sciences R&D;
- c. identifies and defines Earth sciences R&D needs;
- d. develops and updates long-range plans for the overall Federal R&D effort in Earth sciences;
- e. addresses specific programmatic and operational issues and problems which affect two or more Federal agencies;
- f. provides reviews, analyses, advice and recommendations to the Chairperson of FCCSET on Federal policies and programs concerned with Earth sciences R&D, particularly in assessing humankind's impact on the global environment;
- g. develops the Administration's response to the call for a report to Congress, in the NSF Authorization Act of 1987, concerning Federal Government action with respect to the establishment of an International Year of the Greenhouse Effect mandated in calendar year 1991.

Structure

The Chairperson and Vice-Chairperson of the CES are appointed by the Chairperson of FCCSET; the Vice-Chairperson is from an agency other than that which the Chairperson represents. The Executive Secretary is designated by the CES Chairperson. Additional staff assistance is provided by member agencies as required by the Committee. Chairpersons of CES task forces or working groups arrange assistance from their own agencies.

The following departments and agencies are represented on this Committee:

Department of Agriculture
Department of Commerce
Department of Energy

Department of the Interior
Department of State
National Science Foundation
Environmental Protection Agency
National Aeronautics and Space Administration
Office of Science and Technology Policy
Office of Management and Budget
Council on Environmental Quality

Other Federal agencies participate, as appropriate, upon invitation by the Committee Chairperson or the Chairperson of FCCSET.

The CES Chairperson approves the establishment, continuation, or termination of task forces and working groups as necessary to achieve the Committee's purposes. Membership on such task forces and working groups is not restricted to Committee members and is established as the Committee may determine appropriate.

The Committee meets at the call of the CES Chairperson who also approves the agenda. Meetings are held not less than two times a year. Meetings of task forces and working groups are held as necessary to meet their specific objectives. Minutes of meetings are prepared by the Committee Executive Secretary and distributed to all members of the Committee, the leaders of task forces and working groups, and to the Executive Secretary of FCCSET.

Compensation

All members are full-time Federal employees who are allowed reimbursement for travel expenses by their agencies plus per diem or subsistence while serving away from their duty stations and in accordance with standard governmental travel regulations.

Documentation

Agendas and records of actions of Committee meetings are prepared and disseminated to members by the Executive Secretary. Records of actions are submitted to members for approval. Complete records of all Committee activities, including those of task forces and working groups, are maintained in the office of the Chairperson. The Committee prepares a report for the Chairperson of FCCSET not later than 60 days after the end of each fiscal year. The report contains, as a minimum, the Committee's functions, a list of members and their business addresses, the dates and places of meetings, and a summary of the Committee's activities and recommendations during the year.

Termination date

Unless renewed by the Chairperson of FCCSET prior to its expiration, the Committee on Earth Sciences of FCCSET shall terminate not later than December 31, 1990.

Determination

I hereby determine that the formation of the Committee on Earth Sciences is in the public interest in connection with the performance of duties imposed on the Executive Branch by law and that such duties can best be performed through the advice and counsel of such a group.

Approved:

March 6, 1987

Date

William R. Graham

Chairman, FCCSET

**Appointment of New Member
and Amendment to the Charter
of the
Committee on Earth Sciences
(FCCSET)**

APPOINTMENT: By my authority as Chairman, Federal Coordinating Council for Science, Engineering, and Technology (FCCSET), I appoint the Department of Transportation as a permanent member of the Committee on Earth Sciences (CES).

AMENDMENT: Charter of the Committee on Earth Sciences of the Federal Coordinating Council for Science, Engineering, and Technology as signed and approved on March 6, 1987, by the Chairman, FCCSET, is amended as follows.

Under the Section "Structure," add the following new member:

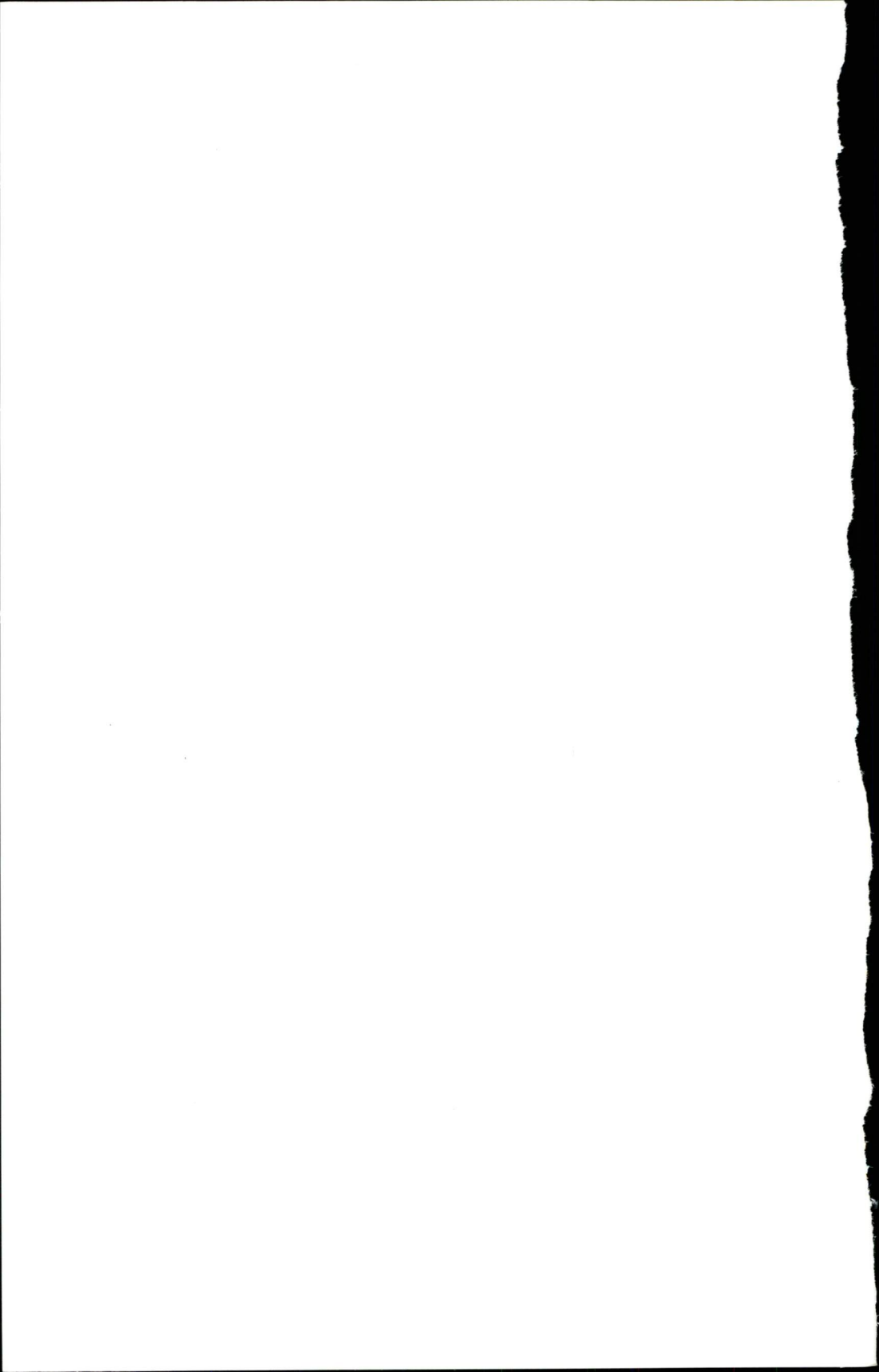
"Department of Transportation"

August 24, 1988

Date

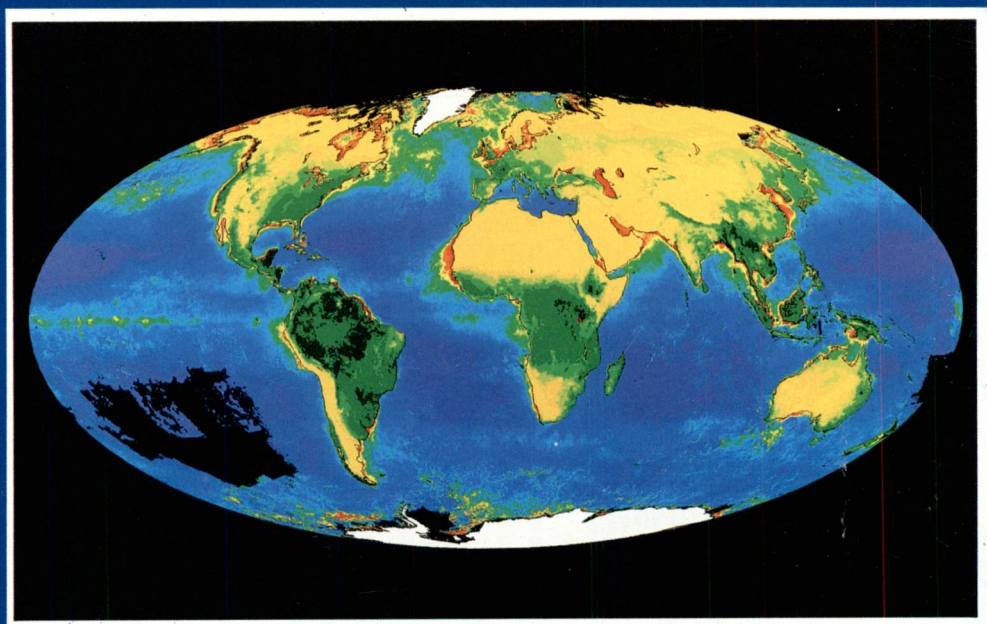
William R. Graham

William R. Graham, Chairman
Federal Coordinating Council
for Science, Engineering,
and Technology



Global patterns of biological productivity showing land and ocean vegetation. Land patterns are determined from measurements taken from the NOAA-7 polar orbiting satellite and ocean patterns from the NASA Nimbus-7 satellite. Ocean productivity patterns represent an average over 18 months and range from red (most productive) to purple (least productive). Land patterns represent the potential productivity averaged over 3 years and range from deep green (representing rain forests) to beige (representing deserts and barren regions).

*The U.S. Global Change
Research Program*



THE WHITE HOUSE

WASHINGTON

July 2, 1990

MEMORANDUM FOR ED GOLDSTEIN

FROM: ADAM ISLES *AI*

SUBJECT: DOJ Meeting

I attended a meeting at the Department of Justice on your behalf last Thursday, June 28. Below, you will find a typed version of the notes I took at that meeting. Attached are two handouts given to me at the meeting.

Participants discussed putting together an initial August meeting of experts in Paris to outline an agenda for the December conference on emissions trading. The goal would be use the Stockholm IPPC meeting this October to generate reactions to the initial outline and amend it accordingly. The group stressed that it did not want to grow too independent of the IPPC process, nor did it want it to appear as though the U.S. was coopting anyone into agreeing on certain options.

Everyone seemed to agree that it would be important to include both OECD and UNEP in these initial meetings. Mentioned personally were Michael Guinn and Sam Tuowumba (sp?) Also mentioned were a Mr. Ibrahim from Egypt and a "gal" from Mexico, both of whose input and ability to draw in other nations was considered especially helpful. More generally, it was agreed that it would be very important to have developing countries at the meeting. The participants felt it imperative to get out the message about the initial meeting (something the French are terrible at doing), and to have travel funds available for representatives of lesser developed countries.

It was felt that the Norwegians would be especially interested, while the Germans would be too preoccupied by unification efforts to become too involved. The participants implied that there had been trouble, especially from the Japanese, in agreeing which nations to invite.

The participants expressed a desire to inventory the scattered research efforts currently underway in the United States. They also hoped to convince Yale professor of economics William Nordhaus to include an econometric model in his present research. More generally, the Secretary General of the OECD is apparently personally interested in continuing involvement research of economic instruments as they affect climate change.

EMISSIONS TRADING IN GREENHOUSE GASES:
DISCUSSION OF POSSIBLE OECD SEMINAR AND FUTURE WORK

Meeting with Paul Stolpman, OECD
Dept. of Justice, Room 2143
June 28, 1990, 4:00 p.m.

Draft List of Issues

The following list identifies issues that are in need of study and discussion and that could serve as the basis for an OECD seminar and/or study by the OECD.

I. Design of a Seminar

Organizational and logistical issues include:

- Timing, including possibility of appending it to a larger climate meeting
- Location
- Format, presenters, chair
- Auspices, links to other organizations (e.g. IPCC, UNEP)
- Invitees, including means to assure developing country participation

II. Issues to Address

A. National (Domestic) Trading

1. Informal vs. formal trading: considerations may differ depending on whether joint arrangements are permissible subject to governmental oversight (informal trading) or whether an allowance/permit system is created (formal trading). That is, informal trading can occur through ad hoc mutual reallocations of emissions by two or more parties to meet their aggregate obligations. Formal trading involves the inventory, registration, or issuance of some kind of permits or allowances, with subsequent trading to be denominated in these permits or allowances. Variations and permutations of these approaches can also be devised.

2. Identifying which gases, sources and sinks could feasibly be included in a trading system. Examining the practicality of a trading system that is comprehensive: including

CO2 only, or other gases as well? Sinks as well as sources? What types of sources and/or sinks? Would the choice of a comprehensive trading system affect the requirements for monitoring and verification, as compared with a simpler trading system or as compared with a non-trading regulatory system? Could a system start with a subset of gases, sources and sinks and then expand as knowledge and monitoring capacity improves? Could such an expansion be encouraged by incentive approaches (e.g. offering offset credit to newly demonstrated reductions in currently unmonitorable emissions)?

3. Identifying who would trade, and to whom emissions and emissions reductions are assigned. For example, emissions attributable to electricity use (and attendant tradeable allowances) could be assigned to utilities, appliance manufacturers, end users (businesses, farms & households), or some combination. Similarly, emissions attributable to gasoline combustion (and attendant tradeable allowances) could be assigned to oil extraction companies, oil refiners, automobile manufacturers, automobile owners, or some combination.

4. Consideration given in return for emissions allowances, including financial and technology assistance that may flow to allowance sellers. Important distributional impacts may concern national policymakers, as they have in the debates about the Clean Air Act here.

5. Facilitating trades. National and subnational governmental bodies could act as information clearinghouses, allowance/permit banks, brokers, auctioneers, and so forth. Private entities might also take on these roles.

6. Monitoring trading. Emissions would have to be monitored under any agreement, but trading would require some oversight of the trades. Depending on who does the trading, monitoring could be designed in different ways. National or subnational governmental bodies could perform this role, perhaps hiring private contractors. Monitoring could consist of spot checks, reporting or registration requirements, designated times and places for trading, or other arrangements. Some types of verification, through satellite detection or on-site inspection (e.g. of sinks) could be useful to monitor certain trades, though these techniques relate primarily to verification of emissions reductions themselves. Administrative costs and financing of such institutions need to be considered.

7. Nature and duration of allowance/permit rights. Trading could involve sales, leases, or other arrangements. Allowances could be set to expire or change (rise or fall) in face value over time. Sophisticated markets for trade currency might arise (as well as black markets if conditions limit the transferability of allowances), including futures and options

markets. The tax implications and tax status of allowances may be important. These arrangements can be structured to address concerns about "hoarding" and market-cornering by wealthy parties (see below).

8. Dealing with moral concerns about trading, such as the "license to pollute" issue and the notion that extra reductions should "go to benefit society." Comparison to regulation and emissions taxes.

9. Dealing with economic concerns about trading. Concerns may include: "hoarding" of tradeable rights; fears that wealthy parties would buy up all of the poorer parties' rights; monopsony and monopoly problems; hindrances to trading related to inadequate awareness of other market participants; problems of transferring allowances across industry lines and along vertical market lines.

10. Possible environmental concerns. Trading in greenhouse gases generally has no "hotspot" problem because the gases mix globally in the atmosphere. But there may be spatial distribution issues regarding, e.g., the residence time of short-lived gases such as CH₄, and the toxicity of gases such as CO and tropospheric O₃. These issues may be insufficiently significant to address at this time.

11. Initial and subsequent allocation of allowances: how would it differ if trading is available or not. Would the option of trading ease or exacerbate "gaming" of the initial allocation? Would the possibility of future legislated changes in allocations (which could possibly raise "takings" concerns) deter trading? What would the length of rights be? What flexibility should government have to modify the total stock? Would government derive revenue by auctioning rights off, taxing them, or other means?

12. Use of empirical experience with trading to deal with these issues. E.g. lead phasedown, Clean Air Act trading to date, local trading programs. Also, what trading has occurred under the Montreal Protocol (domestically or internationally)?

13. Documenting and predicting the advantages to trading: allocative efficiency (possibly start with an explanation of the ordinary gains from trade), incentives to reduce emissions, dynamic efficiency and innovation, incentives to use resources efficiently, incentives for sink enhancement, more affordable pollution control, equity.

14. Relationship to other laws, e.g. laws pertaining to trade, clean air, energy production, forestry, and agriculture. Relationship of national law to subnational governmental law, e.g. federalism concerns, the ability of states

to impose requirements that affect trading, preemption of state law.

More generally: can trading be designed to match the legal, institutional and economic structures and systems of nations with central planning or with limited or emerging free markets?

B. International Trading

In addition to the elements listed above under national trading, e.g. the comprehensivity of trading (item 2) and the nature of allowance rights (item 7), the following issues may also be relevant:

1. Informal or formal trading. As with national trading, international trading could initially occur "informally" through ad hoc bilateral or regional governmental treaties. Or more formal trading systems could be created, involving the issuance of allowances or permits in which trades are to be denominated.

2. Identifying who would trade. International trading could be undertaken, on a bilateral, multilateral or regional basis, by national governments. Yet private enterprises may be better situated to identify and make productive trades. Trades by private enterprises could be subject to clearance or monitoring by national governments. A mixed system of trading by both governments and enterprises could also be created.

Nations with different economic systems may find trading to be best conducted by different actors. For example, fully centrally planned economies may not find trading by "private" entities to be appropriate. At the extreme, must a nation have a domestic trading program in operation in order to participate effectively in international trading?

3. International institutions to monitor trading. The questions concerning who would trade have important implications for how trading would be monitored, and for the degree of formality and comprehensiveness of the international institutions monitoring trades. Unrestricted private trading, for example, could require a more elaborate international clearinghouse and monitoring apparatus than might a system limited to trading by national governments. Private trading could also (or alternatively) be monitored by national governments. Trading by national governments would presumably be monitored by an international body. Monitoring could vary from simple reporting requirements to prior approval requirements; procedures could be routine or elaborate. International monitoring mechanisms such

as inspections and audits might also raise concerns about sovereignty.

4. Scope of trades. Trading could occur among any interested parties within a global "bubble," or it could be conducted under regional "bubbles." The scope chosen could vary depending on the gas, sources and sinks in question.

5. Consideration for trades and related trade and development issues. Trading of net greenhouse gas emissions would create a new medium of exchange, with associated flows of capital and technology. (Some have argued that the consideration for trades should be limited to emissions-reducing technology, while others would favor unrestricted mutual bargains among parties.)

Trading could be a vehicle for resource transfers to developing nations. If developing nations have lower reduction costs than developed nations, perhaps owing to their ability to shift directly to non-fossil fuel energy sources and their abundant afforestation opportunities, developing nations could earn resources by selling excess allowances. (The same could be true of other low-cost reducers, such as planned economies about to turn over their capital stock, and nations that develop useful innovations.) Some argue that this mechanism poses the risk of undue economic leverage for developing nations, and that it will influence the gaming of initial allocations. Others see this mechanism as a decentralized, market-based alternative to resource flows dictated by international organizations, central international assistance funds, and preferential terms for technology transfer demanded by developing nations, and a way to reduce the gaming of initial allocations.

5a. Item 5 raises important issues regarding international trade regimes, e.g. the role of GHG emissions trading in international energy markets, GATT, efforts by national governments to distort international trade in allowances or to protect domestic allowance holders, and others.

5b. Item 5 also raises important issues regarding international aid regimes, e.g. the role of GHG emissions trading as an alternative to central aid funds and other aid vehicles, the link between emissions trading and international debt markets, and the calculation and ownership of the net emissions impacts of aid-funded projects.

6. Facilitating trades. International organizations and national governments could serve as information clearinghouses, brokers, bankers, auctioneers, and so forth. In some national economies and in the world economy, private entities might also assume these roles.

7. Dealing with moral, environmental and economic concerns. The usual concerns raised by trading may be influenced, in an international context, by the variety of cultures and stages of development of different nations. Some nations have expressed the view that trading is a "license to pollute" and therefore immoral. Experience with some debt-for-nature swaps (e.g. Bolivia) suggests that trades for sink resources may raise concerns about sovereignty and local opposition to outright sales of sink property rights to other nations. Some nations unfamiliar with trading may express the view that it is simply a means to allow illicit emissions. There are also concerns that developed nations would "buy up" all the allowances held by developing nations. One means for addressing these concerns would be to make allowances leasable for a term of years rather than fully alienable.

8. Initial allocation of allowances: how will it be set? How will the opportunity to trade affect the allocation-setting process? Will it tend to ease or exacerbate "gaming"? What scope would there be for varying the basis of allocation across nations? What flexibility would there be for subsequently modifying the stock of rights? Modification, perhaps based on initially limited duration of allowance rights, could be prompted, for example, by changing scientific understanding of emissions sources and sinks. The opportunity for modifications in the allocation of rights among nations (as opposed to the total stock) could discourage trading, because nations anticipating the allocations to be renegotiated might fear that selling some of their allowances would demonstrate that their initial allocations were "too high" and should be reduced.

9. Use of empirical experience with international trading to support discussion. Trading in goods, services, currencies, debt-for-nature, under the Montreal Protocol, etc.

10. Documenting and predicting the advantages to international trading. The advantages mentioned under national trading must be considered in the international context.

11. Relationship to other international law and international institutions.

C. Organizing Analysis:

1. Institutional analysis. Develop the institutional underpinnings of international trading: identify international entities that could assist in monitoring, facilitating and verifying the legitimacy of trades (e.g. regional economic organizations (such as OECD and EC), stock exchanges, and commodities exchange institutions), agencies with relevant information, and international instruments that might apply to such trading (e.g. GATT). Examine who would trade.

2. Economic analysis. (a) What would be the likely aggregate environmental and economic costs and benefits of employing international emissions trading? Studies could examine several policy scenarios, such as the degree of formality of trading and the likely participants. (b) What would be the advantages to different nations of (i) employing national (domestic) trading, and (ii) participating in international trading? The former depends in part on the nation's domestic economic structure and degree of government regulation. The latter depends in part on the gains from trade that might be available to different nations, based on their costs of net emissions control.

In order to address these questions, organizations such as the OECD could begin work on models of emissions trading: (a) Models of national greenhouse gas limits, with and without trading, for selected national (domestic) applications. (b) Model of international greenhouse gas limits, with and without international trading. In each case scenarios would address whether: limits apply only to CO₂, or to several gases; trading is informal, or formal; trading involves sinks, or not; sales or leases; expiration of allowances; etc. As to international trading, scenarios would also address whether nations trade or private entities trade. The models should allow estimation of environmental impacts as well as economic results.

3. Division of labor: farming out work to those with expertise and interest.

**COST EFFECTIVE POLICY RESPONSES
TO GLOBAL WARMING**

Prepared by:

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May, 1990

8910/papers

**PRELIMINARY DRAFT
DO NOT QUOTE OR CITE
COMMENTS WELCOMED**

COST EFFECTIVE POLICY RESPONSES TO GLOBAL WARMING

I. Introduction

Some gases that make up only a small part of the atmosphere absorb a great deal of the heat radiated by the Earth. The heat absorbed by these trace gases warms the lower atmosphere creating a greenhouse effect. Carbon dioxide is estimated to be responsible for approximately half (49%) of the greenhouse effect. Other gases that contribute to climate warming include: methane (18%), chlorofluorocarbons (14%), nitrous oxide (6%), ozone (6%), and other gases (6%).

Atmospheric concentrations of carbon dioxide have risen by 25 percent since 1800. Atmospheric concentrations of most of the other greenhouse gases have been rising more rapidly than that of carbon dioxide. Increased concentrations of the greenhouse gases in the atmosphere will raise the average temperature, although the speed and extent of the global warming are uncertain.

To study the consequences of global warming, scientists have analysed the consequences of doubling the carbon dioxide concentration in the atmosphere. Global climate models predict that if the carbon dioxide concentration doubles, the average temperature will rise between 1.5 and 4.5 °C. The equivalent of a doubling of carbon dioxide concentrations could occur before the end of the next century unless steps are taken to reduce emissions of greenhouse gases.

Climate warming on this scale poses serious threats to the planet, including rising sea levels, the spread of disease and mass starvation in poor countries and loss of plant species and animal habitats.

Scientists estimate that to stabilize the Earth's climate will entail that current emissions of greenhouse gases, except methane, be cut by at least 60 percent. As an interim target, the Toronto Climate Conference proposed reducing carbon dioxide emissions by 20 percent from 1988 levels by 2005. The feasibility of this target has been studied for a number of countries. Generally it is found to be a very challenging target. Regardless of the specific interim target adopted, stabilizing the Earth's climate poses a formidable challenge. Every possible means of reducing emissions of greenhouse gases will need to be deployed in pursuit of that goal.

Given the scale of the challenge, the policies adopted to meet the interim targets, and ultimately stabilize the climate, will need to be cost-effective. In this paper we draw upon the experience with emissions abatement policies for other pollutants in various countries to mould a composite set of policies which we believe hold promise for encouraging cost-effective, enforceable, international efforts to reduce emissions of greenhouse gases. In contrast to other discussions of this topic we suggest that the most effective approach involves different types of policies targeted on the areas where they work best, but orchestrated to produce the greatest reductions at the lowest cost.

The paper begins by establishing the context for the reduction of greenhouse gases. Next, it briefly reviews what we know about the advantages and disadvantages of cost-effective policies. These insights are then used to propose policies that might be implemented to mitigate global warming at the international level and at the national level. The last section presents our conclusions.

II. The Context

The Intergovernmental Panel on Climate Change (IPCC) is reviewing the scientific evidence on global climate change, assessing the socio-

economic implications of global warming and analysing possible response strategies. Over 70 countries are now participating on the IPCC. The final report of the IPCC is expected to be published in the fall of 1990.

As an outgrowth of the work of the IPCC, discussions on the development of a framework convention on climate change have started. It is expected to involve a convention and protocols for reducing emissions of carbon dioxide and other greenhouse gases. The framework convention is expected to be adopted in 1991 or 1992. Policies for reduction of greenhouse gases should facilitate, and if possible encourage, adherence to the international agreements by as many countries as possible.

Emission Reduction Targets

One component of the convention on climate change is likely to be a set of emission reduction targets specified for each country. Not only has the Montreal Protocol, the international agreement which sets ceilings on production of ozone depleting gases, established the precedent, but several countries have announced plans unilaterally to limit their emissions. Norway has adopted a target of stabilizing CO₂ emissions by 2000, the Netherlands and Canada have committed themselves to stabilizing CO₂ emissions at 1990 levels by 2000, and Great Britain has announced an objective of reducing CO₂ emissions by 30% from projected levels by 2005 (approximately the same as stabilization at 1990 levels).

These are only *interim* targets. Climate stabilization will require a series of progressively more stringent targets until emissions of carbon dioxide and most other greenhouse gases have been cut by over 60 percent from current levels. Control policies for greenhouse gases should recognize the need for further reductions in emissions and be designed to achieve those reductions with a minimum of disruption.

Carbon Dioxide Emission Reduction Options

The dominant anthropogenic source of carbon dioxide emissions is the combustion of fossil fuels. The carbon dioxide emissions vary significantly by fuel type, but they are relatively stable over time and for different combustion conditions. In other words, carbon dioxide emissions can be determined fairly accurately from fuel use.

Studies of options for reducing carbon dioxide emissions consistently show that improved energy efficiency is the most cost-effective strategy available over the next decade or two. In developed countries, reduced use of fossil fuels is likely to be the backbone of the carbon dioxide emissions control strategy. Other options include fuel switching and reforestation. Fuel switching covers both substitution of fossil fuels with lower emissions per unit of energy (e.g., natural gas) for fossil fuels with relatively higher carbon dioxide emissions (e.g., coal) and substitution of non-fossil energy (e.g., hydro-electric, nuclear, solar) for fossil fuels.

The analyses completed to date suggest that fuel switching or reforestation alone could not achieve sufficient reduction in forecast carbon dioxide emissions to meet the proposed interim targets nor those adopted to date. Improved energy efficiency is the most promising means of achieving significant reductions in carbon dioxide emissions over the next two decades. To go beyond the interim targets will require more substitution of non-fossil energy for fossil fuels because of the diminished scope for further efficiency improvements.

Policies to reduce greenhouse gas emissions will need to encourage adoption of the optimum mix of energy-efficiency improvements, fuel switching, reforestation and other measures if the interim and ultimate targets are to be achieved in the most cost-effective manner.

III. Cost-Effective Pollution Control

Cost-Effective Pollution Control

How can the necessary reductions be achieved in a cost-effective manner? What policies will be needed?

The theory of cost-effective pollution control is now well established.¹ Cost-effective control is defined as that allocation which meets the predefined target at minimum cost. Cost-effectiveness is distinguished from efficient pollution control. Efficiency requires that the pollution target maximize the net benefits to society while cost-effectiveness seeks to meet a predetermined target at minimum cost. That predefined target may or may not maximize the net benefits to society.

The conditions that a cost-effective allocation of control must satisfy depend on the nature of the pollutant. If the location of the emissions is important, the pollutants are called nonuniformly mixed. If location does not matter, the pollutants are referred to as uniformly mixed. For uniformly mixed pollutants, it is enough to control the aggregate level of emissions. Greenhouse gases are uniformly mixed pollutants.

For uniformly mixed pollutants a cost-effective allocation is achieved when the marginal control costs are equalized across all sources. It is the total greenhouse gas emission reduction that counts, not where the emissions occur. Equal magnitude reductions in India and Canada would have the same impact on global warming. A cost-effective allocation of

¹ Baumol, William, and Oates, Wallace E., The Theory of Environmental Policy (Englewood Cliff, NJ: Prentice-Hall, 1975). For a textbook treatment see Tom Tietenberg, Environmental and Natural Resource Economics, 2nd ed., (Glenview, IL: Scott, Foresman & Co., 1988).

reductions is achieved when the marginal cost of reductions in India is the same as the marginal cost of reductions in Canada and every other country.

The two primary policy instruments for achieving cost-effective control are emission taxes and transferable emission permits. Traditional command and control regulations generally do not equalize marginal control costs across all sources and so do not achieve cost-effective control.

Emission Taxes

Emission tax approaches involve charging a per unit fee on each unit of pollutant emitted into the atmosphere. They offer the potential for using market forces to produce a cost-effective allocation of the pollution control responsibility, a result not even remotely possible under traditional command-and-control regulation. Why emission charges allow cost-effective control, but standard command-and-control regulations do not, is not difficult to understand.

An important theorem in environmental economics demonstrates that polluters faced with emission taxes will minimize their costs by controlling discharges until the marginal cost of control is equal to the per unit tax. More control would raise costs unnecessarily because the cost of the additional control would exceed the cost of simply paying the tax. Less control would also result in an unnecessarily high cost, because the tax paid on uncontrolled emissions would exceed the cost of eliminating those emissions.

Taken together with the necessary conditions for cost-effectiveness, this theorem implies that forcing all polluters to face the same per unit tax on emissions results in an allocation of the control responsibility that is cost-effective; the marginal costs are equalized by polluters acting to minimize their own costs. Since uniform tax rates may well be perceived as being

more just than differentiated taxes (and therefore administratively easier to implement on a global basis), the finding that uniform taxes are a cost-effective means of reducing emissions is a significant result.

Additional virtues of an emission tax are that it can stimulate the development of environmentally benign technologies and that it can stimulate the reduction, not merely the control, of discharges. Under a command-and-control system based on emission standards, once the source has met the legal standard further effort to reduce emissions is neither necessary nor in its economic interest. With an emission tax, all uncontrolled emissions constitute financial burden. Adopting a new control technology which permits additional emission reductions at reasonable cost is an attractive strategy for a source facing emission taxes, but not for a source currently meeting emission standards. Hence emission taxes stimulate more efforts to control and reduce emissions.

Emission taxes also produce revenue. In Europe, where emission taxes are quite common, most of the revenue has been earmarked for environmental improvement projects related to the taxed emissions.² For example, revenue from taxes on water pollutants has been used to subsidize waste treatment plants.

Emission taxes also have a significant disadvantage. Sources confronted by emission taxes face an additional financial burden that serves to diminish their enthusiasm for the approach. Under traditional command-and-control regulation sources pay only for the required pollution control equipment. With emission taxes, not only do they have to pay for the control equipment, but they also have to pay taxes on uncontrolled emissions. A number of studies have found that the additional financial burden associated with the taxes can be substantial.

² Sweden has already announced an emissions tax for carbon dioxide.

While some tactics to reduce the financial burden of emissions taxes exist (tax rebates or taxing only emissions above a certain level), these tactics have not been very successful in deflecting political opposition. In recognition of, and in response to, this burden industries in the United States have been reluctant to accept an emission tax approach. They fear that the resulting rise in pollution control costs would make them competitively vulnerable in world markets. In Europe concern over the financial burden has not been sufficient to prevent emission taxes from being instituted, but it has served to keep the tax rates lower than economists believe they should be.

Emissions Trading

In the United States, the economic incentive approach to cost-effective pollution control has taken the form of emissions trading. Instead of putting a price on pollution (the concept behind emission taxes), emissions trading sets transferable quantity limits on emissions. Emissions trading begins with traditional command-and-control regulation in which each discharge point is assigned an emissions limit. Sources which voluntarily reduce pollution more than required can have the excess reduction certified as an "emission reduction credit." Certification is handled by the U.S. Environmental Protection Agency. Only those reductions which are demonstrably surplus, quantifiable, enforceable and permanent receive certification. Sources comply with the law by combining sufficient emission reductions and emission reduction credits to meet the legal standard.²

² One way in which this approach was used rather creatively and successfully is called the "offset" policy. In the mid-1970's several geographic regions in the United States found themselves in violation of the ambient air quality standards designed to protect human health. The law provided that new industries would not be allowed to move into those areas if they emitted any amount of the pollutant responsible for the standard being violated. Since even sources adopting the most stringent control technologies would typically have some emissions, in effect the policy prohibited new firms from locating in nonattainment areas. This was a serious political blow to communities eager to expand their employment and tax base. How could they allow economic growth while assuring the air quality would improve to the level dictated by the

Emissions trading shares with emission taxes the characteristic that it promotes both cost effectiveness and technology development. Cost effectiveness is promoted because sources which can reduce their emissions most cheaply choose to do so, selling the resulting emission reduction credits to others. The proceeds can be used by the selling source to finance the additional control. In these transfers the price of the emission reduction credits plays the same role in stimulating cost-effectiveness as does the tax rate in the emission charge system; it encourages a reallocation of control responsibility until the marginal control costs are equalized. Similarly technological progress is stimulated by emissions trading because additional control creates emission reduction credits which can be sold.

One of the most significant characteristics of the emissions trading approach is the opportunity it offers for cost sharing.³ With emissions

ambient standard?

To respond positively to this conflict of goals, regulators adopted the offset policy. Under this policy any firm wanting to move into an area currently in violation of the ambient air quality standard would be required to acquire 1.2 emission reduction credits for each 1.0 unit of emissions added by the new plant. Since the resulting reduction from sources already located in the area from existing sources would necessarily exceed the amount being added by the new source, air quality would improve every time a new firm moved into the area. With this policy the confrontation between economic growth and environmental protection was diffused. New firms were not only allowed to move into polluted cities, but they became a vehicle for improving the quality of air. With the offset policy, economic growth facilitated, rather than blocked, air quality improvement.

³ It is not at all uncommon for some emission sources to be underregulated due to their financial vulnerability. When firms are on the brink of going out of business, regulators are reluctant to subject them to stringent regulations which might push them over the brink. Yet in many cases the cost of securing additional emission reductions from these sources would be substantially lower than the cost of securing further reductions from already controlled sources. Under traditional command-and-control regulations the emissions from financially vulnerable sources would remain uncontrolled while remaining sources would necessarily be controlled to a proportionally higher degree.

trading, sources can voluntarily create emission reduction credits, using the revenue from the sale of those credits to finance the cost of additional control. Meanwhile sources purchasing emission reduction credits find acquiring the credits a cheaper alternative than controlling their own emissions to a correspondingly higher degree. In effect emissions trading separates the financing of emission reductions from the actual implementation of those reductions. The fact that trading reduces compliance costs usually means that improvements are achieved more quickly and with less litigation than with regulated emissions limits.

Emissions trading now covers the gases associated with stratospheric ozone depletion. As part of its strategy to fulfill the requirements of the Montreal protocol, the United States has adopted a system of transferable production and consumption allowances for the controlled substances named by the agreement. To produce (or consume) these substances it is necessary to possess the required number of production (consumption) allowances. The allowances were allocated to current producers (consumers) on the basis of 1986 production (consumption) levels. The amount of production (consumption) permitted by the allowances declines over time in accordance with the reductions mandated by the protocol. By making these production (consumption) allowances fully transferable, the government sought to stimulate technological progress in the area and to facilitate the flow of allowances from those who can most easily find substitutes to those who cannot. As market forces change, the transferability of these allowances assures that the allocation of the control responsibility can adjust to the changes, while assuring continued compliance with the terms of the agreement.

Some Lessons⁴

Because we now have quite a bit of practical experience with using emission taxes and transferable emissions permits, it is possible to extract some lessons from that experience. These lessons provide the background for targeting each component where it works best.

Emissions trading integrates particularly smoothly into any policy structure which is based either directly (through emission standards) or indirectly (through mandated technology or input limitations) on quantitative emission reduction targets. Emissions charges are superior when the policy target can be expressed in monetary terms such as a revenue targets or a marginal damage estimate.

Emissions taxes are superior when transactions costs associated with certification and/or bargaining are high. It appears that much of the trading activity in the United States has involved large corporations. Emissions trading is probably not equally applicable to large and small pollution sources. The transactions costs are sufficiently high that only large trades can absorb them without jeopardizing the gains from trade. For this reason taxes seem a more appropriate instrument when sources are individually small, but numerous (such as residences or automobiles). Taxes also work well as a device for raising revenue to subsidize environmentally benign projects or to replace other revenue-raising mechanisms.

Because emissions trading allows the issue of who will pay for the control to be separated from who will install the control, it introduces an additional degree of flexibility. This flexibility is particularly important when control requirements are very stringent since marginal control costs are so

⁴ This section relies heavily on T.H. Tietenberg, "Economic Instruments for Environmental Regulation," Oxford Review of Economic Policy, Vol. 6, No. 1, (Spring, 1990), pp. 17-33.

high. It also allows the cost of compliance to be apportioned equitably across all sources regardless of their compliance options.

Emissions trading places more importance on operating permits and emissions inventories than other approaches. Firms which have actual levels of emissions substantially below allowable emissions find themselves with a trading opportunity which, if exploited, could degrade air quality. The trading benchmark has to be defined carefully.

There can be little doubt that the emissions trading programme in the U.S. has improved upon the command-and-control programme that preceded it. The documented cost savings are large and the flexibility provided has been important. Similarly emissions charges have achieved their own measure of success in Europe. To be sure the programs are far from perfect, but the flaws should be kept in perspective. Although economic incentive approaches lose their utopian lustre upon closer inspection, they have nonetheless made a lasting, impressive contribution to environmental policy.

Economic Incentives for Greenhouse Gases

Economic incentive approaches should play a substantial role in policies to deal with global warming if for no other reason than that greenhouse gases fall within the domain where economic incentive policies have been most successful. Greenhouse gases are uniformly mixed gases for which economic incentives are appropriate. In addition larger trading areas facilitate greater cost reductions than smaller trading areas. This augers well for the use of emissions trading as part of the strategy to control global warming because the natural trading areas are all very large indeed. Greenhouse gases could (indeed should!) involve trading areas that are global in scope. Finally it seems clear that the pivotal role of carbon dioxide in global warming may require some fairly drastic changes in energy use,

including changes in personal transportation, and ultimately land use patterns. Some form of charges could play an important role in facilitating this transformation.

Finally, economic incentive approaches can reduce costs substantially when standard command-and-control approaches distribute the burden in a particularly cost ineffective way. As Figure 1 indicates, that appears to be the case with global warming. The discrepancies appear to be most pronounced in the industrial and electricity generation sectors. These are precisely the sectors most likely to offer and use large emission reduction credits, the sorts of trades most likely to be economically attractive.

IV. Distributing the Control Responsibility Among Nations

Our proposed approach involves a two-tiered system of policies. The first tier governs the allocation of emission reduction responsibilities among the nations of the world. The second tier allocates the national responsibility for emission reduction among the various within each nation.

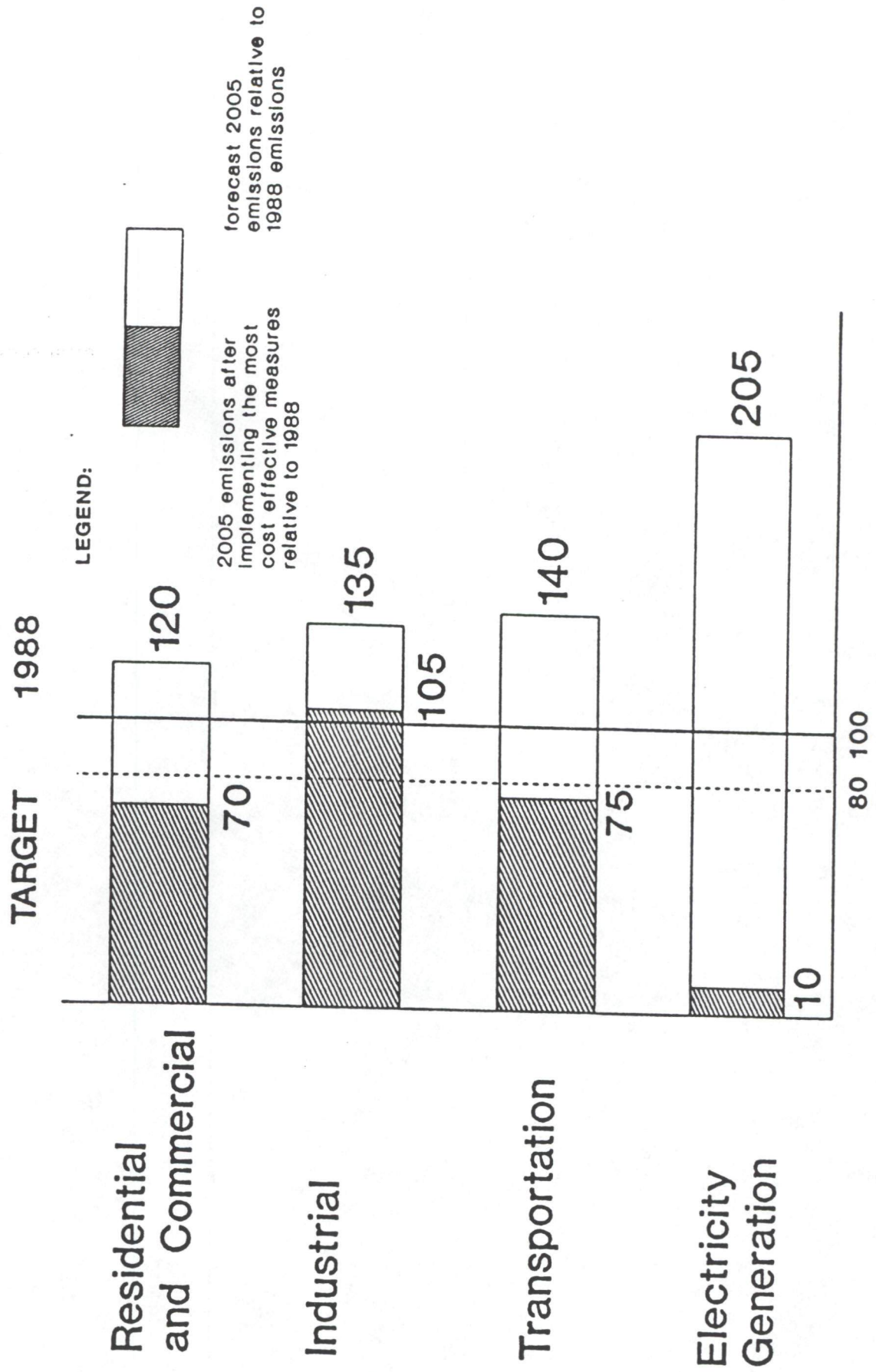
This division has some appealing features. The first tier is handled by international agreements and is subject to international enforcement. The infringement of national sovereignty, however, is limited to the total amounts of greenhouse gases emitted in that country each year. How each country chooses to reach its target is left to its discretion; the second tier policy is determined entirely by that nation.

National Emissions Targets

As indicated earlier, we believe that international agreements on global warming are likely in the near future and that these will contain specific aggregate annual emission targets for greenhouse gases with deadlines for compliance. Those interim targets are likely to be reduced several times in

FIGURE 1

IMPACTS OF MOST COST-EFFECTIVE MEASURES



Source: Calculated from The DPA Group Study on the Reduction of Energy-Related Greenhouse Gas Emissions, March 1989.

the future before the climate is stabilized. The compliance procedures will require updated emissions inventories sufficiently detailed that they can be verified.

It is likely that the national targets embodied in the international agreements will not distribute the control burden among countries in a cost-effective manner. One possibility that has been discussed, for example, is to set targets for developing countries above current emission levels. To achieve a given global reduction, developed countries would then need to cut their emissions by more than this overall target. This implies zero marginal cost of emissions reduction for developing countries and positive marginal costs of emission reduction for developed countries. The marginal costs of emissions reduction are not equal for all sources, so the control burden is not allocated in a cost-effective manner. However fair this approach is, it is certainly not cost-effective.

Nations with the lowest cost means of reducing emissions will not be exploiting those opportunities. Many countries which have low marginal costs of emission reduction also have few resources to devote to environmental protection. Eastern European and Third World Nations fit in this category. The costs of achieving the targets in the international agreements will be unnecessarily high unless economic incentive approaches are adopted.

Emission Permits are Better

While in principle either emissions taxes or transferable emission permits could solve the problem, we believe that emission permits have the edge internationally. Since they are quantity based, emission permits are completely and immediately compatible with quantity-based international

agreements. Emissions trading can produce a cost-effective outcome without imposing an extra financial burden.⁵

Emissions trading can also facilitate international cost-sharing in a manner which encourages the full participation of both Eastern European and Third World nations. If the carbon dioxide reduction targets for developing countries are less stringent than those for developed countries, emissions trading can create an economic incentive for Eastern European and Third World countries to become signatories to the international agreements.

To demonstrate how this would work, consider an example. Suppose Malawi can reduce carbon dioxide emissions for \$1,000 per unit while Canada could reduce emissions for \$4,000 a unit. Suppose that according to the international agreement, Malawi is in compliance while Canada needs further reductions to meet its target.

With emissions trading, Malawi could control more than required by the international agreement, selling the excess to Canada. The sale of the credits would supply the funds to more than cover the Malawian surplus control (say \$1,500 per unit). Canada would also be better off. By purchasing these credits at \$1,500 per unit it eliminates the need to spend \$4,000 per unit to meet its requirements. The costs of compliance have been

⁵ Emission taxes impose a large financial burden that can be avoided by emission permits. The tax payments would be very large indeed, perhaps even larger than the financial outlays on control equipment or energy efficiency. These burdens diminish national enthusiasm for participating in the agreements, not only for Eastern European and Third World Countries, but for the United States and other countries with demonstrated aversions to tax increases.

The emission tax necessary to reach the international target would have to be estimated. Furthermore since each nation would have a different emission reduction assignment, the tax rate compatible with that assignment would differ from nation to nation. But from the previous discussion we know that different tax rates cannot allocate the responsibility for control cost-effectively.

substantially lowered and both countries benefit economically. The economic benefits may induce more countries to participate.

Certification of Emission Credits

In principle an international agency could be designated to certify emission credits for international trade. A country would need to demonstrate that its emission reductions exceeded its agreed target, are permanent, are enforceable under its laws and can be reliably quantified in order to receive certification from the designated agency. The certification process would need to be backed by appropriate international sanctions. This approach entails a considerable surrender of sovereignty by participating nations and the creation of an international bureaucracy.

The alternative is to rely on each country's own certification process. This gives rise to two concerns, namely that:

- the certification process for emissions permits will not be equally rigorous in all countries; and
- countries may sell permits based on future reductions and then not be able to achieve those commitments.

These issues are examined in turn.

Each country that wishes to participate in an international emissions permit trading system will need to establish its own certification process and national emissions trading system. Once they are in place, each country can decide which permits from other countries it will choose to allow in its system. The analogy of inspection standards for foodstuffs is appropriate. Each country decides which foodstuffs can be imported on the basis of the inspection system in the country of origin. In some cases the importing

country sends inspectors to the processing plants in the exporting countries. Similar arrangements are likely to evolve for international trades in carbon dioxide emission permits.

The concern over the sale of emission permits that involve future reductions can be addressed in a straightforward manner. Countries with surplus allowable emissions could create permits to reflect the reductions from target already achieved. Some countries might choose to restrict the purchase of emissions credits from other countries to emissions reductions already achieved.

We believe that reliance on the domestic certification processes is the more likely alternative.

IV. National Policies

The first-tier policy establishes the allocation of responsibility among nations. Each country would limit its emissions to the amount authorized by the international agreement plus the net amount of emissions credits purchased from and sold to other countries. It is our belief that the best policy mix for reaching that target would combine emission taxes in some sectors with emissions trading in others. The policy measures best suited to each sector are reviewed below.

Transportation Sector

In the transportation sector carbon dioxide emissions vary with the type and quantity of fuel used. To influence fuel use so as to obtain a cost-effective reduction of emissions in this sector, there are three options:

- emission taxes;

- emission permits for consumers; or
- emission permits for fuel distributors.

These options are discussed below.

First, it should be noted that energy efficiency standards for vehicles are not a substitute for emission taxes or emission permits. Emissions are related to total fuel use which is the product of vehicle fuel efficiency and distance travelled. Fuel efficiency standards do not determine the distance travelled and so have only a partial influence on emissions. An emissions tax or emissions permit is needed to influence distance travelled. Energy efficiency standards are compatible with emission taxes and permits.⁶

An emissions tax (carbon tax) would raise the cost of fuel and so reduce the distance travelled. An emissions tax alone or in combination with vehicle energy efficiency standards, could achieve a 20 to 25 percent reduction from current transportation fuel use and hence carbon dioxide emissions by 2005. They also move vehicle design in the direction needed to achieve further reductions in emissions beyond the interim target.⁷

To restrict carbon dioxide emissions to target levels, individual consumers would need to be issued with fuel coupons to control their purchases. Emissions permits would be issued for unused fuel coupons.

⁶ A tax may be needed to make the energy efficiency standards effective.

⁷ Non-fossil transportation fuels--ethanol from biomass, electricity and hydrogen--contain less energy per unit weight when stored in a vehicle (e.g., a charged battery) than gasoline or diesel fuel. Improvements in vehicle fuel efficiency will allow vehicles to operate in the manner that owners expect (e.g., trip length and refueling frequency) with less total energy, thus minimizing the disadvantage of the non-fossil fuels.

Implementing an emissions trading system at the consumer level would require an equitable system for distributing fuel coupons. The distribution system for fuel coupons gives rise to a number of issues. For example, should coupons be distributed to drivers or to vehicles? Should commercial drivers/vehicles receive larger allocations? No doubt, these issues can all be resolved satisfactorily.

Two markets would probably arise. A market for fuel coupons as a right to purchase fuel and a market for fuel coupons for conversion to emissions permits. The fuel coupons would probably attract a higher price as a right to purchase fuel.⁸ The demand for gasoline is relatively inelastic and there are few substitutes. On the other hand, many other options for reducing carbon dioxide emissions are available. In short, the fuel coupons are more likely to serve as a basis for allocating available transportation fuels than as a means of achieving further reductions in carbon dioxide emissions.

The carbon dioxide emissions of the transportation sector could also be controlled by limiting the supplies of transportation fuels--gasoline, diesel, aviation turbo, propane for vehicles--at the distributor level. Since the objective is to reduce carbon dioxide emissions, the quantity of fuel supplied must be reduced. The result would be periodic shortages or price increases for transportation fuels. Shortages and/or price rises would be unpopular with the public and would undermine support for the carbon dioxide reduction effort.

Distributors of transportation fuels could purchase emissions permits to enable them to supply larger quantities of fuel. The prices of the permits would be passed on to customers in higher fuel prices. In equilibrium the cost per unit of fuel of the emissions permits purchased should be equal to

⁸ A high carbon or environmental tax may reduce the demand for transportation fuels to the point where this is not the case. Then it is the taxes that achieve the emissions reduction. The fuel coupons serve little purpose.

the emissions tax needed to achieve the same reduction. Rising prices and/or shortages would create public pressure for exemptions or abandonment of the system.

In summary, the transportation sector offers three options:

- emission taxes;
- fuel coupons; or
- emissions trading by fuel distributors.

The first option appears to be the best. It can achieve the desired reduction in carbon dioxide emissions alone or in combination with legislated fuel performance standards with virtually no administration. It also leads vehicle design in the direction needed to achieve further reductions in emissions beyond the interim target.

A system of fuel coupons is likely to generate a market for fuel coupons as such rather than yield further reductions in carbon dioxide emissions. Introducing emissions trading at the distributor level is likely to lead to rising fuel prices and possibly shortages. In short, the role of emissions trading in achieving a target reduction in carbon dioxide emissions from the transportation sector is likely to be small.

Residential Sector

In the residential sector carbon dioxide emissions are dominated by the use of fossil fuel for space heating and, to a lesser extent, space cooling and water heating. Use of electricity for appliances has an indirect impact on carbon dioxide emissions through electricity generation. The carbon dioxide

emissions of the sector are directly related to the quantities of the various fossil fuels used.

The options for reducing the carbon dioxide emissions of the residential sector are analogous to those discussed for the transportation sector. Fuel coupons would be needed to control the emissions of individual households. The coupons would reduce fuel use from current levels. Poor management on the part of the homeowner or unusual weather patterns could leave individual households without fuel during cold weather or heat waves, with possible health consequences for young children, the sick and the elderly. The consequences of fuel shortages, even if due to poor planning by the homeowner, are likely to be publicly unacceptable.

Instituting emissions trading at the distributor level for home heating fuels creates the likelihood of price increases and the possibility of shortages. Again, the consequences are not acceptable.

An emissions (carbon) tax, alone, or together with energy efficiency standards for residential buildings and appliances, can reduce energy consumption by 20 to 25 percent from current levels in the residential sector. The interim target reduction in carbon dioxide emissions can be achieved with little administration through such taxes. The emissions taxes and energy performance regulations would help move building and equipment technology in the direction needed to achieve further reductions in carbon dioxide emissions.

The best option for the residential sector, as with the transportation sector, appears to be improved energy efficiency through emission taxes alone or in combination with energy efficiency standards.

Commercial Sector

Fossil fuel in the commercial sector is used primarily for space heating and cooling. Emission taxes alone, or in combination with energy efficiency standards for buildings and equipment can achieve significant reductions in fuel use and carbon dioxide emissions.

Commercial sector installations can be large sources of carbon dioxide. The possibility of emissions trading may be attractive for such sources. In many instances commercial buildings would convert from fossil fuel to electricity. This might raise carbon dioxide emissions of the electricity utility.

Commercial facilities above a specified size (annual energy use or fossil fuel consumption) would be assigned an individual carbon dioxide emissions reduction target. This target, say a 20 to 25 percent reduction, would be calculated in relation to base year fuel use. Reductions beyond the target reduction could be certified for emissions trading purposes. However, the additional reductions would first be offset by any increase in carbon dioxide emissions imposed on the electric utility or other energy supplier.⁹

The net emissions reduction achieved could be certified annually on the basis of actual results. Or, in the case of a permanent conversion of a heating or air conditioning system, the net emissions could be cumulated over the remaining life of the existing system. Any new facilities above the specified size would need to purchase permits for any emissions generated.

Small commercial facilities could be handled in the same manner as the residential sector.

⁹ The offset is a matter of policy, but it seems unfair to allow a firm to benefit financially through the sale of emissions credits while having transferred the compliance burden to the electric utility. The offset provision would prevent such inequities.

Industrial Sector and Electric Utilities

Industrial plants and fossil-fueled electric generating stations above a specified size are obvious candidates to participate in an emissions trading program. Each facility or firm would be assigned a carbon dioxide emissions reduction target related to the national target.¹⁰ Reductions beyond the target could be offset by any increase in carbon dioxide emissions imposed on the electric utility or other energy supplier.¹¹ The net reduction achieved could be certified for emissions trading purposes.

The net emissions reduction achieved could be certified annually on the basis of actual results. Or, in the case of a permanent conversion of a heating or air conditioning system, the net emissions could be cumulated over the remaining life of the existing system. Any new facilities above the specified size would need to purchase permits for any emissions generated.

In summary, emissions trading is best suited to large commercial, industrial and utility sources. Existing sources of carbon dioxide emissions are treated as having a right to continue such emissions at a reduced level for the remaining life of the facility. This right can be used or sold. All new sources have to purchase emissions permits. The supply of emissions permits from existing sources will decline as those facilities go out of service. Government then becomes the principal source of permits and it can limit the supply to meet future reductions in the target for carbon dioxide emissions.

¹⁰ The targets could be set for each plant or firm (multiple plants). If they are set on a firm basis, the firm can "trade" emissions internally without having to go through the certification process. The difficulty that can arise in setting targets on a firm basis is that the national target may be apportioned among states and plants may be located in different states.

¹¹ An emissions permit could be issued for switching from a fuel with higher carbon dioxide emissions per unit of energy (e.g., coal) to a fuel with lower emissions (e.g., natural gas).

Emissions taxes, alone or in conjunction with energy performance standards, are the best means of reducing carbon dioxide emissions from the numerous small sources in the residential and transportation sectors. Emissions taxes are notoriously difficult to implement and, once implemented, to change. We suggest that the emissions taxes for the residential, small commercial and transportation sectors be linked to the market price for emission permits. For example, the price of emission permits, expressed in dollars per ton of carbon, during the second and third quarters of one year would determine the emission tax for the first half of the following year. This ensures equitable treatment for all sources.

V. Extension to Other Greenhouse Gases

Assuming an emissions trading system is operating nationally for carbon dioxide, should it be extended to other greenhouse gases or to reforestation? This section addresses those questions.

Methane

Methane is the second largest contributor to the greenhouse effect. The principal man-made sources are: leaks from petroleum and natural gas production, transmission and distribution; seepage from land fill sites; dissociation from coal as a result of mining activity; and sewage treatment. Collection and combustion of such fugitive methane reduces the greenhouse effect because methane is 21 times as potent as carbon dioxide in terms of its climate impact.¹²

Currently measures to control methane emissions apply primarily to the petroleum and natural gas industry. Natural gas is essentially pure methane,

¹² Potency is expressed on a per molecule basis.

so there is an economic incentive to reduce emissions. Methane emissions are lost product and hence lost revenue. The transmission and distribution system are carefully monitored to detect leaks because they can cause explosions.¹³ Methane emissions from the transmission and distribution systems are, as a result, relatively small.

Most of the methane emissions by the petroleum and natural gas industry occur at the production stage. Natural gas may be released during testing of new wells. Natural gas is also obtained as a by-product from oil wells. If there is no natural gas collection system near the oil well, the by-product gas is usually released or burned. Regulatory authorities in producing areas have strict rules governing release of natural gas in these circumstances.

Regulations governing methane emissions from coal mines, landfills, sewage treatment plants and other sources can also be found. These regulations are aimed at preventing the accumulation of explosive or toxic concentrations of methane. Where fugitive methane is collected to comply with such regulations it is usually vented or flared. Markets for fugitive methane from these sources are scarce, since it generally does not meet quality standards for natural gas fuel. An emission trading system could provide an economic incentive to collect and use fugitive methane.

In principle, extension of a carbon dioxide emissions trading system to methane provides a cost-effective mechanism for reducing fugitive methane emissions and so mitigating the greenhouse effect. To extend the carbon dioxide emissions trading system to methane, it is necessary to measure the reduction from allowable emissions actually achieved.

¹³ Concentrations of methane in air of 4.5 to 14.0% are explosive.

Current emissions of fugitive methane by specific sources are not known. Apart from the petroleum and natural gas industry, the current recovery of fugitive methane emissions is known; in most cases it is zero but in the few cases where it is recovered the amount recovered can be measured. A base methane emission rate can be established before, or at the time of, installation of collection system.

Tradeable emissions permits could be issued for any fugitive methane recovered and used beyond the prescribed reduction up to the base emission rate. Methane equivalent to the target share of base emissions would need to be recovered and used before emissions credits are awarded.¹⁴ Additional methane recovered and used, up to the base emission rate, could be converted to tradeable emissions permits.

Permits could be issued annually for the methane recovered and used during the previous year. Sale of the recovered methane as natural gas or combustion of the recovered methane for space heating, electricity generation or other uses would constitute evidence of combustion. The methane eligible for a tradeable emission permit could be converted to a carbon dioxide equivalent. The equivalence factor would reflect the relative potency of methane in terms of climate warming and its shorter atmospheric lifetime.

The base emission rate must be established before, or at the time that, the collection system is installed because the rate of methane generation from landfills, coal mines, and some other sources can be manipulated. Thus the methane collected could exceed the base rate by a significant margin. Limiting the emissions permits to the difference between the base

¹⁴ This is a policy option. Sources of CO₂ emissions would be required to reduce their emissions to achieve the interim target at their own expense. The analogy is that a similar share of the fugitive methane is recovered at the owner's cost.

emission rate and the allowable emissions would prevent abuse of the system.

The system outlined would exclude the petroleum and natural gas industry because of the difficulties of establishing a base emissions rate. However, it already has regulatory and economic incentives to reduce natural gas leakage.

Chlorofluorocarbons

Chlorofluorocarbons (CFCs) are the third largest contributor to the greenhouse effect. CFCs are also the major cause of the depletion of the stratospheric ozone layer. An international agreement--the Montreal Protocol--has been negotiated to reduce the production of CFCs by 50 percent during the 1990's. Scientific opinion is that larger cutbacks will be needed to protect the ozone layer and several countries have announced their intention to go beyond the Montreal Protocol.¹⁵

Including CFCs in a carbon dioxide emissions trading system would provide an economic incentive to reduce those emissions even more quickly. The difficulty with including CFCs in an emissions trading system is that there are millions of small emissions; leaks from refrigerators or automobile air conditioners, releases from aerosol sprays and CFCs that escape from foams as they are crushed.

All CFCs are man made. There are no natural sources and there are no commercial destruction technologies for CFCs. The Montreal Protocol reduces emissions of CFCs by restricting their **production**. To include CFCs in an emissions trading system, a tradeable permit could be based on lower

¹⁵ The Montreal Protocol is scheduled to be formally updated in London in June, 1990.

than permitted production. Since the Montreal Protocol only defines production ceilings for specific dates, a more precise definition of allowable production each year would be needed to determine the tradeable emissions credits. The foregone production would be assumed to be the least potent of the CFCs. If a commercial destruction process is developed for CFCs, tradeable emissions permits could be issued for the quantities collected and destroyed.

Whether based on foregone production, actual destruction, or both, tradeable emission permits could be issued annually for actual performance during the previous year. Initially, the equivalence of CFC emissions could be based on CFC-11 which is estimated to be 12,000 times as potent as carbon dioxide in terms of its climatic impact on a per molecule basis. However, as production of CFCs is phased out during the 1990's, it will become appropriate to shift the conversion to the "soft" chlorofluorocarbons (HCFCs) currently being developed as substitutes.¹⁶

Nitrous Oxide and Tropospheric Ozone

Two significant contributors to global warming (nitrous oxide and tropospheric ozone) do not lend themselves to inclusion in a greenhouse gas emission trading system. Not enough is known about the sources and possible control technologies for nitrous oxide at this time to provide a basis upon which permits can be issued.

¹⁶ Soft chlorofluorocarbons contain hydrogen and/or do not contain chlorine or bromine. They react with hydroxyl radicals found in the lower atmosphere thereby degrading more quickly, often before reaching the stratosphere. CFCs which contain only fluorine, rather than chlorine or bromine, do not pose a threat to the ozone in the stratosphere. The "soft" CFCs, like today's CFCs, are greenhouse gases. The objective of the current international agreement on CFCs is to reduce the destruction of the stratospheric ozone layer. Soft CFCs help achieve that objective, but they still contribute to the greenhouse effect. A switch to soft CFCs means that these gases contribute primarily to the greenhouse effect, rather than ozone depletion. This is another reason for including CFCs in a CO₂ emissions trading system.

Ozone is formed in the troposphere rather than emitted, so emissions trading for ozone itself is not possible. The precursors of tropospheric ozone are nitrogen oxide (NO_x) and volatile organic compounds (VOCs) but the relationship between emissions of NO_x and VOCs and ozone formation is complex. Under some circumstances, reducing NO_x emissions can increase ozone formation. The same applies to emissions of VOCs. Finally, ozone is relatively short-lived and so is more of a regional than a national or global problem.

Reforestation

Growing forests absorb carbon dioxide and sequester it until the tree decays or is burned. The rate of carbon dioxide absorption varies significantly by species and climate. Unless there is a commitment to maintain the forest on a sustainable yield basis in perpetuity, reforestation only sequesters the carbon dioxide temporarily. Temporarily in this case can be 50 to 150 years. That is a significant contribution to dealing with the mitigation of global warming.

In temperate climates reforestation is currently a relatively costly approach to reducing atmospheric concentrations of carbon dioxide. The ability to earn tradeable emissions credits would improve the economic attractiveness of this option. Reforestation could create employment in areas that are adversely affected by other measures to reduce emissions of greenhouse gases. Hence, efforts should be made to include reforestation in a carbon dioxide emissions trading system.

Permits could be based on annual or bi-annual "audits" of forest growth actually achieved and estimated carbon dioxide sequestered, with an appropriate discount to reflect the fact that the carbon dioxide probably will not be sequestered permanently. Permits would be restricted to net

increases in forest growth. For example, pulp and paper or lumber companies would need to replace all trees harvested before becoming eligible for emissions permits.¹⁷ It might be necessary to apply this requirement on a cumulative basis from the inception of the program to preclude abuse through years of low activity followed by a period of intensive reforestation.

VI. Conclusions

The advantages of economic incentive approaches in helping to achieve environmental goals at the lowest overall cost are well known. They reduce compliance costs, encourage the development of more environmental benign technologies, and facilitate international cost-sharing where appropriate.

The climate for using economic incentive approaches is supportive. The problem of global warming is so serious that action is likely. Compliance costs are high so the importance of cost-effectiveness as a policy objective is elevated. Greenhouse gases are uniformly mixed pollutants, the type of pollution problem where economic incentive approaches work best. And finally, cost-sharing will probably be an essential component of any international agreement as the condition for participation by Eastern European and Third World countries.

If, as we expect, future international agreements on global warming adopt as their modus operandi, quantitative limits on greenhouse gas emissions from each nation, we believe that the policy objectives can be best achieved by adopting a two-tier policy process. The first tier would allow trading of emission reduction responsibilities among nations. Allowing

¹⁷ This same restriction would apply to other firms and individuals, such as utilities that clear rights-of-way.

responsibilities to be transferable would facilitate lower compliance costs and market-driven cost sharing. It would also provide economic incentives for countries to become signatories to the agreements.

The second tier of policies, designed to achieve the emissions target determined by the first tier, could also promote cost-effectiveness by selectively targeting emissions taxes and emissions permits at those sectors where they are most appropriate. We find emissions taxes to be better suited to sources with relatively small emissions; vehicles, households and small commercial establishments. Tradeable emissions permits are better suited to large sources such as large commercial and industrial establishments and fossil-fired electricity generating stations.

A carbon dioxide emissions trading system could, in our judgement, be extended to include methane and CFCs as well as reforestation.

We live in an age when the call for tighter environmental controls intensifies with each new discovery of yet another injury modern society is inflicting on the planet. But resistance to additional controls is also growing with the recognition that compliance with each new set of controls is more expensive than the last. While economic incentive approaches to environmental control offer no panacea, they frequently do offer a practical way to achieve environmental goals more flexibly and at lower cost than more traditional regulatory approaches. That is a compelling virtue.